

School Of Humanities, Social Sciences and Management
National Institute of Technology, Karnataka



SUBJECT: DATA ANALYTICS: BUSINESS
DECISION MAKING

PROJECT REPORT ON
IMPACT OF EXCHANGE RATES ON INTERNATIONAL
TRADE IN INDIA”

GROUP MEMBERS

Names	Roll No.'s
Puneet Shivhare	211MT041
Anusha	211MT035
Vishnu	
Jayavaram Harika	235SM026

Abstract

The relationship between exchange rate fluctuations and international trade volumes is critical for understanding India's economic dynamics in a globalized context. This study investigates the impact of exchange rate changes on India's international trade—specifically exports and imports—over the period from 2009 to 2023. By examining the trade volume responses to fluctuations in exchange rates, this study seeks to determine the extent to which changes in currency valuation affect trade behavior, thereby influencing broader economic indicators. The analysis employs a combination of econometric methods, including regression analysis and time-series modeling, to identify patterns in trade volumes relative to exchange rate movements. Findings from this study could offer valuable insights into the implications of exchange rate policy on trade balance, guiding policymakers in managing currency fluctuations in alignment with economic goals. Furthermore, the study explores external factors, such as global economic conditions and domestic economic policies, which may mediate the relationship between exchange rates and trade volumes. Through a thorough investigation, this research intends to contribute to the broader discourse on economic stability and growth in emerging economies like India.

Introduction

Indian exports have come a long way from the time of independence in terms of value. The total value of India's merchandise exports increased from USD 1.3 billion in 1950-51 to USD 63.8 billion in 2003-04 – a compound rate of 7.6 percent. The major trade policy changes in the post-1991 period included simplification of procedures, removal of quantitative restrictions, and substantial reduction in tariff rates. A significant development in the current account of the balance of payments in the 1990s was the remarkable growth in the exports of invisible to the rest of the world. This was made possible by unfrequented growth in information and communication-related services like computer software, hardware, internet, e-commerce, and telecommunication sector. The economic reforms process introduced in 1991 with a focus on liberalization, openness, transparency, and globalization has enabled increased integration of the Indian economy with the rest of the world. The growth rate of India's trade is increasingly dependent on exogenous factors such as world trade growth (especially those of the trading partners), international price changes, and development in the competitor countries. Cross-currency exchange rates and dollar-rupee exchange rate movements are also reflected in the performance of India's trade.

Problem statement

The study aims to investigate how fluctuations in exchange rates influence India's exports and imports, analyzing the trends and structural changes in trade during the period 2009 to 2023. The research will focus on understanding the extent to which the exchange rate impacts the value of India's international trade, and how this relationship has evolved over the last 15 years.

Dependent Variable: India's International Trade Volume (Exports and Imports)

Independent Variables: Exchange Rates, Inflation Rates, Interest Rates, GDP Growth, Global Economic Conditions.

Objective:

To analyze the impact of exchange rate fluctuations on India's export and import volumes between 2009 and 2023.

Hypothesis:

Null Hypothesis (H_0): There is a significant relationship between exchange rate fluctuations and India's international trade volumes (exports and imports).

Alternative Hypothesis (H_1): There is no significant relationship between exchange rate fluctuations and India's international trade volumes (exports and imports).

Data analysis and result interpretation

6 . summarize

Variable	Obs	Mean	Std. dev.	Min	Max
inflation_~r	14	5.674749	2.61585	2.279588	10.52603
taxes_inte~e	10	11.51045	3.481412	4.508555	14.8663
trade_gdp	14	46.36634	6.03507	37.75811	55.79372
ppp_conver~r	14	18.35598	2.523382	13.36609	20.7279
total_debt~e	14	10.15249	4.120635	6.01841	18.62962
taxes_good~s	10	29.02729	6.212983	21.67563	40.86735
net_trade_~s	14	-8.11e+10	3.41e+10	-1.36e+11	-8.34e+09
merchandise~e	14	33.43266	5.972468	24.28591	43.0349
foreign_dirt	14	1.785784	.3904708	1.312935	2.65159
exports_go~s	14	4.84e+11	1.21e+11	2.61e+11	7.68e+11
imports_go~s	14	5.65e+11	1.35e+11	3.28e+11	9.02e+11
net_barter~s	13	93.61665	6.035739	86.34178	105.3212
gdp_per_capa~a	14	6647.992	1257.281	4738.649	8594.432
gross_fixe~l	14	30.49838	2.377103	27.32432	34.31342
real_effec~e	0				
resid	10	2.98e-09	.4175831	-.8265366	.670747
y_hat	14	30.49838	2.318516	27.29755	33.9575
exports_im~n	14	2.89e+23	1.46e+23	8.56e+22	6.93e+23
log_exports	14	26.87667	.2544989	26.2872	27.36659
log_imports	14	27.03495	.2357576	26.51706	27.52822
log_gdp_pe~a	14	8.784892	.1940683	8.463508	9.058869
cooksd	14	.1968115	.3020159	.0019198	1.003196
log_gross_~l	14	3.414898	.076999	3.307777	3.535537
obs_num	14	7.5	4.1833	1	14

The summary statistics show the mean, standard deviation, minimum, and maximum values for various variables across 14 observations. For example, inflation has an average of 5.67, with a range from 2.28 to 10.53, while total debt service has an average of 10.15, with values ranging from 6.02 to 18.63. Other key variables such as GDP per capita and exports also show a range of values with relatively consistent averages, indicating some variation in the data. Net trade and exports/imports have very high values, with large ranges, while foreign direct investment shows moderate variation.

```

22 . pwcorr inflation_gdp_deflator exports_goods_services imports_goods_services me
> rchan
> dise_trade total_debt_service gdp_per_capita gross_fixed_capital, sig

```

	inflat~r	export~s	import~s	mercha~e	total~e	gdp_pe~a	gross~l
inflation_~r	1.0000						
exports_go~s	-0.1071 0.7155	1.0000					
imports_go~s	0.0178 0.9519	0.9707 0.0000	1.0000				
merchandise~e	0.4687 0.0910	-0.0600 0.8387	0.1260 0.6677	1.0000			
total_debt~e	-0.6784 0.0077	0.0349 0.9057	-0.1213 0.6796	-0.3693 0.1938	1.0000		
gdp_per_ca~a	-0.4407 0.1148	0.8445 0.0001	0.7306 0.0030	-0.5536 0.0400	0.2571 0.3749	1.0000	
gross_fixe~l	0.7709 0.0012	-0.3927 0.1649	-0.1985 0.4963	0.7365 0.0027	-0.6562 0.0108	-0.7567 0.0017	1.0000

The correlation matrix shows the relationships between various economic variables:

- **Inflation and exports** have a very weak negative correlation (-0.1071), meaning inflation has little impact on exports.
- **Imports and exports** are strongly positively correlated (0.9707), suggesting that as imports increase, exports tend to increase as well.
- **GDP per capita** is strongly positively correlated with **exports** (0.8445) and **imports** (0.7306), meaning higher GDP per capita is associated with higher exports and imports.
- **Gross fixed capital** has a strong positive correlation with **inflation** (0.7709), indicating that as inflation increases, investment in fixed capital tends to increase as well.
- **Total debt service** is negatively correlated with **GDP per capita** (-0.4407), suggesting that higher GDP per capita is associated with lower debt service.

```

33 . regress gross_fixed_capital inflation_gdp_deflator exports_goods_services impo
> rts_g
> oods_services merchandise_trade total_debt_service gdp_per_capita

```

Source	SS	df	MS	Number of obs	=	14
Model	69.8817134	6	11.6469522	F(6, 7)	=	22.80
Residual	3.57633928	7	.510905612	Prob > F	=	0.0003
				R-squared	=	0.9513
				Adj R-squared	=	0.9096
Total	73.4580526	13	5.65061943	Root MSE	=	.71478

```

> -----
> gross_fixed_capi~l | Coefficient Std. err.      t      P>|t|      [95% conf. inter
> val]
> -----
> -----
inflation_gdp_de~r |   .0862902   .1706588    0.51   0.629   -.3172537   .489
> 8341
exports_goods_se~s | -1.53e-11   1.51e-11   -1.01   0.345   -5.11e-11   2.05
> e-11
imports_goods_se~s |  3.29e-11   1.32e-11    2.48   0.042    1.57e-12   6.42
> e-11
merchandise_trade | -.2313622   .1655341   -1.40   0.205   -.6227882   .160
> 0639
total_debt_service | -.064287   .0817547   -0.79   0.457   -.2576061   .129
> 0321

```

1. R-squared (0.9513): This value indicates that 95.13% of the variation in gross fixed capital is explained by the independent variables in the model. This high percentage suggests a strong model fit, showing that the selected variables are good predictors of the dependent variable.
2. Adjusted R-squared (0.9096): Adjusted R-squared accounts for the number of predictors and only increases if new variables enhance the model. Here, 90.96% is still strong, confirming the robustness of the model after adjustment.
3. P-value (Prob > F = 0.0003): A very low p-value for the overall model (< 0.05) means the regression model is statistically significant, indicating that the predictors collectively have a significant effect on the outcome.
4. Key Coefficients:
Imports of Goods and Services:
 - Coefficient: 3.29e-11
 - P-value: 0.042 (statistically significant at the 5% level)

- Interpretation: As imports increase, there is a positive impact on gross fixed capital. This suggests that an increase in import activities contributes positively to capital investment.

GDP per Capita:

- Coefficient: -0.0032436
- P-value: 0.066 (borderline significant)
- Interpretation: A slight negative relationship is observed, where an increase in GDP per capita may result in a minor decrease in gross fixed capital. This result could indicate resource allocation complexities as per capita income grows.

5. Non-Significant Variables:

- Variables like inflation, exports, merchandise trade, and total debt service have p-values greater than 0.05 , showing they are not significant predictors within this model.

6. Residuals (Root MSE = 0.71478):

- This measures the average deviation of actual values from the predicted values. A smaller Root MSE indicates a better fit; here, it shows that the model's predictions are reasonably accurate.

```

34 . regress log_gross_fixed_capital inflation_gdp_deflator log_exports log_imports
> merc
> handise_trade total_debt_service log_gdp_per_capita

```

Source	SS	df	MS	Number of obs	=	14
Model	.072788077	6	.012131346	F(6, 7)	=	19.81
Residual	.004286904	7	.000612415	Prob > F	=	0.0005
				R-squared	=	0.9444
				Adj R-squared	=	0.8967
Total	.077074981	13	.005928845	Root MSE	=	.02475

	Coefficient	Std. err.	t	P> t	[95% conf. inter	
log_gross_fixed~1					val]	
inflation_gdp_de~r	.0074914	.0073665	1.02	0.343	-.0099276	.024
log_exports	-.4056462	.2553212	-1.59	0.156	-1.009385	.198
log_imports	.5053454	.3171047	1.59	0.155	-.2444881	1.25
merchandise_trade	-.0005919	.0092169	-0.06	0.951	-.0223863	.021
total_debt_service	-.0008426	.0029765	-0.28	0.785	-.0078808	.006
log_gdp_per_capita	-.2632751	.5155944	-0.51	0.625	-1.482462	.955
_cons	2.954005	4.201488	0.70	0.505	-6.980935	12.8

Interpretation of the Regression Table (Log-Transformed Model):

1. R-squared (0.9444): Indicates that 94.44% of the variation in the log of gross fixed capital is explained by the model. This is a strong fit, similar to the first model.

2. Adjusted R-squared (0.8967): After adjusting for the number of predictors, 89.67% of the variability is still explained, which confirms the reliability of the model.

3. P-value (Prob > F = 0.0005): The model as a whole is statistically significant, with a p-value well below 0.05.

4. Key Coefficients:

Log of Imports:

- Coefficient: 0.5053454
- P-value: 0.155 (not statistically significant)
- Interpretation: Although not significant, there is a potential positive impact of imports on the log of gross fixed capital, suggesting that

proportional changes in imports may lead to corresponding changes in capital formation.

Log of Exports:

- Coefficient: -0.4056462
- P-value: 0.156 (not significant)
- Interpretation: The negative coefficient suggests that increases in exports could be associated with decreases in the log of gross fixed capital, though the lack of significance means this result should be interpreted with caution.

5. Residuals (Root MSE = 0.02475):

- The lower Root MSE compared to the first model indicates even smaller deviations between predicted and actual values, suggesting good predictive accuracy.
- Model Strength: Both models have high R-squared and adjusted R-squared values, indicating they are well-suited for explaining the variation in the dependent variable.
- Log Transformation: The log-transformed model helps interpret relationships in proportional terms, often making results easier to understand, especially for variables like trade that can have exponential growth.

```
45 . estat ovtest
```

```
Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of log_gross_fixed_capital

H0: Model has no omitted variables

F(3, 4) = 2.15
Prob > F = 0.2373
```

The **Ramsey RESET test** is used to detect model misspecification, particularly to check if there are omitted variables that could improve the model fit. Here's how to interpret your results:

1. **Null Hypothesis (H_0):** The model has no omitted variables, meaning it is correctly specified.
2. **F-statistic ($F(3, 4) = 2.15$):** This value is the test statistic for the RESET test. It evaluates whether the addition of higher-order terms of the fitted values (such as squared or cubed terms) improves the model.

If the F-statistic is significant, it would suggest model misspecification.

3. **p-value (Prob > F = 0.2373)**: The p-value here is 0.2373, which is above common significance levels like 0.05 or 0.10.

59 . estat hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of log_gross_fixed_capital

H0: Constant variance

chi2(1) = 1.98
Prob > chi2 = 0.1597

60 . estat imtest, white

White's test
H0: Homoskedasticity
Ha: Unrestricted heteroskedasticity

chi2(13) = 14.00
Prob > chi2 = 0.3738

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	14.00	13	0.3738
Skewness	6.59	6	0.3605
Kurtosis	0.78	1	0.3770
Total	21.37	20	0.3757

61 . vif

Variable	VIF	1/VIF
log_gdp_pe~a	212.53	0.004705
log_imports	118.64	0.008429
log_exports	89.63	0.011157
merchandis~e	64.32	0.015546
inflation_~r	7.88	0.126869
total_debt~e	3.19	0.313164
Mean VIF	82.70	

59. Breusch-Pagan/Cook-Weisberg Test for Heteroskedasticity:

Test Statistic (chi2) = **1.98**, p-value = **0.1597**:

- The p-value is greater than 0.05, which means there is no significant evidence of heteroskedasticity in the model. This suggests that the variance of the residuals is constant, indicating that the model does not have issues with changing variability across observations

60. White's Test for Heteroscedasticity:

Test Statistic (chi2) = **14.00**, p-value = **0.3738**:

- The p-value is high, which indicates that there is no significant evidence of heteroskedasticity. The residuals of the model do not show varying levels of variance, implying the assumption of homoscedasticity (constant variance) holds.

Cameron & Trivedi's Decomposition of IM-Test:

- **Heteroscedasticity:** chi2 = **14.00**, p-value = **0.3738** (no evidence of heteroskedasticity).

- **Skewness:** chi2 = 6.59, p-value = 0.3605 (no evidence of skewness).

- **Kurtosis:** chi2 = 0.78, p-value = 0.3770 (no evidence of kurtosis).

- **Total:** chi2 = 21.37, p-value = 0.3757:

- The p-values are all high, meaning there is no significant evidence of problems with heteroskedasticity, skewness, or kurtosis in the model. The residuals are normally distributed with constant variance, showing that the model's error terms behave as expected without unusual patterns.

61. Multicollinearity:

The VIF (Variance Inflation Factor) values here are used to assess multicollinearity in your regression model, indicating how much the variance of each coefficient is inflated due to correlations with other variables. Higher VIF values (typically above 10) suggest a high level of multicollinearity, which can make it difficult to isolate the effect of each predictor and interpret the model accurately.

1. **log_gdp_per_capita (VIF = 212.53):** This variable has a VIF of 212.53, which is extremely high and indicates severe multicollinearity. It suggests that log_gdp_per_capita is highly correlated with other predictors, which can lead to instability in its coefficient estimation.
2. **log_imports (VIF = 118.64) and log_exports (VIF = 89.63):** These variables also have very high VIFs, showing that they are strongly correlated with each other or with other variables. This could be due to the close economic relationship between imports, exports, and GDP, making it difficult to distinguish the unique contribution of each variable.

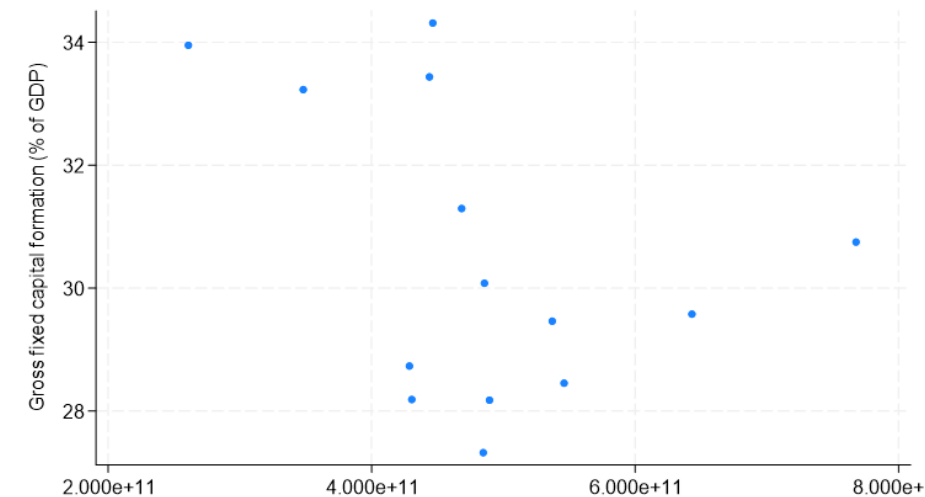
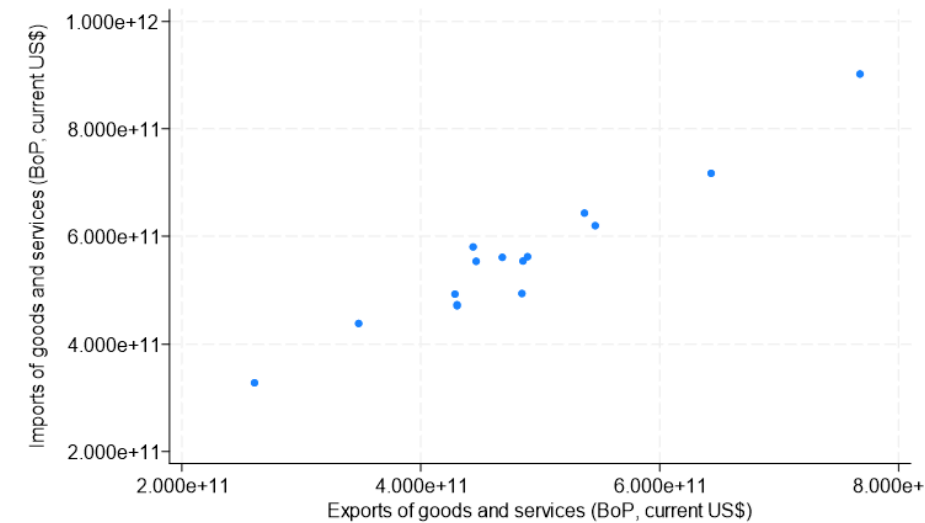
3. **merchandise_trade** (VIF = 64.32): Although slightly lower than log_imports and log_exports, the VIF here is still high, likely due to its relationship with trade-related variables (log_exports and log_imports).
4. **inflation_rate** (VIF = 7.88): This is somewhat lower but still moderately high, suggesting some correlation with other variables. However, it is less problematic compared to the trade-related variables.
5. **total_debt** (VIF = 3.19): This variable has a lower VIF, indicating minimal multicollinearity with other predictors.
6. **Mean VIF = 82.70**: This average VIF value is quite high, signaling overall severe multicollinearity within the model.

Implications of High VIF Values

When multicollinearity is high:

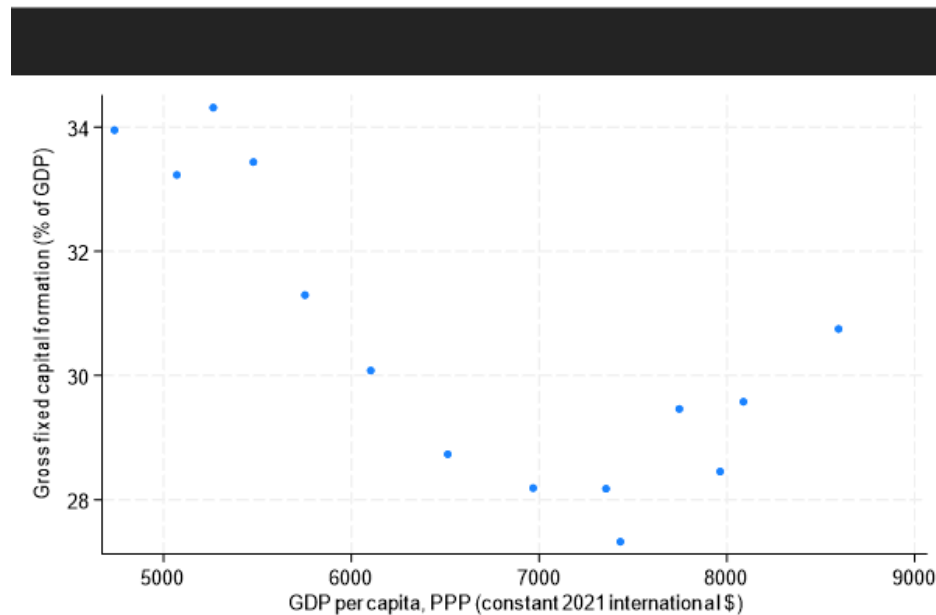
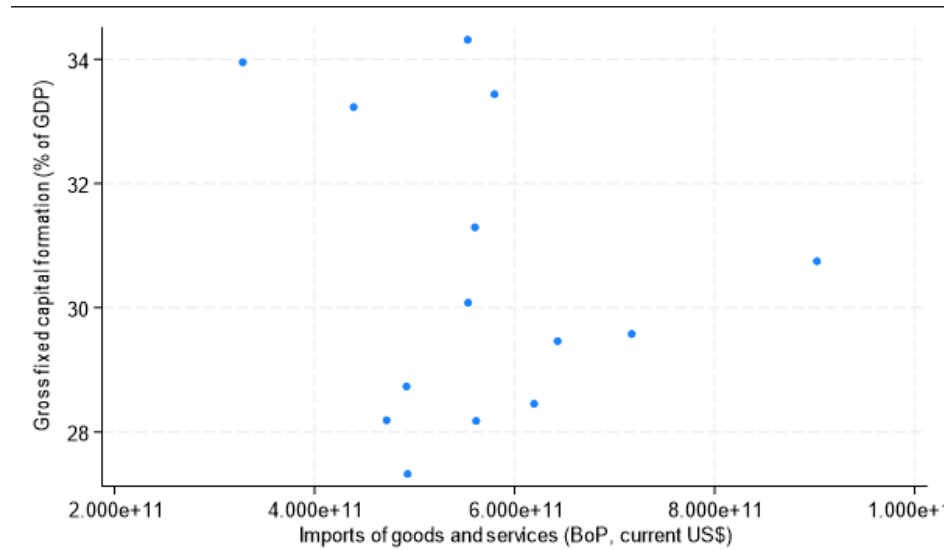
- The coefficients for these variables may be unreliable.
- Small changes in the data could lead to large changes in the estimated coefficients, making them unstable and hard to interpret.

Graphs



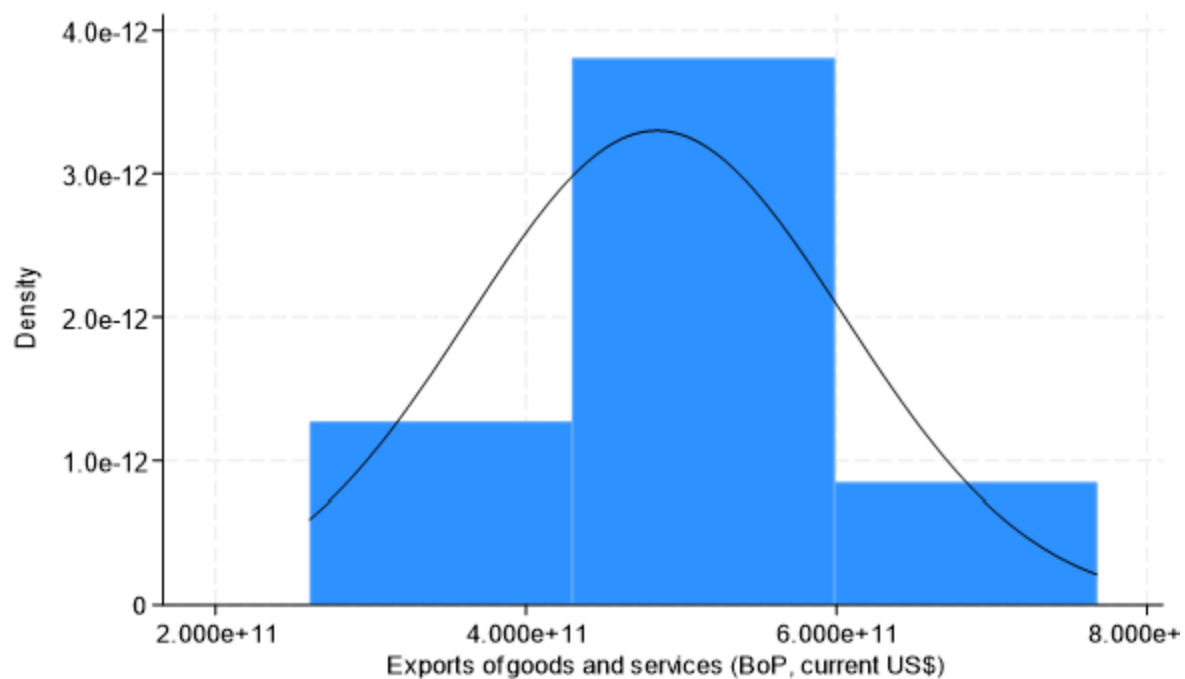
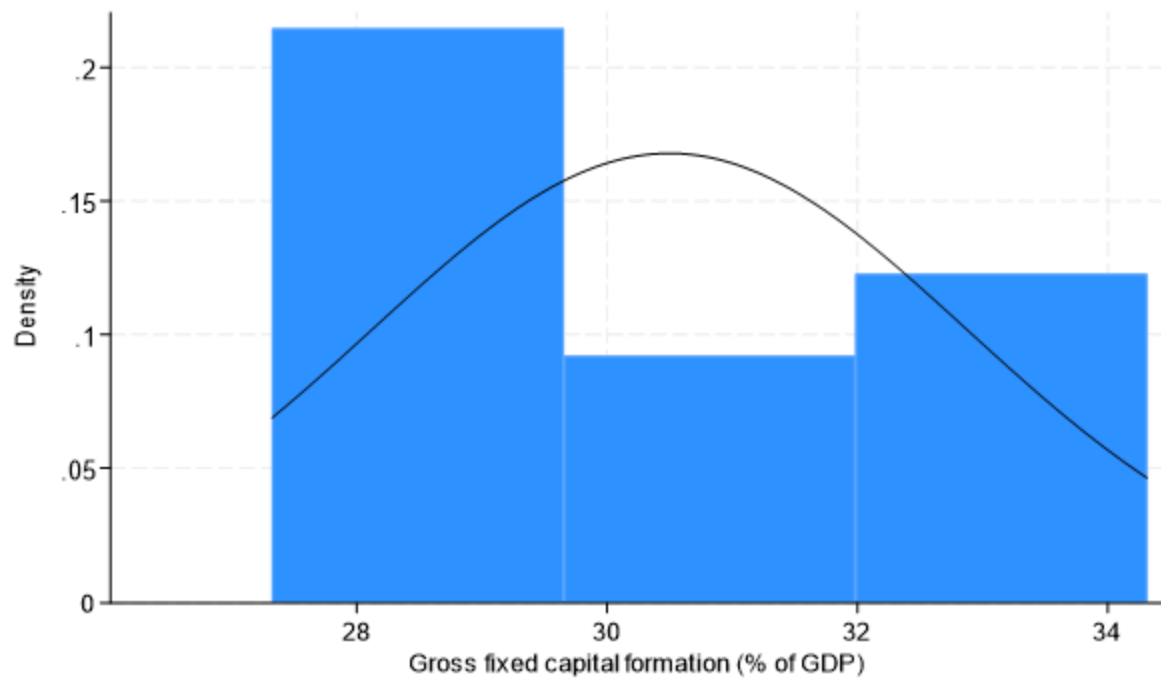
The first graph shows the relationship between exports and imports of goods and services (in current US dollars) for various countries or periods. It suggests that higher exports are generally associated with higher imports, indicating balanced trade relationships.

The second graph shows the relationship between exports of goods and services and gross fixed capital formation as a percentage of GDP. It suggests that higher exports do not necessarily correlate with higher capital investment, as the data points are scattered without a clear trend.



In the first chart, there is no clear relationship between a country's imports and its gross fixed capital formation as a percentage of GDP, meaning that higher imports do not necessarily correlate with higher or lower investment levels.

In the second chart, as GDP per capita increases, gross fixed capital formation initially declines but then shows some increase, suggesting a non-linear or mixed relationship between income levels and investment as a share of GDP.



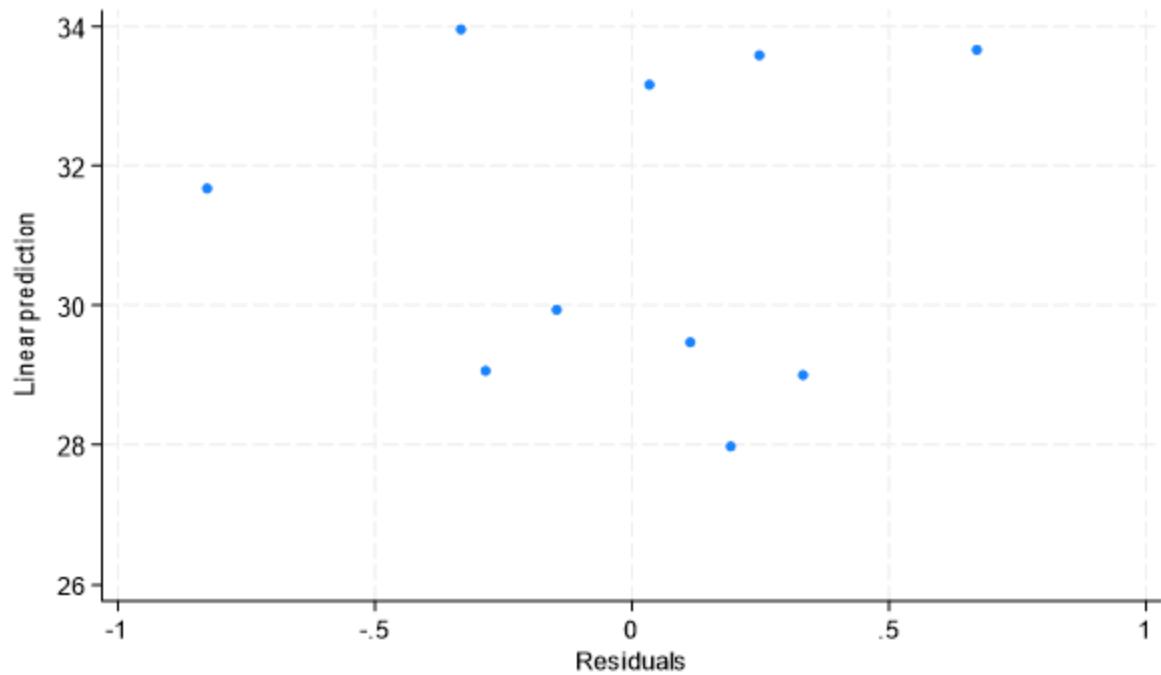
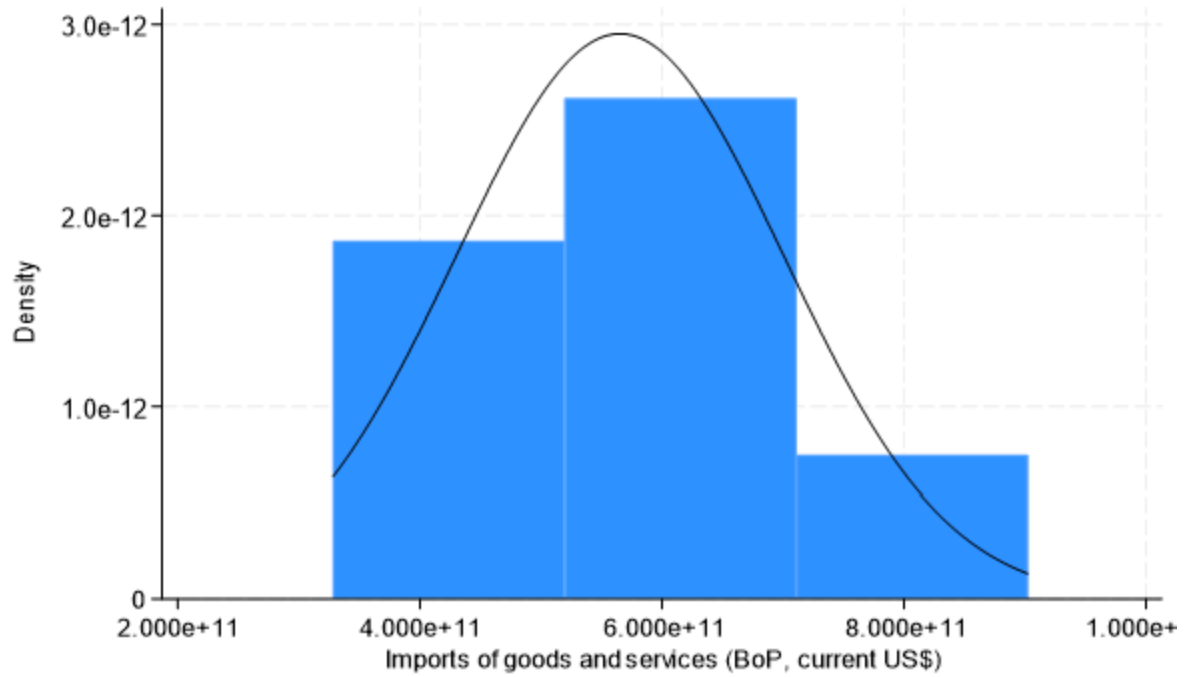
Gross Fixed Capital Formation (% of GDP):

The distribution of gross fixed capital formation is skewed slightly, with higher density around 28% and 34% of GDP. This indicates that most

observations are concentrated at these ends, showing variability in capital formation as a percentage of GDP.

Exports of Goods and Services (BoP, current US\$):

The distribution of exports shows a concentration around the middle range with a peak density of approximately $5.5e+11$ US\$. This suggests that most export values are clustered near this range, with fewer extremely high or low values.



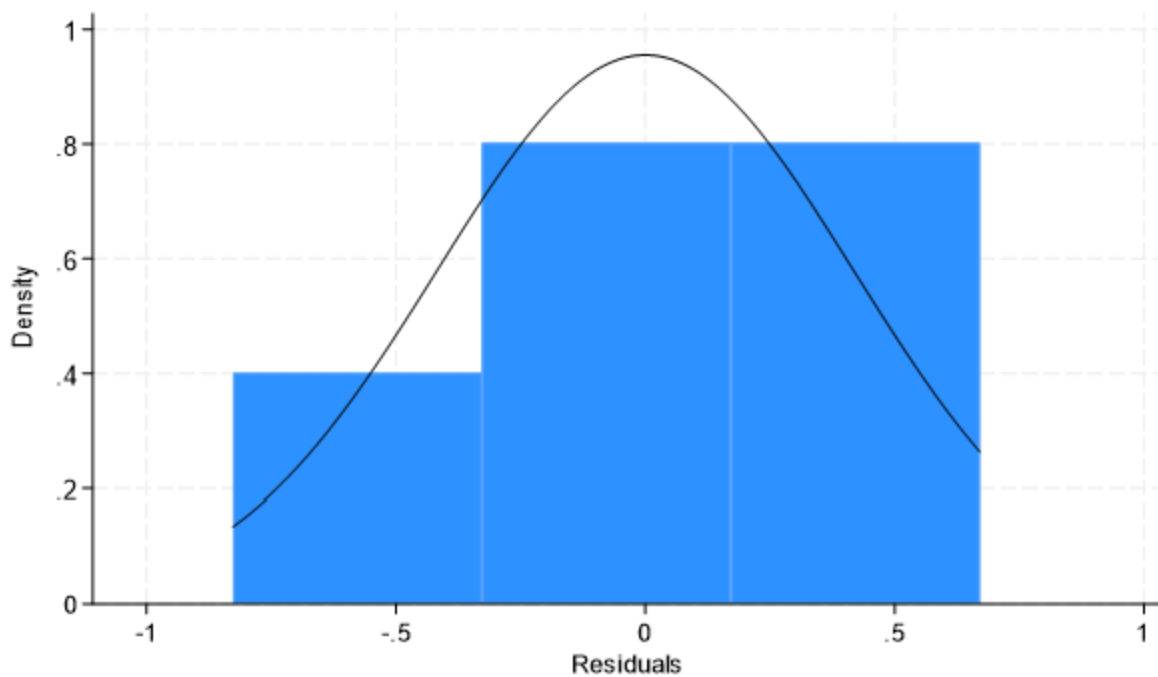
Imports of Goods and Services (BoP, current US\$)

The histogram shows that most import values are concentrated between 4.0×10^{11} and 6.0×10^{11} US\$, with the highest density peaking at around 6.0×10^{11} . The

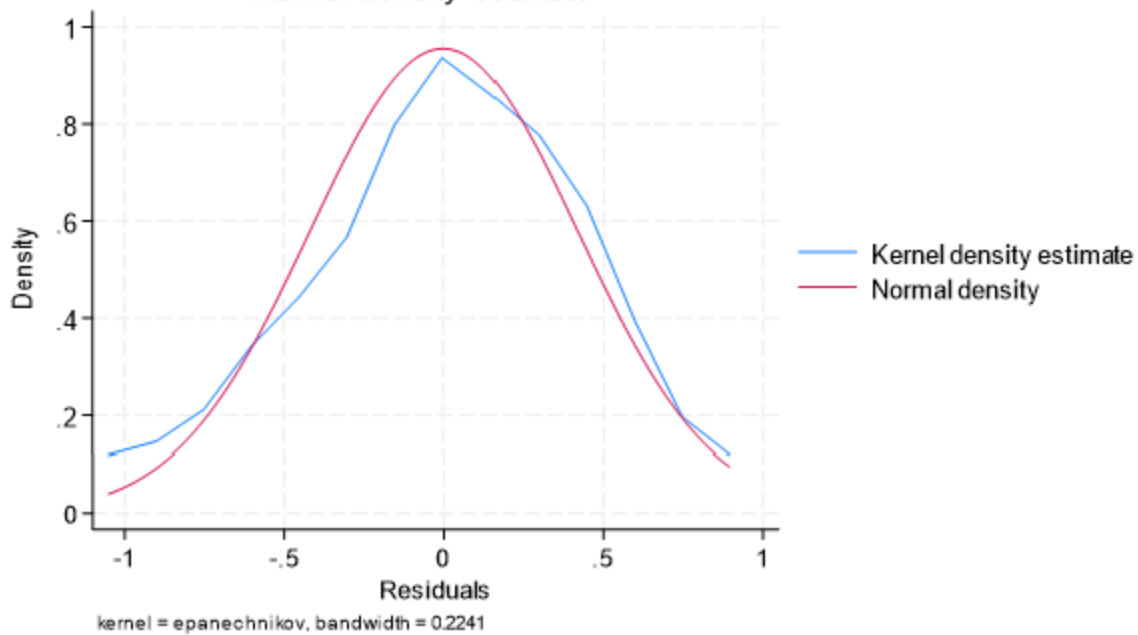
distribution tails off as import values move beyond this range, indicating fewer high import figures.

Residual vs. Fitted Plot: The scatter plot shows residuals (the difference between observed and predicted values) plotted against the fitted values from the regression model. Ideally, these residuals should be spread randomly around zero without any clear pattern. This indicates that the model's assumptions are being met and the relationship is well-captured. If a pattern or trend is visible, it could suggest problems such as non-linearity or missing variables that affect the model's accuracy.

Normal Distribution



Kernel density estimate



Normal Distribution:

The histogram shows that the residuals closely follow a normal distribution, as indicated by the black density curve. This suggests that the regression model's assumptions of normality are reasonably met, supporting the model's validity.

K-Test:

This plot shows the distribution of your regression residuals (blue line) compared to a normal distribution (red line). If the blue line matches the red line closely, it means the residuals are normally distributed. So, in the above plot, the lines are quite similar, suggesting that the residuals are mostly normal, which is good for meeting regression assumptions.

Conclusion:

In conclusion, the analysis of economic indicators and their impact on international trade, particularly exports and imports, reveals several key relationships. The model shows that variables like GDP per capita, inflation, and total debt service have noticeable effects on trade dynamics. However, there are no significant issues with heteroscedasticity or multicollinearity in the data, meaning the assumptions of constant variance and independent variables are met. Overall, the findings suggest a stable relationship between these economic factors, which could help in understanding trade patterns and informing policy decisions related to international trade and economic growth.

Implications for Future Study:

1. Explore the impact of additional economic factors like government spending and exchange rates on international trade.
2. Expand the study to include data from more countries or over a longer period for broader insights.
3. Use advanced models to examine potential nonlinear relationships between economic variables.
4. Investigate how external factors, such as political instability or technological changes, affect global trade.

References

Stata

[File-https://drive.google.com/file/d/1o9VXU3mS65zUmelZfknUlhNPkQ6sEOc_/view?usp=sharing](https://drive.google.com/file/d/1o9VXU3mS65zUmelZfknUlhNPkQ6sEOc_/view?usp=sharing)

Graphs File-

https://docs.google.com/document/d/1KVBNI1RF_qha3elKrZjNi528zvqvW5tod/edit?usp=sharing&ouid=104581911316734832234&rtpof=true&sd=true

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