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"

<u>GROUP MEMBERS</u>

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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
 merchandis~e |         14    33.43266    5.972468    24.28591     43.0349
 foreign_di~t |         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_ca~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   1.0000
              |   0.7155
              |
  imports_go~s |   0.0178   0.9707   1.0000
              |   0.9519   0.0000
              |
  merchandis~e |   0.4687  -0.0600   0.1260   1.0000
              |   0.0910   0.8387   0.6677
              |
  total_debt~e |  -0.6784   0.0349  -0.1213  -0.3693   1.0000
              |   0.0077   0.9057   0.6796   0.1938
              |
  gdp_per_ca~a |  -0.4407   0.8445   0.7306  -0.5536   0.2571   1.0000
              |   0.1148   0.0001   0.0030   0.0400   0.3749
              |
  gross_fixe~l |   0.7709  -0.3927  -0.1985   0.7365  -0.6562  -0.7567   1.0000
              |   0.0012   0.1649   0.4963   0.0027   0.0108   0.0017
              |
```

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
-------------+----------------------------------   F(6, 7)         =    22.80
       Model | 69.8817134        6  11.6469522     Prob > F        =   0.0003
    Residual | 3.57633928        7  .510905612     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
-------------+----------------------------------    F(6, 7)         =     19.81
       Model |  .072788077         6   .012131346    Prob > F        =    0.0005
    Residual |  .004286904         7   .000612415    R-squared       =    0.9444
-------------+----------------------------------    Adj R-squared   =    0.8967
       Total |  .077074981        13   .005928845    Root MSE        =    .02475

--------------------------------------------------------------------------------
> ----
log_gross_fixed_~l | Coefficient  Std. err.      t    P>|t|     [95% conf. inter
> val]
-------------------+------------------------------------------------------------
> ----
inflation_gdp_de~r |   .0074914    .0073665     1.02   0.343    -.0099276    .024
> 9104
       log_exports |  -.4056462    .2553212    -1.59   0.156    -1.009385    .198
> 0925
       log_imports |   .5053454    .3171047     1.59   0.155    -.2444881    1.25
> 5179
 merchandise_trade |  -.0005919    .0092169    -0.06   0.951    -.0223863    .021
> 2025
 total_debt_service |  -.0008426   .0029765    -0.28   0.785    -.0078808    .006
> 1957
log_gdp_per_capita |  -.2632751    .5155944    -0.51   0.625    -1.482462    .955
> 9119
             _cons |   2.954005    4.201488     0.70   0.505    -6.980935    12.8
> 8894
--------------------------------------------------------------------------------
> ----
```

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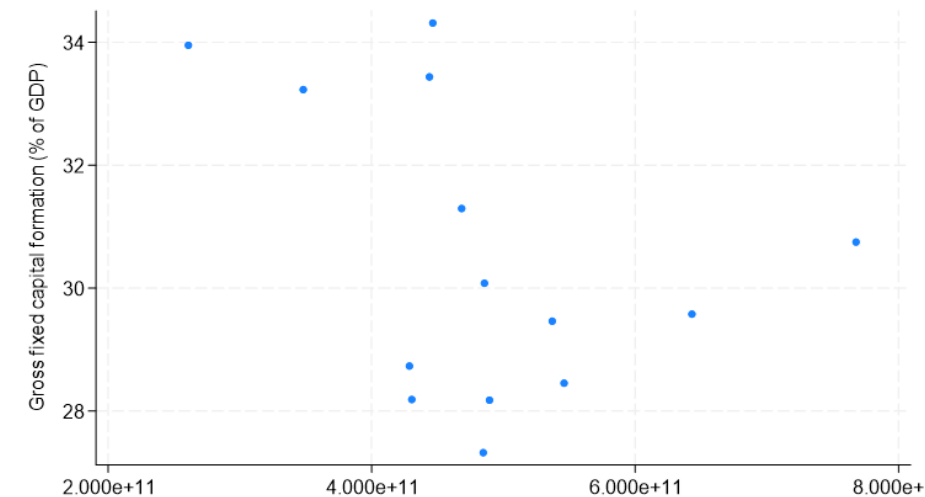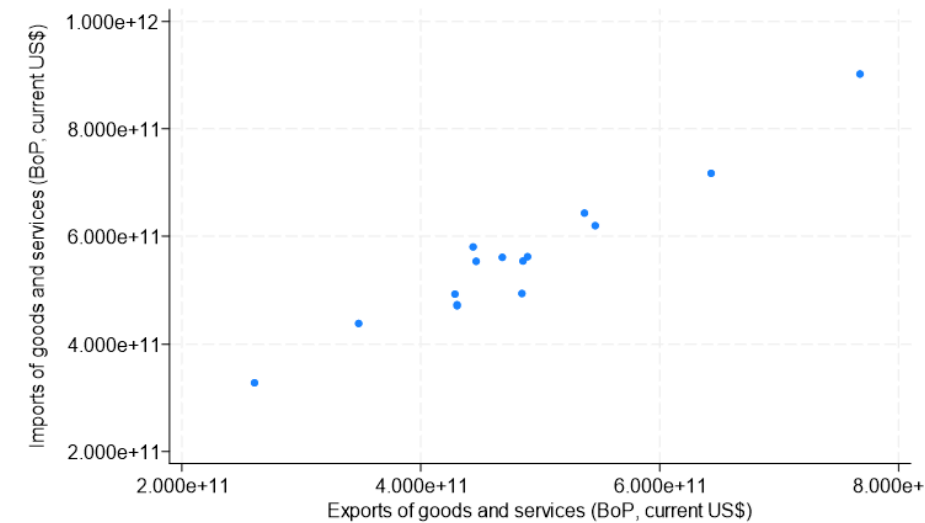
The first graph shows the relationship between exports and imports of goods and services (in current US dollars) for various countries or periods. It suggests that higher exports are generally associated with higher imports, indicating balanced trade relationships.

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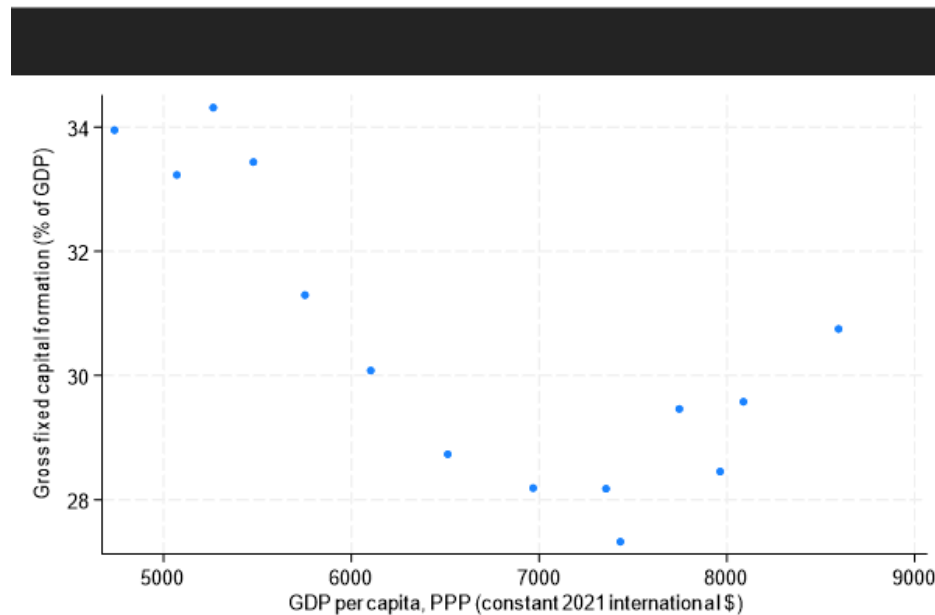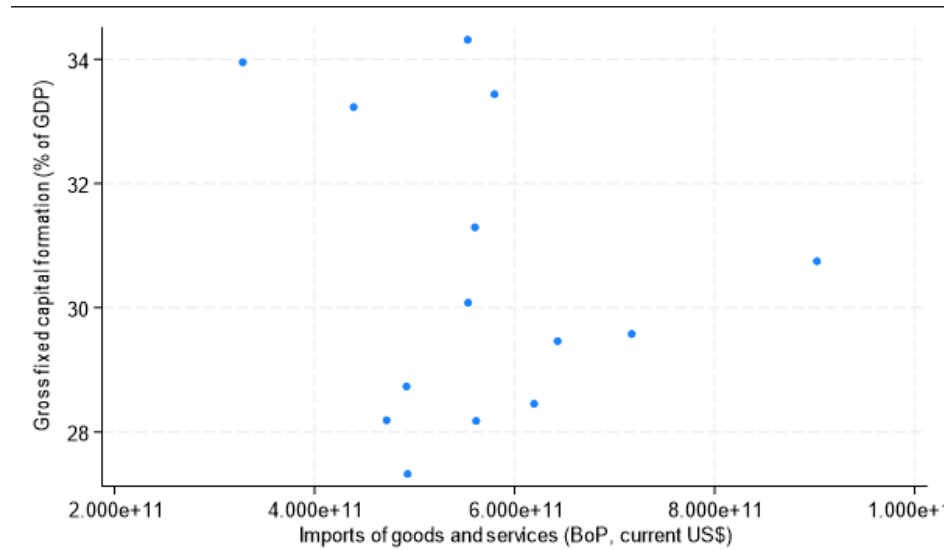
In the first chart, there is no clear relationship between a country's imports and its gross fixed capital formation as a percentage of GDP, meaning that higher imports do not necessarily correlate with higher or lower investment levels.

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)

Exports of goods and services (BoP, current US$)
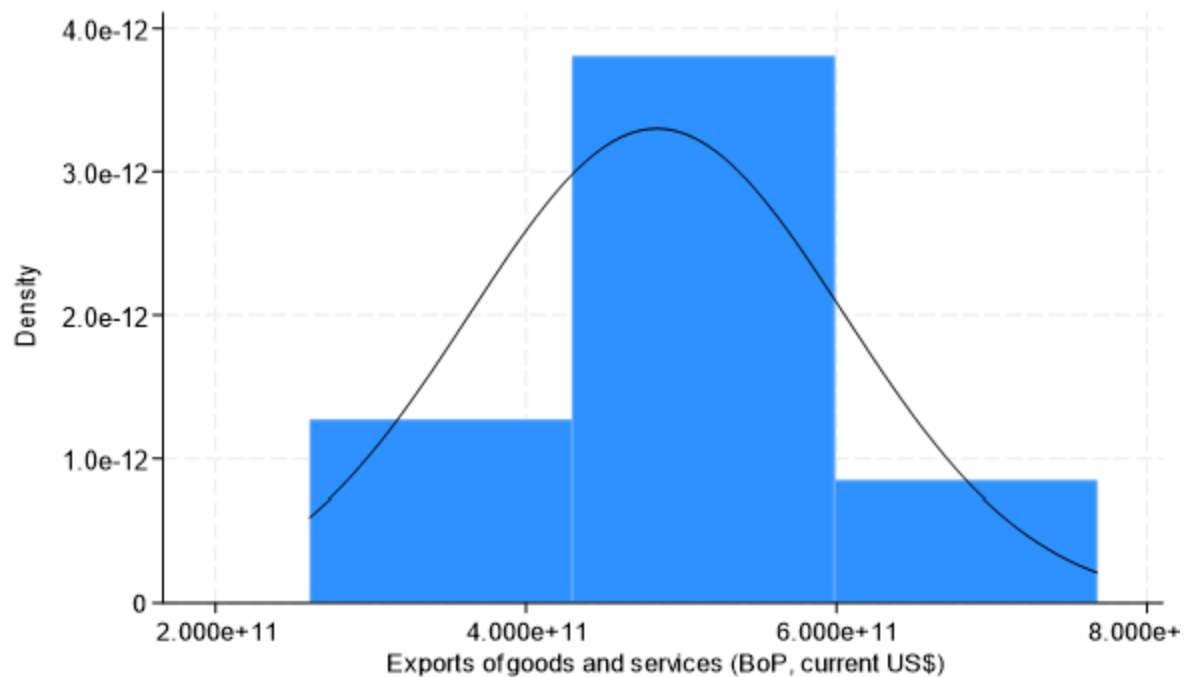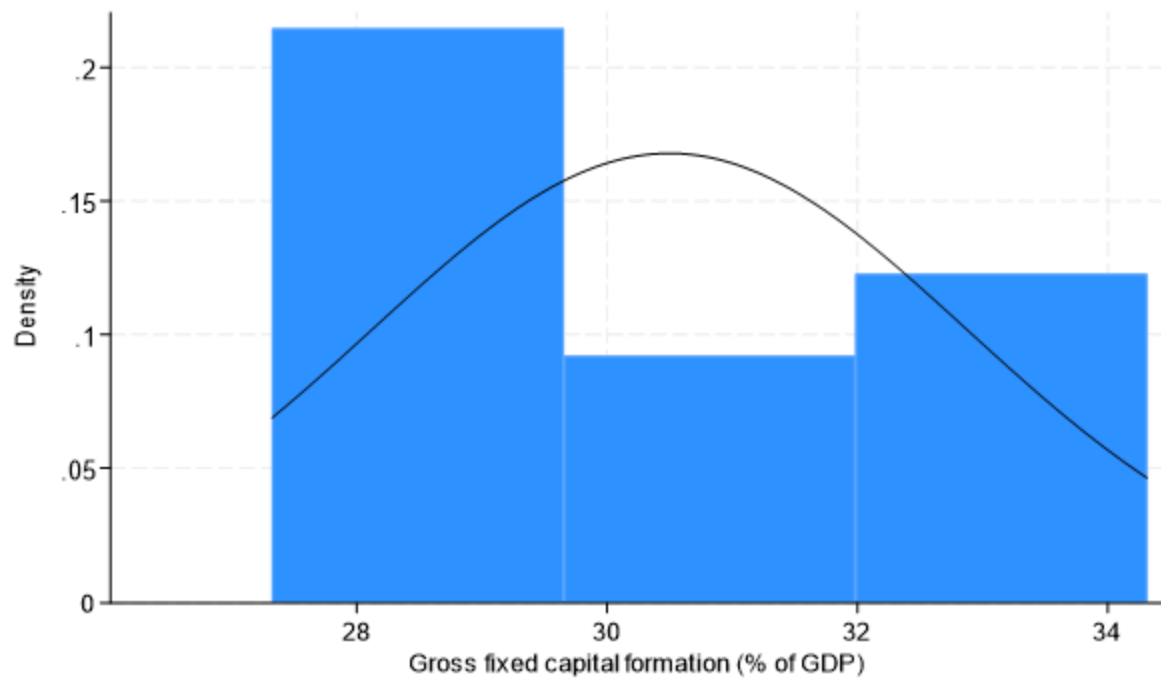
Gross Fixed Capital Formation (% of GDP):
The distribution of gross fixed capital formation is skewed slightly, with higher density around 28% and 34% of GDP. This indicates that most

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.
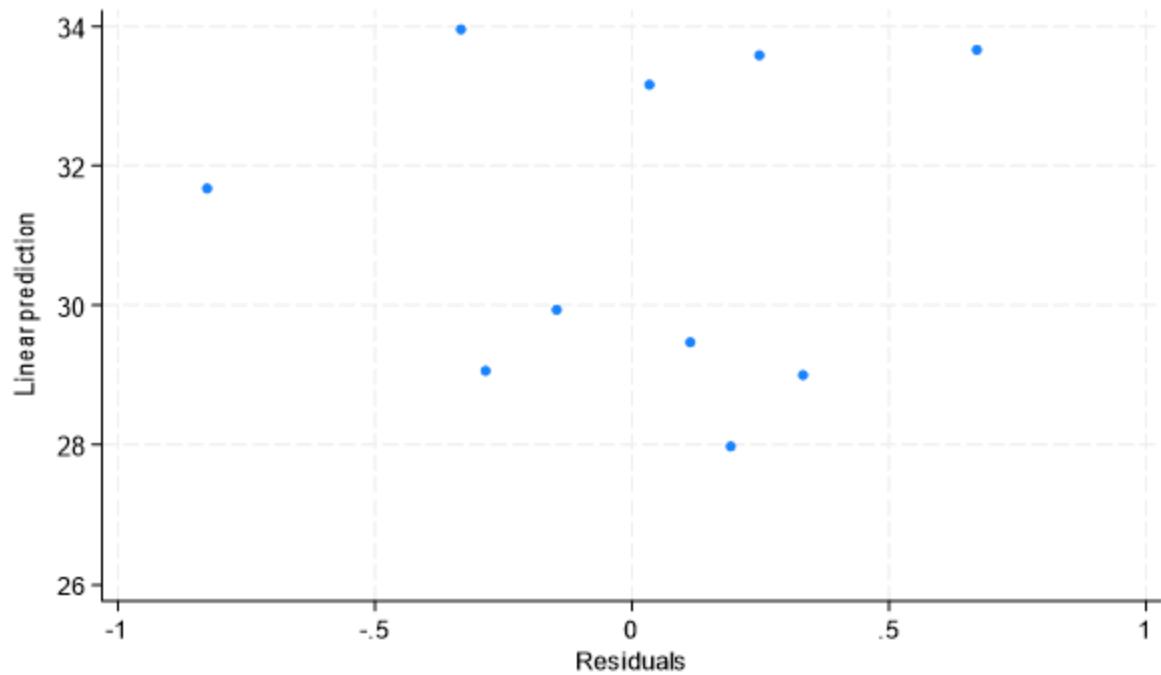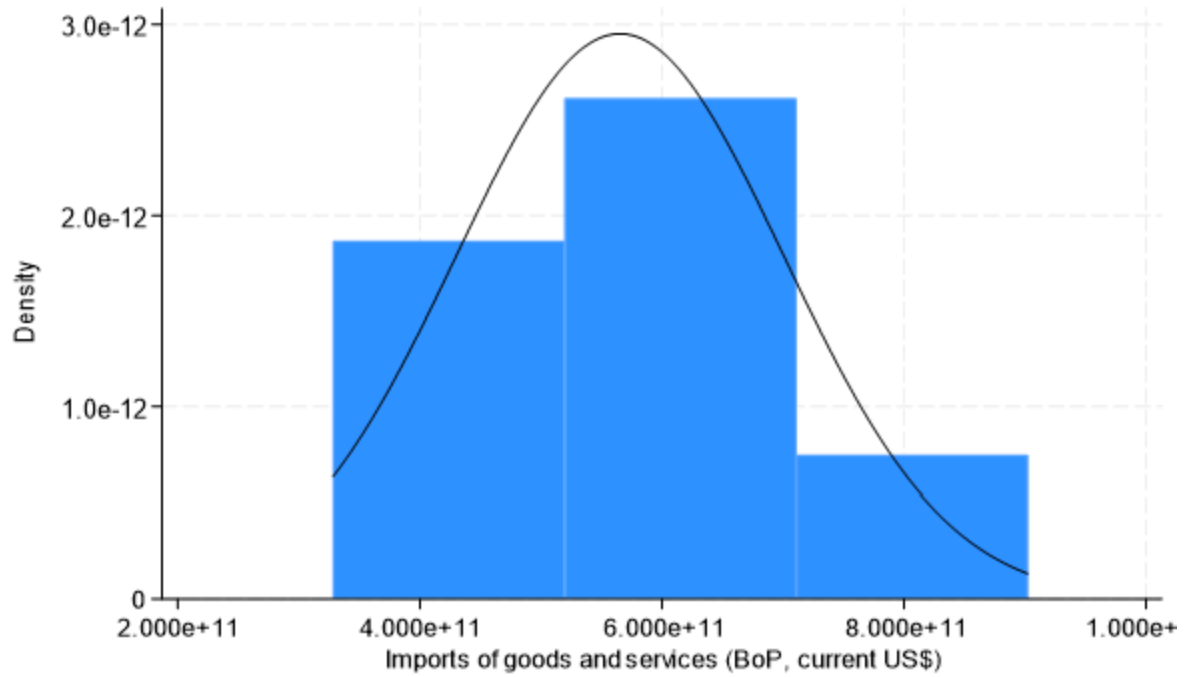
Imports of Goods and Services (BoP, current US$)
The histogram shows that most import values are concentrated between 4.0e+11 and 6.0e+11 US$, with the highest density peaking at around 6.0e+11. The

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
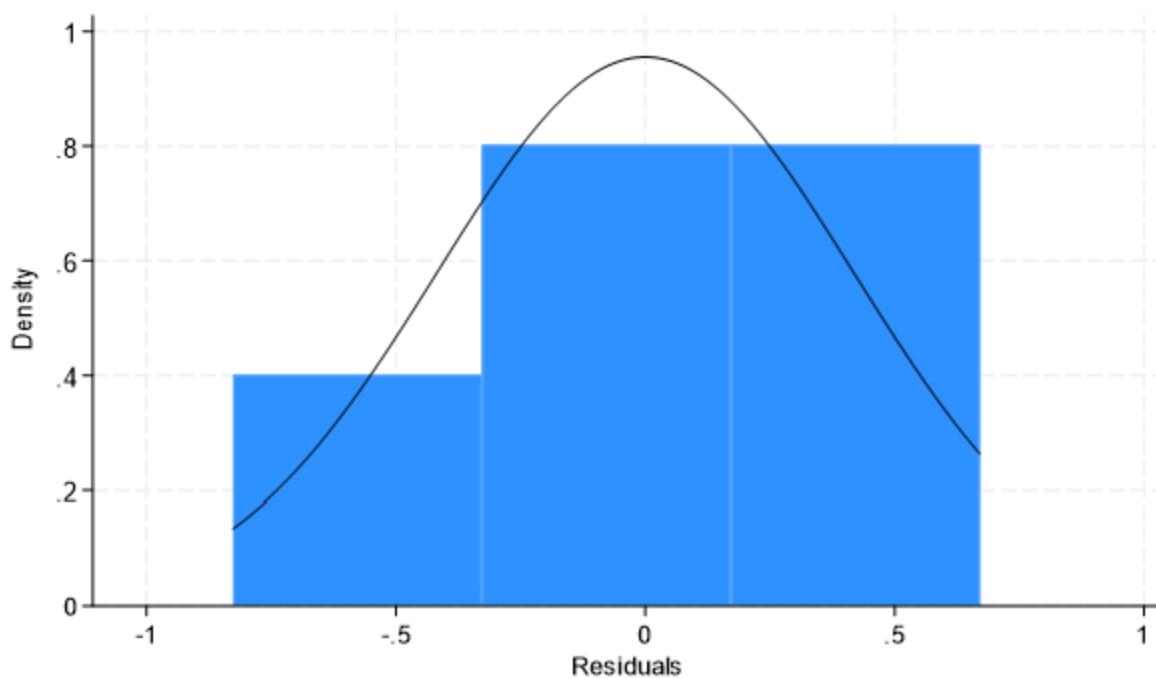
Kernel density estimate

kernel = epanechnikov, bandwidth = 0.2241
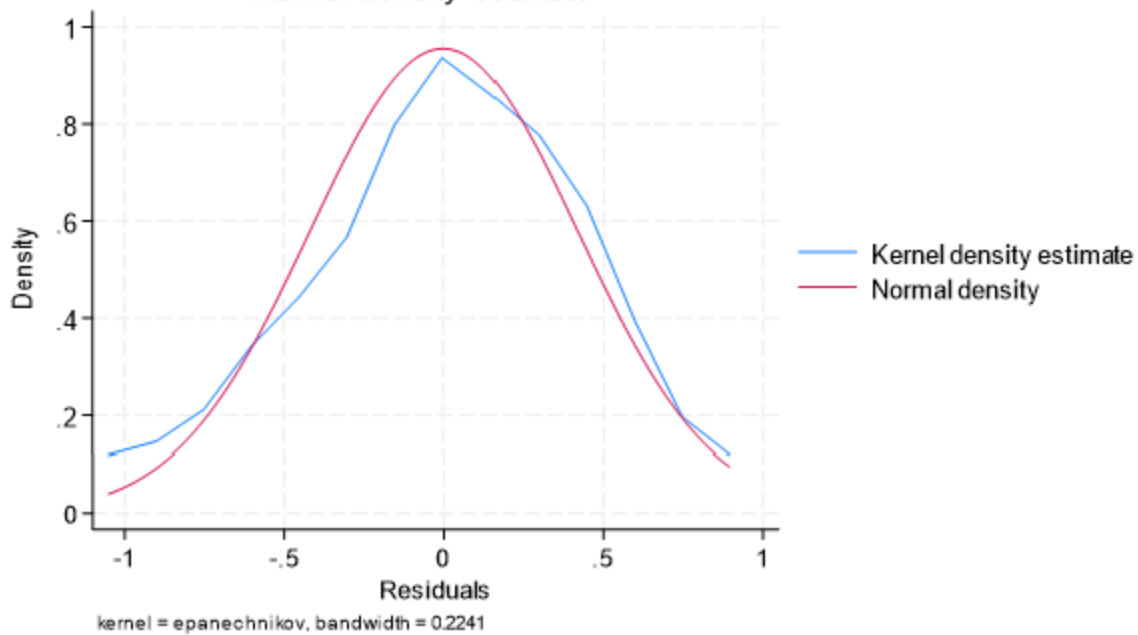
Normal Distribution:

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

Graphs File-
https://docs.google.com/document/d/1KVBNlRF_qha3elKrZjNi528zvqvW5tod/edit?usp=sharing&ouid=104581911316734832234&rtpof=true&sd=true

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