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Visualization Process of International Trade and its impact on GDP through Multi-criteria Decision Model: A Case Study of India's Merchandise Trade

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Abstract

When it comes to international trade, India is one of the most important nations. This paper intends to analyze the effect of International Trade on a nation's GDP growth through the process of visualizing the current trends. For this research, some statistical (economical) data is considered and its effect on the GDP is analyzed for the previous accounting years ranging from 2015 to 2021. The data considered for this include – the monetary value of exports from India (in US$ Millions), the monetary value of imports from India (in US$ Millions), India's share of exports to the nation out of all the nations, India's share of imports to the nation out of all the nations in, export growth rate, import growth rate, currency exchange rate, Inflation rate. This paper examines and explains how these economic factors influence a country's (India's) GDP growth through the process of visualization.

Keywords: Export Growth Rate; Import Growth Rate; Currency Exchange Rate; Inflation Rate; GDP Growth Rate; Visualization; Decision Modeling

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1. Introduction

Imports and Exports of a country play a crucial role in its GDP growth as it forms a major chuck of it. The entire market value of all finished products and services generated in an economy over a given year is known as the gross domestic product (GDP), and it is stated in dollars. GDP reveals whether an economy is creating more production (growing) or less output (contracting) which in turn affects its import or export rates. As a result, it is one of the most significant and often published economic indicators and a helpful indicator of the state of the economy. Business owners and governments alike take into account GDP when making choices. The GDP includes a measure of foreign commerce, which is a significant and expanding portion of our country's economy.

The formula of GDP is as follows: GDP = C+I+G + (X - M).

WHERE:

C = Consumer spending on goods and services X = Exports
I = Investment spending on business capital goods M = Imports G = Government spending on public goods and services

Net exports are determined by subtracting imports from exports (X - M). The net products figure is positive when commodities outperform imports. This shows the presence of an exchange overflow that country. The net products number is negative when commodities are lower than imports. This suggests that there is an import/export imbalance in the country. Import/export imbalance.

An import/export imbalance can contort a country's equilibrium of trade and debilitate its cash when there are a larger number of imports than sends out, which are merchandise conveyed from that country to an unfamiliar objective. Since the worth of a cash is one of the principal factors influencing an economy's performance and its gross domestic product, the importance of understating the devaluation of a country's currency can significantly affect the inhabitants' everyday lives (Gross domestic product). A country should keep a good overall arrangement among imports and commodities. A nation's Gross domestic product, swapping scale, level of expansion, and loan costs can be generally influenced by its import and commodity exercises.

Trade Surplus

A country's economy grows when there is a trade surplus. A higher level of production from a nation's factories and industrial and its important facilities, as well as a higher number of people who are employed to maintain these industries running, are indicators of higher exports. When a business exports a lot of items, money flows into the nation, which encourages consumer spending and promotes economic growth, which yields GDP growth.

To get results, the author has used exploratory research methodology and statistical tools such as Tableau Software to visualize the data and trends, RStudio to perform correlation and regression analysis, and Microsoft Excel for pre-processing and visualization.

2. Research Objectives

The objective of this research is to analyze the impact of the International Trade (Import & Export of Goods) on the GDP of India by using various economic instruments such as import growth rate, export growth rate, etc., and to study the growing trends as well as identifying major trading partners on the basis of data used.

3. Literature Review

In this mentioned paper the authors [1] has examines the connection between commodity, import and Total national output (Gross domestic product) in Albania by involving yearly information for the period somewhere in the range of 1984 and 2012. Different experimental explores and large-scale econometric models show that there is a harmony connection between products, imports and Gross domestic product in the long haul. The creators [2] analyzes the utilizations of the Autoregressive Circulated Slack (ARDL) model in the examination of Egypt's import and commodity information. Considering that commodities and imports fundamentally influence the monetary status of Egypt through the equilibrium of installment, policymakers really must satisfactorily appreciate and comprehend the variables influencing the income of the nation's economy. The authors have analyzed the impacts of commodity and import on Gross domestic product of Bangladesh utilizing yearly information from 1972 to 2006. Pertinent information was gathered from the reports of the World Bank. Information was then examined by utilizing econometrics apparatuses. The investigation uncovered that both commodities and imports are decently connected with the development of Gross domestic product. Sending out contributes emphatically to our Gross domestic product though import's commitment is apathetic. The author [3] has explained that the rates of commodity and import development also play a significant role in determining the growth of an economy. In one of his works, he

examined the relationship between Indian trade and financial development using the causality and error revision mechanisms and discovered that there was a causal relationship between the two. The author [4] investigated the relationship between Iranian import, trade, and financial development between 1962 and 2011. In order to test for cases of direct long-term relationships, aberrant long-term relationships, and motivation and reaction capability among commodity and import and financial development, the role of the import and product factors in the examination of monetary development yield co-integration examination is highlighted. The precise results supported a long-term relationship between the elements taken into consideration. As a result, commerce had a long-term, direct, and favorable association with financial development. Similar to how imports had a negative and significant link with economic development, imports had a long-term, major impact on economic development. The Pedroni's board co-mix test totally modified normal least square (FMOLS), dynamic customary least square, and vector blunder rectification model have all been used by the authors [5]. Pedroni's co-mix test results show that there is a long-term relationship between export, import, gross capital arrangement, and economic growth. Furthermore, a bidirectional causal relationship between commerce and monetary development was discovered, supporting the idea that commodities drive development (ELG) and development drives send out (GLE). The authors [6] analyze the volume and consistency of Zhanjiang's total imports and commodities in relation to changes in the region's gross domestic product and the level of occupant utilization. This paper applies econometrics to set up a model that focuses on the factors that affect imports and products in Zhanjiang. The findings indicate that Zhanjiang's Gross Domestic Product and population density have a major impact on the regions. The authors [7] analyze the volume and consistency of Zhanjiang's total imports and commodities in relation to changes in the region's gross domestic product and the level of occupant utilization. This paper applies econometrics to set up a model that focuses on the factors that affect imports and products in Zhanjiang. The findings indicate that Zhanjiang's Gross Domestic Product and population density have a major impact on the region's import and commodity exchange, and that import, and product have grown to be a key indicator of the region's financial development. Thus, it is highly likely that the import and commodities exchange Zhanjiang should be vigorously expanded to promote financial improvement in this area. The authors [8] focus on loose linkages between Bhutan's raw materials, imports and GDP (gross domestic product) using annual information from 1980 to 2005. Granger causality tests and concordance models were used to address the stochastic nature of Bhutan's factors to be addressed. Co-voting surveys suggest the existence of a long-run equilibrium relationship. The results of the Granger causality test show that there is a causal relationship between the tested factors. The causality is one way from products to imports and GDP and from GDP to net imports. The author [9] intends to analyze the impact of commodities, imports and speculation on the financial development of Riau Islands, Indonesia. Information extracted from the quarterly financial reports of the Indonesian Province of the Riau Islands Region for the period 2009-2016 or 8 years. The shipper/exporter delivers the product and import goods to Indonesian customs. While the risk is estimated based on the speculative lending disclosed by all Indonesian banks and the total amount of provincial local projects provided by the central metering department. A recurrence study was conducted on board information to decompose the effect of free factors on the dependent variable. The most appropriate fallback model for board information in this study is the irregular influence model. The survey found that some shipping has a significant impact on financial development, imports have a huge adverse impact, and speculation has a crucial positive impact three at the same time factors had genuinely tremendous impact to the financial development of Riau Islands Region Indonesia. The author [10] It means analyzing the Indian economy in the period before and after the transition. This paper attempts to analyze what India's financial changes in 1991 meant for the rate of GDP growth, and what their commitment to maintain the rate of GDP growth meant for a number of monetary and non-monetary variables. To complete this related examination, some monetary factors and some non-financial variables are considered and their effects on the rate of GDP (Gross Domestic Product) development (at factor cost) over the period 1970-2011 are disaggregated. Financial variables considered are capital development rate, horticultural area development rate, shipping development rate, imports development rate and non-monetary variables are electricity consumption (kWh per capita), number of people living in poverty at $2 per day (PPP) (% of population).

4. Exploratory Research Methodology

The study describes the impact of International Trade on GDP in the Indian Economy. The period that has been chosen for the present study is from 2015 to 2021. For the research study, data has been gathered from World Bank Databank and the Indian Ministry of Commerce Trade and Industry. The period of study comprehends seven years, as it will provide us with a sound analytical position for observing the relationship between GDP, Import and Export growth, Inflation,

and Exchange Rate Fluctuations, as well as major trading partners in the Indian economy. The analysis has been carried out with the help of multiple graphical and statistical instruments using Tableau, RStudio, and Microsoft Excel.

4.1 Gathering Data

The most crucial step in the process is to gather the data on which the research must be conducted, also while maintaining its integrity and usability. For this study, the data was obtained from radestat.commerce.gov.in, verified by the Indian Ministry of Commerce Trade and Industry's website. The data consisted of more than 222 countries for Export and 198 countries for Imports.

DATA INPUT –
Exports – 222 Rows | 9 Columns
Imports – 198 Rows | 9 Columns
Economic Factors – 7 Rows | 8 Columns
TYPICAL RAW DATASET OF EXPORTS

5. Data Trends & Results

The study describes the impact of International Trade on GDP in the Indian Economy. The period that has been chosen for the present study is from 2015 to 2021. For the research study, data has been gathered from World Bank Databank and the Indian Ministry of Commerce Trade and Industry. The period of study comprehends seven years, as it will provide us with a sound analytical position for observing the relationship between GDP, Import and Export growth, Inflation, and Exchange Rate Fluctuations, as well as major trading partners in the Indian economy. The analysis has been carried out with the help of multiple graphical and statistical instruments using Tableau, RStudio, and Microsoft Excel.
This section analyses and studies all the estimated results and economic trends from 2015 to 2021 and their impact on GDP. Correlation Analysis (Factors Affecting GDP) TOTAL IMPORT & TOTAL EXPORT

Table 1. Correlation Analysis of Import, Export & GDP

Variable	Total Exports	Total Imports	GDP
Total Exports	1.0000000	0.9641282	0.8725584
Total Imports	0.9641282	1.0000000	0.8124863
GDP	0.8725584	0.8124863	1.0000000

Table 1 shows the correlation coefficient between Imports, Exports, and GDP in India during 2015 – 2021. As the correlation coefficient between Exports and GDP is 0.8725884 and Imports and GDP is 0.8124863 which clearly states that these all have a positive correlation and are directly proportional to each other, moreover it can also be seen that the correlation coefficient between Total Imports & Total Exports is 0.9641282 which translates to a positive correlation and direct proportionality. Inflation & Currency Exchange

Table 2. Correlation Analysis of Exchange Rate, Inflation & GDP Growth%

Variable	Exchange Rate	Inflation	GDP % Growth
Exchange Rate	1.0000000	0.5644860	-0.5407258
Inflation	0.5644860	1.0000000	-0.5954423
GDP % Growth	-0.5407258	-0.5954423	1.0000000

Table 2 shows the correlation coefficient between the Exchange rate, Inflation, and GDP Growth% in India during 2015 – 2021. As the correlation coefficient between Exchange Rate and GDP Growth% is -0.5407258 and Inflation and GDP is -0.5954423 it helps us to understand that these all have a negative correlation and are inversely proportional to each other. On the contrary, the correlation coefficient between Exchange Rate and Inflation is 0.5644860 which is positive and is directly proportional to each other. **Trade % (% of trade in GDP) & GDP growth rate**

Table 3. Correlation Analysis of Trade% & GDP Growth%

Variable	Trade%	GDP % Growth
Trade%	1.0000000	0.7854564
GDP % Growth	0.7854564	1.0000000

Table 3 depicts the correlation coefficient for the Trade% in GDP of India and the GDP Growth Rate during 2015 – 2021. The correlation coefficient between both is 0.7854564 which tells us that these both have a positive correlation and are directly proportional to each other.

5.2.1 Data trends (factors affecting GDP)

Total import & total export
Figure 1. Shows the trends of Imports and Exports in India during 2015 – 2021. It can be clearly stated that the value of imports is much higher than the exports, which

adversely affects the economy. From 2015 onwards the value for both imports and exports can be seen as rising in the pre-covid era. During the pandemic era of late 2019 and early 2020, there is a gradual fall in the values. Also, there is an astounding jump in the values during the post-covid era as observed.

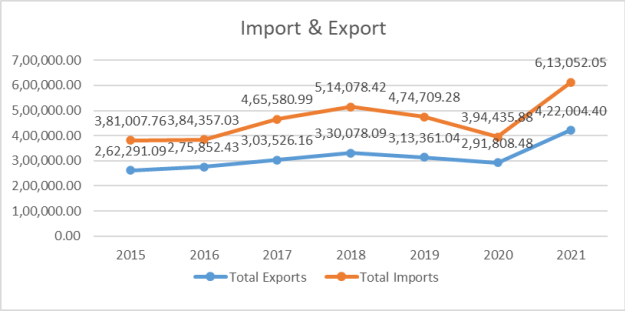

Figure 1. Total Imports & Exports in India from 2015 to 2021

Figure 2. Total Imports Exports & GDP in India from 2015 to 2021

Figure 2. Shows the trends of Imports and Exports in India during 2015 – 2021. It can be clearly stated that although the value of imports is much higher than the exports, the GDP value gradually increases across the scene. This shows that these two factors do not significantly impact individually on the GDP growth rate. From 2015 onwards the value for both imports and exports can be seen as rising as well as GDP in the pre-covid era. During the pandemic era of late 2019 and early 2020, there is a gradual fall in the values. Also, there is an astounding jump in the values during the post-covid era as observed.

Inflation & Currency Exchange

Figure 3. shows a gradual decline in the inflation rate and an uprise in the exchange rate during the pre-covid era (2015 – early 2019). During the pandemic era (late 2019 – 2020), there is a sudden rise in the inflation rate, but the exchange rate kept rising, Until the post covid era (late 2020 onwards) in which the Inflation rate went down and there is a minor appreciation in the currency as well.

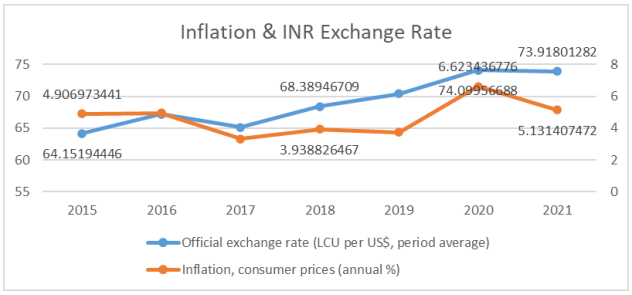

Figure 3. Inflation and Currency Exchange Rate in India from 2015 to 2021

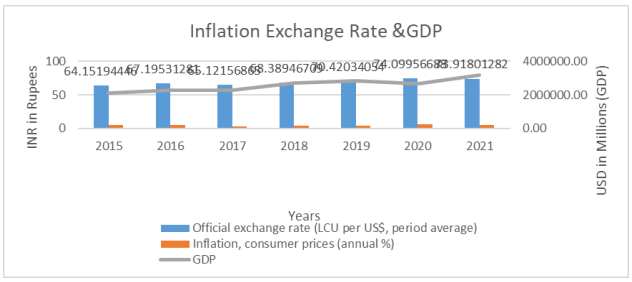

Figure 4. Inflation and Currency Exchange Rate in India from 2015 to 2021

Table 4. Change in Inflation Rate and Exchange Rate

Variables	Coefficients	Standard Error	p-value	Multiple R-Squared
Total Imports	0.3566	1.157e-01	0.0274 *	0.6552
Total Exports	0.6149	1.557e-01	0.0109 *	0.7572
Inflation	4332	14886	0.7827	0.01666
Exchange Rate	8072	2143	0.0131 *	0.7394
Trade %	377.4	6656.7	0.957	0.0006425

Figure 4. And Table 4 shows a gradual decline in the inflation rate and an uprise in the exchange rate during the pre-covid era (2015 – early 2019). During the pandemic era (late 2019 – 2020), there is a sudden rise in the inflation rate, but the exchange rate kept rising, however the GDP is at its lowest in 2020. This shows that inflation and exchange rate negatively impact GDP growth. Until the post covid era (late 2020 onwards) in which the Inflation rate went down and there is a minor appreciation in the currency as well, whereas the GDP is the highest.

Trade% (% of Trade in GDP) & GDP Growth Rate

Figure 5. Represents the relationship between the GDP Growth Rate and Merchandise trade (% of GDP) in India. As it can be observed that there is a consecutive decline in the GDP growth rate during the pre-covid era (2015 to early 2019) itself, But the % Merchandise trade remains almost similar with minor fluctuations until the pandemic era (late 2019 and 2020) when there is a huge downfall in the GDP Growth rate as well as a noticeable decline in Merchandise trade (% of GDP) as well. Apart from that, there is a rapid recovery in terms of GDP Growth rate and merchandise trade (% of GDP) during the post covid era.

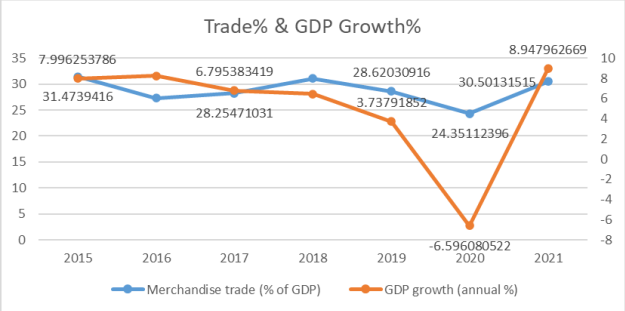

Figure 5. GDP Growth Rate & Merchandise trade (% of GDP) in India from 2015 to 2021

5.2.2 Data Trends (Trade Relations) Exports

Figure 6 shows the export data visualization in terms of the monetary value of the top 22 trading countries from India's trading perspective which are: -
Bangladesh, Belgium, China, France, Turkey, Germany, Hong Kong, Italy, Malaysia, Nepal, Netherlands, Saudi Arabia, Sri Lanka, Singapore, Indonesia, Korea RP, Japan, United Arab Emirates, UK, USA, Vietnam SOC REP, Australia.

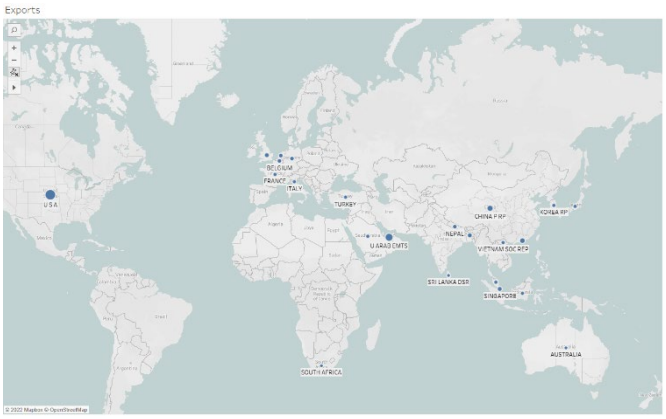

Figure 6. Top 22 highest exporting countries in terms of India

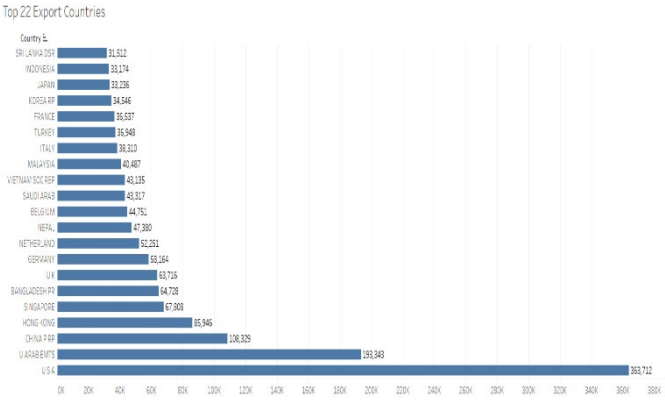

Figure 7. Top 22 highest exporting countries in terms of India with their depicted values

Figure 7. Depicts the values of the top countries and after analysing the graph it could be observed that the U.S.A., United Arab Emirates, and China have the highest values in comparison to other countries which clearly shows that India has strong trade relations with these countries in terms of exports and these countries majorly rely on India for their imports.

Imports

Figure 8. shows the import data visualization in terms of the monetary value of the top 21 trading countries from India's trading perspective which are: - Russia, Thailand, Kuwait, South Africa, Nigeria, Qatar, Belgium, China, Germany, Hong Kong, Malaysia, Saudi Arabia, Singapore, Indonesia, Korea RP, Japan, United Arab Emirates, USA, Australia, Iraq, Switzerland.

Figure 8. Top 22 highest importing countries in terms of India

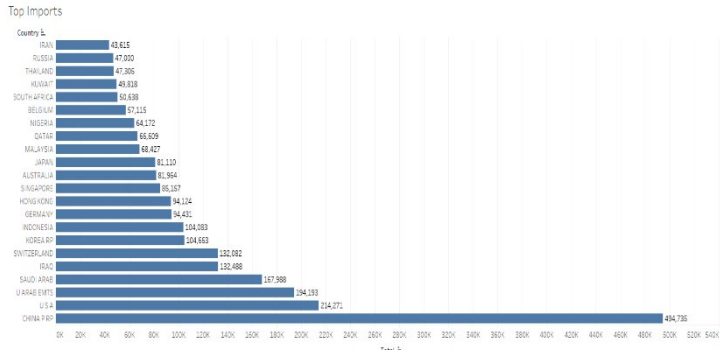

Figure 9. Top 22 highest importing countries in terms of India with their depicted values

Figure 9. Depicts the values of the top countries and after analyzing the graph it could be observed that China, U.S.A., and United Arab Emirates have the highest values in comparison to other countries which clearly shows that India has strong trade relations with these countries in terms of imports and India majorly relies on these countries for its imports.

Taking into account the observations for import and export data it appears that the U.S.A., China, and U.A.E. are the largest contributors to India's International trade and India has strong trade relations with them. If due to any political, natural, and social issues, for example, the COVID-19 pandemic, there is a decrease in the volume of Imports/Exports, India's GDP growth will decline drastically.

6. Regression Analysis (Factors Affecting GDP)

At the point when every variable was independently relapsed on Gross domestic product results got show that not all elements thought about have an immediate importance on the Gross domestic product.

Table 5. Simple Linear Regression Analysis of Exchange Rate, Inflation, Trade%, Total Exports, Total Import & GDP

Variables	Coefficients	Standard Error	p-value	Multiple R-Squared
Total Imports	0.3566	1.157e-01	0.0274 *	0.6552
Total Exports	0.6149	1.557e-01	0.0109 *	0.7572
Inflation	4332	14886	0.7827	0.01666
Exchange Rate	8072	2143	0.0131 *	0.7394
Trade %	377.4	6656.7	0.957	0.0006425

The positive connection between the Gross domestic product and add up to Imports can be ascribed to the way that India has primarily imported unrefined substances or semi-completed merchandise that were input into the creation interaction. Alongside the import of products India has been bringing in innovation too from the remainder of the world. Consequently, imports were prompting an expansion in total result because of better innovation utilized underway cycles. Subsequently, the All-out Imports impacted the Gross domestic product emphatically.

The impact of All out Imports, Complete Commodities, and swapping scale on Gross domestic product development rate is critical since the p-esteem > 0.05 at 5% degree of importance. Then again, the impact of Expansion and Exchange % on Gross domestic product is immaterial. It shows that on a singular premise Expansion and Exchange % didn't add to the assurance of Gross domestic product during the time of 2015-2021. R-square i.e., coefficient of determination is high for many of the factors such as Total Imports it is 0.6552 which translates to explaining 65.5 % of the variability in data, and for Total Exports, R-square is 0.7572 which is also quite reasonable as it explains 75.7 % of the variability in the data, Also the R-Square for Exchange Rate is 0.7394 which explains 73.9 % of the variability in the data. For Inflation and Trade%, it is 1.6 % and 0.06 % i.e., almost negligible.

Multiple Regression Model (All Variables)

```
> multiple.regression <- lm(GDP ~  Inflation + Trade. + Exchange.Rate + Total.Exports + Total.Imports, data=Regress)
> summary(multiple.regression)

Call:
lm(formula = GDP ~ Inflation + Trade. + Exchange.Rate + Total.Exports +
    Total.Imports, data = Regress)

Residuals:
    1     2     3     4     5     6     7
-911.4 1593.6 -820.1 1305.1 -539.3 -396.1 -231.9

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  -5.562e+05  5.310e+04 -10.475   0.0606 .
Inflation    -1.409e+04  3.213e+03  -4.387   0.1427
Trade.        4.262e+03  8.733e+02   4.880   0.1287
Exchange.Rate 1.071e+04  7.841e+02  13.665   0.0465 *
Total.Exports 1.937e-01  1.990e-01   0.973   0.5086
Total.Imports -9.460e-02  1.431e-01  -0.661   0.6282
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2500 on 1 degrees of freedom
Multiple R-squared:  0.9992,    Adjusted R-squared:  0.9955
F-statistic:   266 on 5 and 1 DF,  p-value: 0.04651
```

Figure 10. Regression Analysis of Exchange Rate, Inflation, Trade%, Total Exports, Total Import & GDP Growth% (Multiple Regression)

In Figure 10, have created a multiple regression model consisting of all the variables where the GDP is set as the dependent variable and all others as the independent variable. In this model, only the Exchange rate shows significance as its individual p-value is less than the

minimum threshold of 0.05 and the overall p-value for the model is 0.04651 which is also < 0.05. Apart from that, the Adjusted R-Squared value is 0.9955 which means the model explains 99.5% of the variability in data.

Conclusion

This paper discusses the effect of international trade on the growth of the Gross Domestic Product of India. This effect is analyzed on the import and export data of India for the accounting years ranging from 2015 to 2021. Although Import and Export rates majorly impact the GDP of a country (India), however, it's not possible to entirely analyze the effect without taking into account various other economic factors such as total imports, total exports, currency exchange rate, merchandise trade%, and inflation rate as these help us to completely understand. To get results, the author has used exploratory research methodology and statistical tools such as Tableau Software to visualize the data and trends, RStudio to perform correlation and regression analysis, and Microsoft Excel for pre-processing and visualization. In order to do this, the author suggests pre-processing the data to assess the data's integrity. Then the correlation between the above-mentioned factors is calculated in order to find the related factors. After the visualization of the related factors, it is concluded that the top three countries accountable for India's International trade are U.S.A., China, and U.A.E. The visualization of correlation analysis also explains that some factors (trade %, imports, and exports) affect the GDP positively and few (inflation and exchange rate) have a negative effect. Lastly, regression analysis is performed, individually and collectively to prove the significance of the variables (economic factors) used to determine the GDP. During linear regression, it was observed that total import, total export, and exchange rate proved to be more significant than the other factors. However, the multiple regression model shows exchange rate to be the only significant factor and the model explains 99.5% of the variability in data.

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