A Study on Impact of Exchange Rate Fluctuations on Indian Exports

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Abstract

The exports of a nation are advantageous to its growth as exports help expand and create a global market for locally produced goods, contributes towards the growth of the Gross Domestic Product (GDP), assists a country earn foreign exchange reserves which could potentially be used to import necessary goods and services to the nation. One of the major ways of promoting exports is to devalue the home currency thereby making the exports cheaper for the potential importers allowing them to import a larger volume of goods from the home country i.e. a cheaper domestic currency increases the total volume of exports. This study takes into account Annual Exchange Rates and exports of different basket of commodities namely Chemical Products, Mineral Products, Precious Metals, Metals & Machines and estimates the existence of correlation between the two variables and estimate the impact of the independent variable (Annual Exchange rates) on the dependent variable (Basket of goods Exported). The correlation between the Annual Exchange rates and Chemical Products and Machines is positive and has a higher regression, the correlation value for Metals is positive. However, the regression is low and the significant value for Mineral Products and Precious metals is greater than 0.05 hence the correlation and regression will not be accepted.

Keywords: Annual Exchange Rates, Annual Exports, Baskets of Commodities.

1. Introduction

The Indian Economy has experienced significant growth in recent years and the thriving exports sector has continuously served as a cornerstone fuelling this economic growth, and integrating the domestic economy with the global economy. The economic growth has been significant due to the extremely dynamic nature of the exports of this nation. India's overall exports projected to scale new heights, growing at 13.84 percent during FY 2022-23 over FY 2021-22 to achieve USD 770.18 billion worth of exports[i]. The main drivers of merchandise export growth in February 2024 include Engineering Goods, Electronic Goods, Organic & Inorganic Chemicals, Drugs & Pharmaceuticals and Petroleum Products. The exports of Drugs and Pharmaceutical Products in February 2024 stands at USD 2.51 Billion, an increase of 22.24% over USD 2.06 Billion in February 2023 Petroleum Products exports in February 2024 register growth of 5.08% at USD 8.24 Billion from USD 7.84 Billion in February 2023[ii].

After the adoption of the Liberalisation, Privatisation and Globalisation model, India's exports have shifted from primary goods to secondary goods such as readymade garments, refined petroleum which made up a significant portion of the exports followed by gems and jewellery and basic chemicals and pharmaceuticals. During the same period, exports of agricultural products such as Rice, Cotton, and fabrics

have declined due to higher demand in the internal market and the objective of the nation to become self-reliant. However, these exports still form a major noticeable part of the total exports of the nation even till this day. From 1995-2005, the primary export from India was textiles which contributed towards the total exports at a declining rate over the decade followed by precious metals. From 2006, the exports of mineral products were the primary exports followed by the exports of gems and jewellery until 2014 when chemical products took over. From 2015-2017, gems and jewellery made up the primary exports which was overtaken by mineral products in 2018. From 2019-2021, chemical products formed the primary exports followed by mineral products.

As exports are one of the factors which contribute towards the growth of an economy, there are several factors which affect the growth of exports. These factors are further divided into Internal factors such as production costs, quality and standards of the product, Government policies and External factors such as Economic conditions across the global economy. Trade policies and regulations, Competition from other nations and Exchange rate fluctuations.

The Indian Rupee has adopted a floating exchange rate, a form of currency peg with respect to the US dollar wherein the value of the Indian Rupee is expressed in terms of US Dollars and this value will be determined and fixed by the market forces of demand and supply. The adoption of a floating exchange rate overtime creates exchange rate fluctuations. Exchange rate fluctuations refers to the continuous change in the relative values of two currencies where the value of one currency expressed in terms of another currency is constantly shifting i.e. it is either appreciating or depreciating. The changes occur in the short term due to speculation and in the long run due to changes in interest rates, inflation and supply and demand.

According to the principles of macroeconomics and features of the global market, exchange rate fluctuations have an impact on the price of exports which indirectly affect the total volume of exports. Following these principles, the changes in value of the Indian Rupee (exchange rate fluctuations) have an impact on the nation's exports wherein a stronger Rupee makes exports expensive and less competitive on the global markets thereby reducing the total volume of exports and a weaker Rupee offers an advantage to the exporters by making the product or service cheaper for potential importers, makes exports more competitive in comparison to other exporters thereby increasing the total volume of exports from the country.

1.1. Need For Study

Exchange Rate fluctuations are complex and affect different sectors, industries and exports from these sectors and industries asymmetrically. The study would take into consideration various basket of goods namely Chemical Products, Mineral Products and Precious Metals exported from India and aims to understand the relationship between exchange rate fluctuations and exports of these basket of commodities and determine the extent of such impact of exchange rates on exports of these basket of commodities.

1.2. Review of Literature

Yin-Wong Cheung & Rajeswari Sengupta (December 2012): This study shows the impact of exchange rate movements on exports specifically from the non-financial sector firms where it was found that the exchange rate movements such as appreciation does have a negative impact on the exports whereas depreciation promotes exports. It was also found that the firms which had smaller export shares tend to have a stronger response to this volatility.

P. R. Venugopal & P. Avinash (November 2022): The study concluded that there is an inverse relationship between the exports of India and the Average exchange rate. If AER (-1) Increases by Rupee

1 then there is a decrease in current year Exports by Rupee 0.607932 & if AER (-1) decrease by Rupee 1 then the Current Period Exports will increase by Rupee 0.607932.

Javed Iqbal, Misbah Nosheen & Mark Wohar (June 2023); This study along with examining the impact of exchange rate fluctuations, also examines the impact of the "Third Country Effect". It finds that when there is an increased volatility in Rupee-Yen exchange rate, it may likely convert into more trade from India to the Us rather than Japan, the third country in the study.

P. Srinivasan &M. Kalaivani (April 2013): This study analyses the impact of exchange rate volatility on the exports of India taking the time period from 1970-2011. The findings indicate that the exchange rate volatility has a noticeable negative impact on real exports both in the short-run and long-run, implying that higher exchange rate fluctuation tends to reduce real exports in India.

Oxford Brookes University (June 2015): This study examines the effect of exchange rate volatilities on international trade of Mexico, Turkey, Nigeria and Indonesia (MINT Economies). It has been found that in the short run, the volatility had a significant impact on the import/exports of Mexico and Indonesia. However, in the long run, only Turkey had shown an impact of volatility on imports and exports which was not very significant.

Manoj Kumar Sinha (September 2016): This study examines the Structural changes in the composition of the Indian Exports post Economic reform period. Taking into account the exports from 1987, the study found out that the overall export of Petroleum products, Chemical Products and Pharmaceuticals have steadily increased over the decades whereas the contribution of precious metals and gemstones to the total exports have remained the same over the years. This study also showed that the policy of import substitution and export promotion has worked in the post-economic reform period as earlier primary commodities were exported whereas now, processed and manufactured goods are being exported alongside primary goods.

Muhammad Azhar (2022); The following study evaluates India's Emergence as a Petroleum Product Exporter. The study took into consideration the data regarding Petroleum Imports and estimated its proportion in total imports, Petroleum Exports and estimated its proportion in total exports, Exports of Motor spirit and its proportion in total exports of Petroleum Products, and Exports of Naphtha and its proportion in total exports of Petroleum Products. Petroleum Products have been contributing to a significant proportion of the Indian Exports. However, the domestic demand still remains high due to which the government needs to play a balancing act to promote exports as well as satisfy the nation's demand.

The World Bank: This study by the International Monetary Fund and International Financial Statistics, which published the data about the Official Exchange rates. These are the rates determined by the national authorities or legally authorised exchange markets. The calculation is done as annual averages which are calculated from the monthly averages of the local currency in units relative to the US Dollar. The Exchange rates in this study are taken from this study for the years 2013-2022

The Observatory of Economic Complexity: This study shows the historical data of Indian Exports until 2022 and defines all the exports and groups them based on the characteristics of the exported commodity. For this study, Exports of Chemical Products (includes Packaged Medicaments, Nitrogen Heterocyclic Compounds, Pesticides, Cyclic Hydrocarbons, Synthetic Colouring Matter, vaccines, Blood, Antisera and Toxin, etc.), Exports of Mineral Products (includes Refined Petroleum, coal tar oil, Iron Ore, Granite, Electricity, Petroleum Gas, Sulphur, Salt, Coke, Petroleum Coke, Barium Sulphate, Clays, Titanium Ore, Coal Briquettes, Cement, Petroleum Jelly, Quartz etc.) and Exports of Precious Metals (includes primarily

includes Diamonds and Jewellery, followed by Synthetic Reconstructed Jewellery Stones, Precious Stones, Precious Metals Scams, Imitation Jewellery, Gold, Platinum, Pearl Products, Metal-Clad Products, Precious Stone Dust, Silver etc.) for the period of 2013-2022.

1.3. Objective

- **Identify types of goods exported:** The first objective of the study is to identify and select the type of goods being exported based on the total value of that type of goods exported. E.g. Chemical products, Mineral products etc.
- **Correlation & Regression Analysis:** Statistical analyses such as Correlation and regression would be applied on the values of exchange rates on a yearly basis and total annual exports to compare and analyse the impact of the former on the latter.

1.4. Methodology of Study

This study would utilise quantitative approach and data to analyse the relationship between the data of the exchange rates and exports of various types of goods from the time period 2013-2022. A correlation analysis would be performed to determine whether there is a direct or inverse relationship between both factors and regression analysis would be performed to obtain the impact and relationship between Exchange rate volatility and exports of various types of goods.

1.5. Scope of Study

The study will take into account the exchange rates of India from a period of 2013-2022 and the exports of three types of goods which are Chemical Products which includes packaged medicaments, pesticides, vaccines, essential oils, etc, Mineral Products which includes Refined petroleum, Iron ore, Salt, Petroleum gas, Coal etc, and precious metals which includes Diamonds, Gold, Silver, Jewellery etc, over the same time period. Correlation and regression analysis will be performed to understand and estimate the impact of exchange rate volatility on the above goods.

1.6. Limitations of Study

- **Time Period:** This study completely uses secondary data for the time period of 2012-2021 and generalisation for the entire time period cannot be done due to change in the dynamics of the economy.
- **Sectoral Focus:** This study takes into account only a few sectors of the exports from India and generalisation of these results to the overall exports of the nation cannot be done due to the varied characteristics and unique demands of each type of goods exported.
- **Policy changes:** The policy changes made by the government during the selected time frame might affect the values and variables in the data which might adversely affect the data taken into consideration.

2. Theoretical Framework

2.1. Exchange Rates

An Exchange rate is the rate at which one nation's currency can be exchanged with another nation's currency. It can also be considered as the value of one currency expressed in terms of another currency. There are several factors which affect exchange rates of currencies. They include Macro-economic factors such as Inflation, Interest Rates, Recession, Balance of trade, Current Account Deficits, etc. and Political factors such as Political Stability of the nation, Public Debt and Government Interventions with the assistance of Central banks.

There are several types of exchange rates which are as follows:

Fixed/Pegged Exchange Rate: Under Pegged exchange rate system, the government or governmental institution such as a central bank sets an exchange rate for the national currency by linking or pegging it to precious metals such as gold (Gold Standard) which was adopted internationally during the 1870s and lasted until the First World War or fixed to a stronger or a globally accepted currency. For e.g. The Saudi Arabian and Qatari Riyal are pegged to the US Dollar since the early 2000s and the value has remained fixed ever since.

Floating/ Flexible Exchange Rate: Under the Floating exchange rate system, the exchange rates are not fixed by the government or governmental institutions. Instead, the exchange rates in this system fluctuate on the basis of demand and supply of both the domestic and foreign currency in the home country and the effects of various economic factors such as inflation and interest rates i.e. the market forces are freely allowed to determine the exchange rates. The examples of such currencies are The US Dollar, Canadian Dollar, Australian Dollar, Japanese Yen, Chilean Peso and Mexican Peso.

Managed Float/ Pegged Float: Managed float exchange rate system is a hybrid system wherein the market forces are allowed to influence the exchange rates. However, from time to time there is an intervention by the nation's government or governmental institutions such as central banks which control and manipulate the demand and supply of the currency in order to artificially appreciate or depreciate the currency value in order to promote exports, impede imports etc. This is done by increasing or decreasing the supply of domestic or foreign currency in the economy, increasing or decreasing the interest rates etc. Examples of currencies that use this system are Indian Rupee, Turkish Lira, Pakistani Rupee, Sri Lankan Rupee etc.

2.1.1. Evolution of Exchange rates in India

In India post-independence, the Bretton Woods system was adopted where a fixed currency exchange rate would be adopted by using gold as the basic standard. During the existence of the system, the India Rupee was pegged to the Pound Sterling. The Rupee was delinked from the Pound Sterling in 1975 as a cause of the decline in trade with the United Kingdom and the subsequent collapse of the Bretton Woods system. From 1975-1992, the exchange rate of Rupee was completely determined by the Reserve bank of India where day to day intervention was done by the Reserve bank. During the 1990s the reserves of foreign currency in India depleted which created a problematic economic system due to which the International Monetary Fund (IMF) suggested India to adopt the Liberalisation, Privatisation and Globalisation (LPG) model. In March 1992, the Liberalised Exchange Rate Management System where dual exchange rate system was adopted where one exchange rate is adopted as the official exchange rate determined by the Central bank i.e. The Reserve Bank of India (RBI) and another exchange rate known as Interbank rate or Market rate where the exchange rate is determined by the market forces of demand and supply dynamics in the foreign exchange market. On 1 March 1993 the dual exchange rate system was converted into one sole exchange rate. The exchange rates in India thereafter have been thus determined by the market dynamics of supply and demand of the foreign exchange rate market with the involvement of the Reserve Bank to maintain the orderly conditions of the foreign exchange market by sales and purchases of the home and foreign currency to maintain the ideal exchange rate[iii].

In this study, the exchange rate refers to the rate determined by national authorities or rates determined by legally sanctioned exchange markets. The exchange rates are annual averages which are estimated based on the monthly average exchange rates and are calculated by the International Monetary Fund and International Financial Statistics and published by the World Bank[iv].

2.2. Exports and Exports of India

Exports are goods and services that are produced in the home country to sell to buyers in a foreign country. Exports along with imports make up international trade. Exports allow the firms of the home country to expand their markets and access the global markets for their goods. The net exports which are the Total Exports less Total Imports (Σ Exports - Σ Imports) form a part of the Gross Domestic Product (GDP) hence Exports also contribute towards the nation's financial and economic well-being and stability. Exports also provide the nation with useful foreign exchange reserves which can be used to purchase necessary imports or manipulate the value of the exchange rate of Indian Rupee in the foreign exchange markets.

2.2.1. History of exports from the Indian Sub-continent

Exports or foreign trade began from the Indian sub-continent during the times of the Indus-valley civilisation where trade primarily flowed to ancient Mesopotamia, another river-based civilization that existed between the Tigris and the Euphrates where it is being believed that the trade surplus was in the favour of the Indus Valley as they exported a lot more than the imports from Mesopotamia. Their exports primarily included gold jewellery, Cotton Textiles, Timber, Precious stones, items made of copper and bronze and livestock such as water buffaloes and live chicken The Mesopotamians primarily exported Woolen textiles, Silver, Copper ingots and Tin.

During later periods the exports still [persisted to flow westwards towards modern day Europe however the trade routes were controlled by the Seleucid Empire and later the Indo-Greek kingdom. However, the trade flowed under heavy restrictions which included precious stones and textiles. With the fall of these kingdoms, direct land routes and sea trade routes were established by the first century B.C.E. between the Roman Empire and the Indian Kingdoms. This trade primarily flowed from the Tamil ports and the primary traded goods were Black pepper, gold, coral, thin clothes, copper, tin, lead, etc.

In the mediaeval era, during the Mughal rule the primary focus was on agriculture hence the primary exports from the Indian subcontinent were of highly valued agricultural products such as cotton, pepper, silk, rice and tobacco.

Later as the British took over India in the form of the establishment of the East India Company and later the merging of the subcontinent into the empire, the exports from India were primarily meant to satisfy the strategic needs of the British Empire. The exports primarily included raw materials, and agricultural goods which included primarily cotton, indigo, salt, pepper, spices, sugar, tea, raw silk, jute. Post independence, till the 1950s the foreign trade still remained directed towards the United Kingdom[v]. In the later years until the Liberalisation, Privatisation and Globalisation model was being adopted, India's exports still primarily consisted of exports of Primary goods such as agricultural produce or the exports of precious metals and gems.

However, upon and after the adoption of the Liberalisation, Privatisation and Globalisation model, India's exports have shifted from primary goods to secondary goods such as readymade garments, refined petroleum which made up a significant portion of the exports followed by gems and jewellery and basic chemicals and pharmaceuticals. During the same period, exports of agricultural products such as Rice, Cotton, and fabrics have declined due to higher demand in the internal market and the objective of the nation to become self-reliant. However, these exports still form a major noticeable part of the total exports of the nation even till this day. From 1995-2005, the primary export from India was textiles which contributed towards the total exports at a declining rate over the decade followed by precious metals. From 2006, the exports of mineral products were the primary exports followed by the exports of gems and

jewellery until 2014 when chemical products took over. From 2015-2017, gems and jewellery made up the primary exports which was overtaken by mineral products in 2018. From 2019-2021, chemical products formed the primary exports followed by mineral products[vi].

From the beginning of time the exports from India always included primary goods such as agricultural products, processed textiles made of cotton, precious metals, gems and jewellery. India has always been a self-sufficient nation when it comes to agricultural goods hence the exports of these products have always existed from the sub-continent. India also always has a thriving precious metals and gemstone industry where India accounts for about 90-95% of the total polished diamonds exports of the world where the primary export markets are the United States of America and China.

In the following study, the exchange rates over the years, Mineral products which primarily includes Refined petroleum, Coal tar, Iron ore, Granite, Petroleum gas, Sulphur, Salt, Titanium ore etc[vii], Chemical Products which include Packaged medicaments, Pesticides, Antibiotics, Vaccines, Toxins, Hormones, Vitamins, Essential oils, Synthetic colouring etc[viii], Precious Metals which includes Diamonds, Jewellery, Synthetic and Reconstructed Jewellery stones, Precious Stones, Gold, Pearl, Platinum products, Imitation Jewellery etc, Metals which include Raw Aluminium, Ferroalloys, Hot Rolled Iron, Iron Structures, Raw Zinc, Semi Finished Iron, Other Iron Products, Iron Pipes, Iron Housewares, Raw Lead, Refined Copper, Other Stainless Steel Bars, Iron Pipe Fittings, Aluminium Foil, Other Aluminium Products [ix], and Machines which include Broadcasting Equipment, Electrical transformers, Gas Turbines, Transmissions, Valves, Insulated Wire, Engine Parts, Combustion Engines, Other Engines, Liquid Pumps, Air Pumps, Excavation Machinery, Electric Motor Parts, Centrifuges, Large Construction Vehicles , Electric Batteries, Electric Motors, ball Bearings etc [x]

2.3. Relationship Between Exchange rates and Exports

A depreciating currency is advantageous for a country interested in export promotion as a depreciating currency makes exports cheaper for foreign buyers. In such a situation, it takes more of the home currency to purchase units of foreign currency and if prices remain relatively stable, it allows the foreign buyers to buy more thereby increasing the export volume and creating a competitive advantage for the home country's exports on the global market. However, this situation will make imports a costly affair for the home country. Conversely, an appreciation of the currency makes the exports of the home currency less competitive as the foreign buyer has to pay more in order to obtain the same amount of goods. However, this conversely makes imports for the home country relatively cheaper.

3. Data Analysis and Interpretation

In this study, line graphs are used to show the changes in exports in comparison to the annual exchange rate fluctuations over the time period of 2013-22 and correlation and regression analyses are performed for Chemical products, Mineral products and precious metals to understand the impact of annual exchange rates on export of the specific group of products and to understand the extent of the impact of changes in annual exchange and exports of specific groups of products.

3.1. HYPOTHESES

- **H_0 (Null Hypothesis):** There is no significant relationship between Annual Exchange Rates and the Exports of Chemical Products, Mineral Products, Precious Metals, Metals & Machines.
- **H_1 (Alternative Hypothesis):** There is significant relationship between Annual Exchange Rates and

the Exports of Chemical Products, Mineral Products, Precious Metals, Metals & Machines.

- The Hypotheses will be tested with the methods of Correlation and Regression and if the significant value is less than 0.05 (Sig Value < 0.05), the null hypothesis will be rejected.

3.2. Data Analysis of Chemical Products:

Exports of Chemical Products include Packaged Medicaments, Nitrogen Heterocyclic Compounds, Pesticides, Cyclic Hydrocarbons, Synthetic Colouring Matter, vaccines, Blood, Antisera and Toxins, Nucleic Acids, Oxygen Amino Compounds, Antibiotics, Essential Oils, Cleaning Products, Beauty Products, Perfumes, Glues, Soap, Hair Products, Shaving Products, Dyes, Enzymes, Waxes etc[xi].

Table 1(a): Years, Exchange Rates [xii](The World Bank) & Chemical Product Exports [xiii](The Observatory of Economic Complexity)

Years	Exchange rates in Rupees	Chemical Products in USD Billions
2013	58.6	37
2014	61.03	36.6
2015	64.15	35.9
2016	67.2	37.2
2017	65.12	40.5
2018	68.39	47.1
2019	70.42	50.6
2020	74.1	50.9
2021	73.92	60.4
2022	78.6	64.3

Table 1(a) shows the data used in the study for 10 years from 2013-2022. It also shows the Annual Exchange rates of India in Rupees for the same time period and Exports of Chemical Products from India whose value is denoted in American Dollars (USD) in Billions. In the table we can see a trend where, as the exchange rate (independent variable) increases, the exports of Chemical products (dependent variable) also rise evenly throughout the 10-year period. This hints towards an existence of a correlation between the two variables.

Graph 1: Annual Exchange Rates (Blue) and Chemical Product Exports in USD Billions
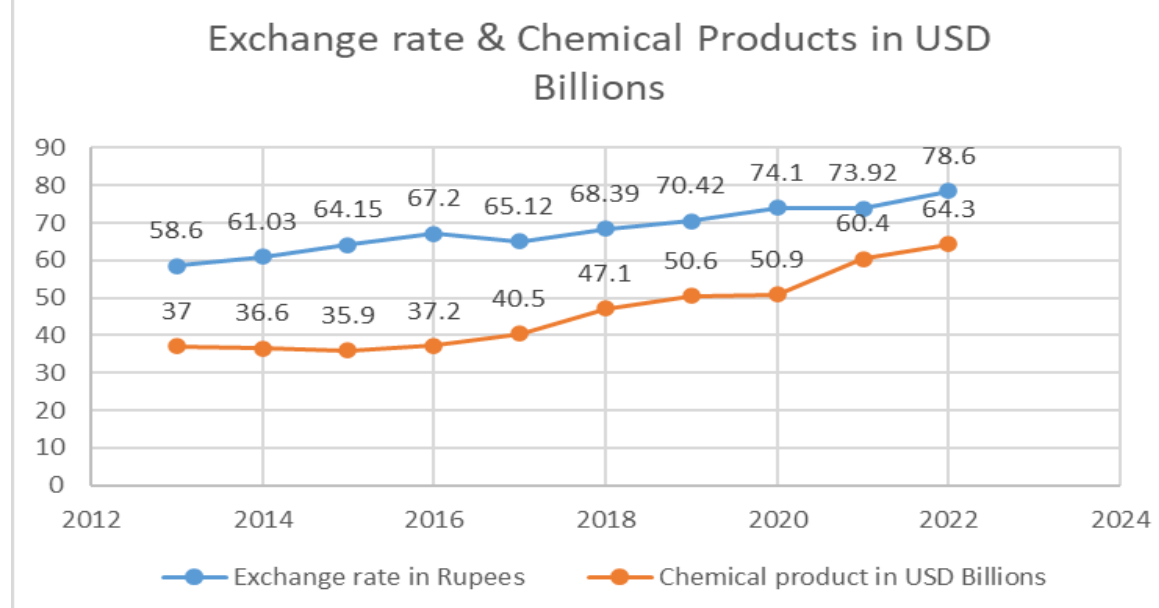
Through Graph 1 where the annual exchange rates and exports of chemical products are shown in the form of a line graph, we can see a clear trend between the two variables where, as the annual exchange rates rise, the exports of Chemical products also evenly climb in value from the year 2013 - 2022. With this it can be assumed that a correlation exists between Annual exchange rates and the exports of said chemical products. The correlation will be estimated by using the Correlation by Pearson and if the significant value is less than 0.05, the correlation is said to be significant and will be accepted.

Table 1(b): Correlation between Exchange rates & Exports of Chemical Products

Correlations		Exchange rate in Rupees	Chemical product in USD Billions
Exchange rate in Rupees	Pearson Correlation	1	.914**
	Sig. (2-tailed)		.000
	N	10	10
Chemical product in USD Billions	Pearson Correlation	.914**	1
	Sig. (2-tailed)	.000	
	N	10	10
**. Correlation is significant at the 0.01 level (2-tailed).			

In the Correlation (Pearson) analysis Table 1(b) Correlation between Exchange Rates and Exports of Chemical Products, the estimated significant value is 0.000. In order to have a significant correlation, the significant value must be less than 0.05 (Sig. <0.05) and since the significant value for the performed analysis is 0.00 which is less than 0.05 (Sig. 0.00 < 0.05), the null hypothesis is rejected and it can be assumed that there exists a significant correlation relationship between Annual exchange rates and Exports of Chemical products. The correlation is considered to be negative if the value is or close -1 and is considered to be positive if the value is or close to +1. Here the Pearson Correlation value for Chemical Products is 0.914, hence there is a highly positive relationship between the Annual exchange rates and

Chemical Product exports i.e. an increase in exchange rates results in the increase in exports of chemical products.

Table 1(c): ANOVA for regression analysis

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	807.605	1	807.605	40.365	.000^b
	Residual	160.060	8	20.008		
	Total	967.665	9			

a. Dependent Variable: Chemical product in USD Billions

b. Predictors: (Constant), Exchange rate in Rupees

To estimate the strength of the relationship between Annual Exchange rates and Exports of Chemical products, Linear Regression analysis is performed. Through ANOVA in Table 1(c) we can estimate the significant value for the two variables i.e. Annual Exchange rates and Exports of Chemical Products. There is a significant impact of one variable on the other if the significant value is less than 0.05 (Sig < 0.05). Here the significant value is 0.00 which is less than the maximum amount of 0.05 (Sig 0.00 < 0.05) Hence the null hypothesis is rejected and it can be assumed that there is a significant impact of the Annual Exchange Rates (independent variable) on Exports of Chemical Products (Dependent Variable).

Table 1(d): Regression Analysis between Exchange Rates & Chemical Products

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.914^a	.835	.814	4.47298

a. Predictors: (Constant), Exchange rate in Rupees

Through the Regression analysis shown in Table 1(d), the estimated R value is 0.914 which indicates a positive correlation i.e. a rise in Annual Exchange rate (independent variable) also results in an even rise in the Exports of chemical Products (dependent variable). R-Square is used to estimate the proportion of variance in the dependent variable (Exports of Chemical Products) which is caused by the independent variable (Annual Exchange rates). Here the R-Square value is 0.835 i.e. 83.5% which indicates that 83.5% of the variance in the dependent variable (Exports of Chemical Products) can be explained by the independent variable (Annual Exchange Rates).

3.2. Data Analysis of Mineral Products

Exports of Mineral Products include a wide bucket of items which are Refined Petroleum, coal tar oil, Iron Ore, Granite, Electricity, Petroleum Gas, Sulphur, Salt, Coke, Petroleum Coke, Barium Sulphate, Clays, Titanium Ore, Coal Briquettes, Cement, Petroleum Jelly, Quartz etc[xiv].

Table 2(a): Years, Exchange rates [xv](The World Bank) & Mineral Product Exports [xvi] (The Observatory of Economic Complexity)

Years	Exchange Rates in Rupees	Mineral Products in USD Billions
2013	58.6	69.1
2014	61.03	66.7
2015	64.15	33.8
2016	67.2	30
2017	65.12	38.4
2018	68.39	52.9
2019	70.42	46.9
2020	74.1	33.5
2021	73.92	59.1
2022	78.6	95

Table 2(a) shows the data used in the study for 10 years from 2013-2022. It also shows the Annual Exchange rates of India in Rupees for the same time period and Exports of Mineral Products from India whose value is denoted in American Dollars (USD) in Billions. In the table, a trend between the Annual Exchange rates (independent variable) and Exports of Mineral Products (dependent variable is not evident. This hints towards limited or no correlation between the two variables.

Graph 2: Annual Exchange Rates (Blue) and Exports of Mineral Products in USD Billions
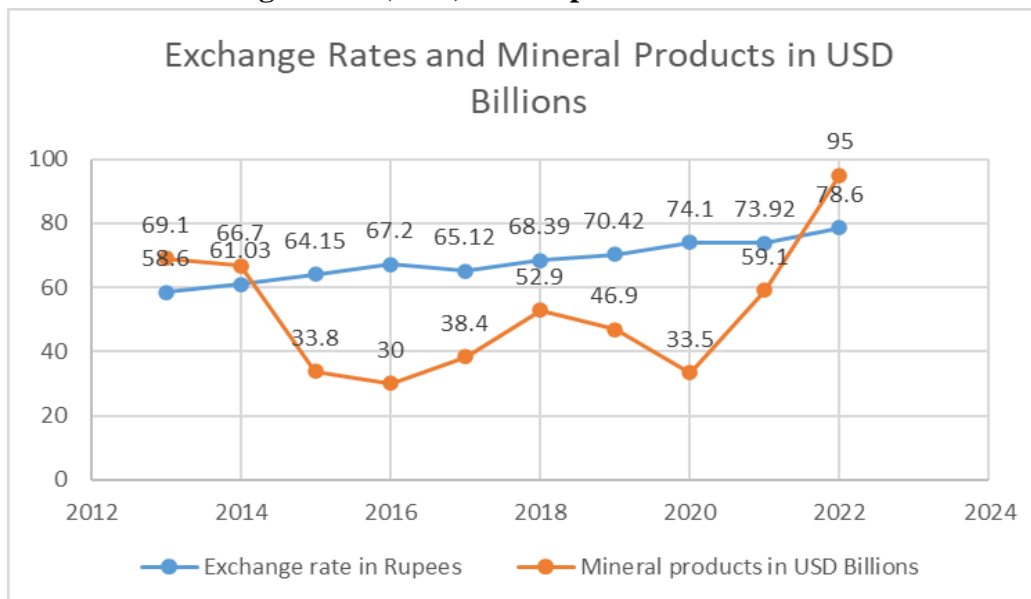
Through Graph 2 where the annual exchange rates and exports of Mineral products are shown in the form of a line graph, there does not exist a clear trend between the two variables, which are annual exchange rates and the exports of Mineral products. There is a clear fall in the exports of mineral products between 2015 and 2018 and another fall in 2019 and 2020. With this it can be assumed that correlation does not exist between Annual exchange rates and the exports of said Mineral Products. The correlation will be estimated by using the Correlation by Pearson and if the significant value is less than 0.05, the correlation is said to be significant and will be accepted.

Table 2(b): Correlation between Exchange rates & Exports of Mineral Products

Correlations

		Exchange rate in Rupees	Mineral & petroleum products in USD Billions
Exchange rate in Rupees	Pearson Correlation	1	.205
	Sig. (2-tailed)		.570
	N	10	10
Mineral &petroleum products in USD Billions	Pearson Correlation	.205	1
	Sig. (2-tailed)	.570	
	N	10	10

In the Correlation (Pearson) analysis Table 2(b) Correlation between Exchange Rates and Exports of Mineral Products, the estimated significant value is 0.570. In order to have a significant correlation, the significant value must be less than 0.05 (Sig. <0.05) and since the significant value for the performed analysis is 0.570 which is greater than 0.05 (Sig. 0.570 > 0.05), the null hypothesis is accepted and the relationship between Annual exchange rates and Exports of Mineral products does not have significant correlation. The correlation is considered to be negative if the value is or close -1 and is considered to be positive if the value is or close to +1. Here the Pearson Correlation value for Mineral Products is 0.205, hence there is a low positive relationship between the Annual exchange rates and Mineral Product exports.

Table 2(c): ANOVA for regression analysis

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	158.374	1	158.374	.350	.570[b]
	Residual	3615.890	8	451.986		
	Total	3774.264	9			

a. Dependent Variable: Mineral &petroleum products in USD Billions

b. Predictors: (Constant), Exchange rate in Rupees

To estimate the strength of the relationship between Annual Exchange rates and Exports of Mineral products, Linear Regression analysis is performed. Through ANOVA in Table 2(c) we can estimate the significant value for the two variables i.e. Annual Exchange rates and Exports of Mineral Products. There is a significant impact of one variable on the other if the significant value is less than 0.05 (Sig < 0.05). Here the significant value is 0.570 which is greater than the maximum amount of 0.05 (Sig 0.570 > 0.05). Hence the null hypothesis is accepted and it can be assumed that there is no significant impact of the Annual Exchange Rates (independent variable) on Exports of Mineral Products (Dependent Variable).

Table 2(d): Regression Analysis between exchange Rate & Mineral Products

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.205[a]	.042	-.078	21.25997

a. Predictors: (Constant), Exchange rate in Rupees

Through the Regression analysis shown in Table 2(d), the estimated R value is 0.205 which indicates a low positive correlation i.e. a rise in Annual Exchange rate (independent variable) results in a low rise in the Exports of Mineral Products (dependent variable). R-Square is used to estimate the proportion of variance in the dependent variable (Exports of Mineral Products) which is caused by the independent variable (Annual Exchange rates). Here the R-Square value is 0.042 i.e. 4.2% which indicates that 4.2% of the variance in the dependent variable (Exports of Mineral Products) can be explained by the independent variable (Annual Exchange Rates) which indicates that factors other than Exchange rates influence the exports of Mineral Products.

3.3. Data Analysis of Precious Metals

Exports of Precious Metals primarily includes Diamonds and Jewellery, followed by Synthetic Reconstructed Jewellery Stones, Precious Stones, Precious Metals Scraps, Imitation Jewellery, Gold, Platinum, Pearl Products, Metal-Clad Products, Precious Stone Dust, Silver etc[xvii].

Table 3(a): Years, Exchange rates [xviii](The World Bank) & Exports of Precious Metals [xix](The Observatory of Economic Complexity)

Year	Exchange rates in Rupees	Precious Metals in USD Billions
2013	58.6	44
2014	61.03	36
2015	64.15	40.3
2016	67.2	43.6

2017	65.12	44.4
2018	68.39	41
2019	70.42	39.2
2020	74.1	26.1
2021	73.92	40.6
2022	78.6	41.6

Table 3(a) shows the data used in the study for 10 years from 2013-2022. It also shows the Annual Exchange rates of India in Rupees for the same time period and Exports of Precious Metals from India whose value is denoted in American Dollars (USD) in Billions. In the table, a trend between the Annual Exchange rates (independent variable) and Exports of Mineral Products (dependent variable) is not evident. This hints towards limited or no correlation between the two variables.

Graph 3: Annual Exchange Rates (Blue) and Exports of Precious Metals in USD Billions
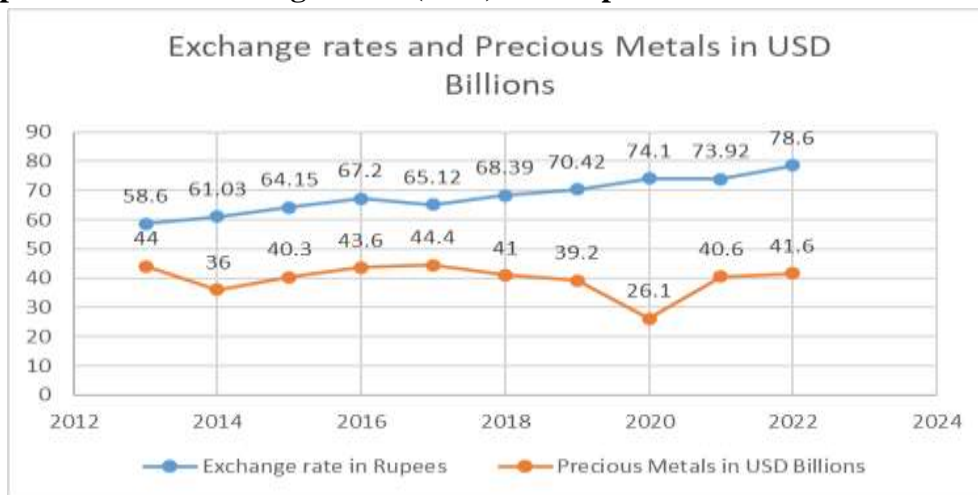
Through Graph 3 where the Annual Exchange Rates and exports of Precious metals are shown in the form of a line graph, there does not exist a clear trend between the two variables, which are annual exchange rates and the exports of Precious Metals. There is a clear fall in the exports of Precious Metals between 2018 and 2020. With this it can be assumed that correlation does not exist between Annual exchange rates and the exports of said Precious Metals Products. The correlation will be estimated by using the Correlation by Pearson and if the significant value is less than 0.05, the correlation is said to be significant and will be accepted.

Table 3(b): Correlation between Exchange rates & Exports of Precious Metals

Correlations

		Exchange rate in Rupees	Precious Metals in USD Billions
Exchange rate in Rupees	Pearson Correlation	1	-.303
	Sig. (2-tailed)		.395
	N	10	10
Precious Metals in USD Billions	Pearson Correlation	-.303	1
	Sig. (2-tailed)	.395	
	N	10	10

In the Correlation (Pearson) analysis Table 3(b) Correlation between Exchange Rates and Exports of Precious Metals, the estimated significant value is 0.395. In order to have a significant correlation, the significant value must be less than 0.05 (Sig. <0.05) and since the significant value for the performed analysis is 0.395 which is greater than 0.05 (Sig. 0.395 > 0.05), therefore the null hypothesis is accepted and there is no significant correlation relationship between Annual exchange rates and Exports of Precious Metals. The correlation is considered to be negative if the value is or close -1 and is considered to be positive if the value is or close to +1. Here the Pearson Correlation value for Precious Metals is -0.303, hence there is a low negative relationship between the Annual exchange rates and Precious metal exports.

Table 3(c): ANOVA for Regression analysis

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.983	1	23.983	.809	.395^b
	Residual	237.173	8	29.647		
	Total	261.156	9			

a. Dependent Variable: Precious Metals in USD Billions

b. Predictors: (Constant), Exchange rate in Rupees

To estimate the strength of the relationship between Annual Exchange rates and Exports of Precious Metals, Linear Regression analysis is performed. Through ANOVA in Table 3(c) we can estimate the significant value for the two variables i.e. Annual Exchange rates and Exports of Precious Metals. There is a significant impact of one variable on the other if the significant value is less than 0.05 (Sig < 0.05). Here the significant value is 0.395 which is greater than the maximum amount of 0.05 (Sig 0.395 > 0.05). Hence the null hypothesis is accepted and it can be assumed that there is no significant impact of the Annual Exchange Rates (independent variable) on Exports of Precious Metals (Dependent Variable).

Table 3(d): Regression Analysis between Exchange rates & Exports of Precious Metals

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.303[a]	.092	-.022	5.44487

a. Predictors: (Constant), Exchange rate in Rupees

Through the Regression analysis shown in Table 3(d), the estimated R value is 0.303 which indicates a low positive correlation i.e. a rise in Annual Exchange rate (independent variable) results in a low rise in the Exports of Precious metals (dependent variable). R-Square is used to estimate the proportion of variance in the dependent variable (Exports of Precious Metals) which is caused by the independent variable (Annual Exchange rates). Here the R-Square value is 0.092 i.e. 9.2% which indicates that 9.2% of the variance in the dependent variable (Exports of Precious Metals) can be explained by the independent variable (Annual Exchange Rates) which indicates that factors other than Exchange rates influence the exports of Precious Metals.

3.4. Data Analysis of Metals

Exports of Metals include Raw Aluminium, Ferroalloys, Hot Rolled Iron, Iron Structures, Raw Zinc, Semi Finished Iron, Other Iron Products, Iron Pipes, Iron Housewares, Raw Lead, Refined Copper, Other Stainless-Steel Bars, Iron Pipe Fittings, Aluminium Foil, Other Aluminium Products etc[xx].

Table 4(a): Years, Exchange rates [xxi](The World Bank) & Exports of Metals [xxii](The Observatory of Economic Complexity)

Year	Exchange Rate in Rupees	Metals in USD Billions
2013	58.6	26.5
2014	61.03	26.8
2015	64.15	22.9
2016	67.2	20.5
2017	65.12	30.2
2018	68.39	28.8
2019	70.42	27.3
2020	74.1	27.2
2021	73.92	46.1
2022	78.6	44.8

Table 4(a) shows the data used in the study for 10 years from 2013-2022. It also shows the Annual Exchange rates of India in Rupees for the same time period and Exports of Metals from India whose value is denoted in American Dollars (USD) in Billions. In the table a clear trend cannot be seen between the Annual Exchange Rates (independent variable) and the Exports of metals (dependent variable), as the exchange rate (independent variable) increases, the exports of Metals (dependent variable) rise unevenly throughout the 10-year period. This hints towards an existence of a moderate correlation between the two variables.

Graph 4: Annual Exchange Rates (Blue) and Exports of Metals in USD Billions
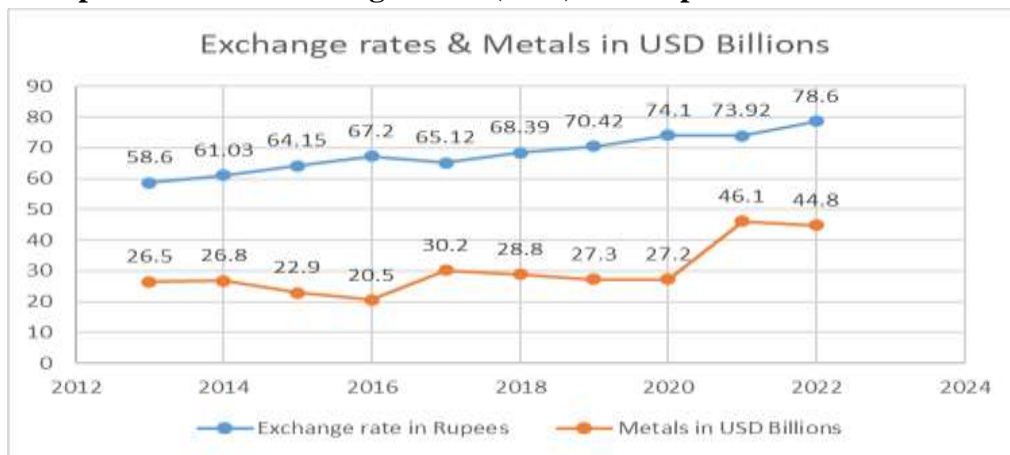
Through Graph 4 where the annual exchange rates and exports of metals are shown in the form of a line graph, we can see a clear trend between the two variables where, as the annual exchange rates rise, the exports of Metals unevenly climb in value from the year 2013 - 2022. With this it can be assumed that a moderate correlation exists between Annual exchange rates and the exports of said metal products. The correlation will be estimated by using the Correlation by Pearson and if the significant value is less than 0.05, the correlation is said to be significant and will be accepted.

Table 4(b): Correlation between Exchange rates & Exports of Metal

Correlations

		Exchange rate in Rupees	Metals in USD Billions
Exchange rate in Rupees	Pearson Correlation	1	.661[*]
	Sig. (2-tailed)		.038
	N	10	10
Metals in USD Billions	Pearson Correlation	.661[*]	1
	Sig. (2-tailed)	.038	
	N	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

In the Correlation (Pearson) analysis Table 4(b) Correlation between Exchange Rates and Exports of Metal Products, the estimated significant value is 0.038. In order to have a significant correlation, the significant value must be less than 0.05 (Sig. <0.05) and since the significant value for the performed analysis is 0.038 which is less than 0.05 (Sig. 0.038 < 0.05), the null hypothesis is rejected and the relationship between Annual exchange rates and Exports of Metal products has significant correlation. The correlation is considered to be negative if the value is or close -1 and is considered to be positive if the value is or close

to +1. Here the Pearson Correlation value for Metal Products is 0.661, hence there is a moderately positive relationship between the Annual exchange rates and Metal Product exports i.e. an increase in exchange rates results in the increase in exports of Metal products.

Table 4(c): ANOVA for Regression analysis

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	287.133	1	287.133	6.196	.038[b]
	Residual	370.756	8	46.344		
	Total	657.889	9			

a. Dependent Variable: Metals in USD Billions

b. Predictors: (Constant), Exchange rate in Rupees

To estimate the strength of the relationship between Annual Exchange rates and Exports of Metal products, Linear Regression analysis is performed. Through ANOVA in Table 4(c) we can estimate the significant value for the two variables i.e. Annual Exchange rates and Exports of Metal Products. There is a significant impact of one variable on the other if the significant value is less than 0.05 (Sig < 0.05). Here the significant value is 0.038 which is less than the maximum amount of 0.05 (Sig 0.00 < 0.05). Hence the null hypothesis is rejected and it can be assumed that there is a significant impact of the Annual Exchange Rates (independent variable) on Exports of Metal Products (Dependent Variable).

Table 4(d): Regression Analysis between Exchange rates & Exports of Metals

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.661[a]	.436	.366	6.8077

a. Predictors: (Constant), Exchange rate in Rupees

Through the Regression analysis shown in Table 4(d), the estimated R value is 0.661 which indicates a positive correlation i.e. a rise in Annual Exchange rate (independent variable) also results in an even rise in the Exports of Metal Products (dependent variable). R-Square is used to estimate the proportion of variance in the dependent variable (Exports of Metal Products) which is caused by the independent variable (Annual Exchange rates). Here the R-Square value is 0.436 i.e. 43.6% which indicates that 43.6% of the variance in the dependent variable (Exports of Metal Products) can be explained by the independent variable (Annual Exchange Rates).

3.5. Data Analysis of Machines

Exports of Machines include Broadcasting Equipment, Electrical transformers, Gas Turbines, Transmissions, Valves, Insulated Wire, Engine Parts, Combustion Engines, Other Engines, Liquid Pumps,

Air Pumps, Excavation Machinery, Electric Motor Parts, Centrifuges, Large Construction Vehicles, Electric Batteries, Electric Motors, ball Bearings etc[xxiii].

Table 5(a): Years, Exchange rates [xxiv](The World Bank) & Exports of Machines [xxv](The Observatory of Economic Complexity)

Year	Exchange Rates in Rupees	Machines in USD Billions
2013	58.6	26.2
2014	61.03	25.4
2015	64.15	24.1
2016	67.2	24.8
2017	65.12	28
2018	68.39	34.3
2019	70.42	38
2020	74.1	33.3
2021	73.92	45.1
2022	78.6	56.9

Table 5(a) shows the data used in the study for 10 years from 2013-2022. It also shows the Annual Exchange rates of India in Rupees for the same time period and Exports of Machines from India whose value is denoted in American Dollars (USD) in Billions. In the table a clear trend cannot be seen between the Annual Exchange Rates (independent variable) and the Exports of Machines (dependent variable), as the exchange rate (independent variable) increases, the exports of Metals (dependent variable) rise unevenly throughout the 10-year period. This hints towards an existence of a moderate correlation between the two variables.

Graph 5: Annual Exchange Rates (Blue) and Exports of Machines in USD Billions
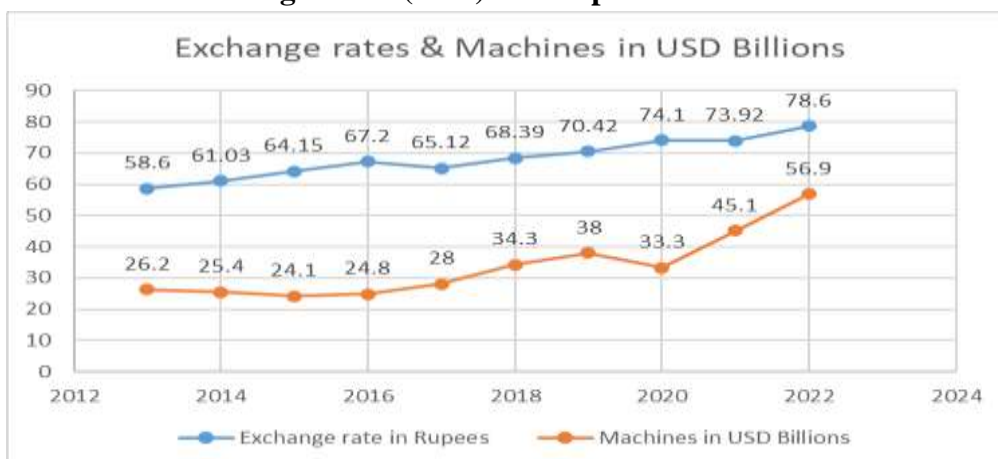
Through Graph 5 where the annual exchange rates and exports of machines are shown in the form of a line graph, we can see a clear trend between the two variables where, as the annual exchange rates rise, the exports of machines unevenly climb in value from the year 2013 - 2022. With this it can be assumed that a moderate correlation exists between Annual exchange rates and the exports of said machines. The correlation will be estimated by using the Correlation by Pearson and if the significant value is less than 0.05, the correlation is said to be significant and will be accepted.

Table 5(b): Correlation between Exchange rates & Exports of Machines

Correlations

		Exchange rate in Rupees	Machines in USD Billions
Exchange rate in Rupees	Pearson Correlation	1	.855**
	Sig. (2-tailed)		.002
	N	10	10
Machines in USD Billions	Pearson Correlation	.855**	1
	Sig. (2-tailed)	.002	
	N	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

In the Correlation (Pearson) analysis Table 5(b) Correlation between Exchange Rates and Exports of Machines, the estimated significant value is 0.002. In order to have a significant correlation, the significant value must be less than 0.05 (Sig. <0.05) and since the significant value for the performed analysis is 0.002 which is less than 0.05 (Sig. $0.002 < 0.05$), the null hypothesis is rejected and there is a significant correlation relationship between Annual exchange rates and Exports of Machines. The correlation is considered to be negative if the value is or close -1 and is considered to be positive if the value is or close to +1. Here the Pearson Correlation value for Machines is 0.855, hence there is a moderately positive relationship between the Annual exchange rates and Machine exports i.e. an increase in exchange rates results in the increase in exports of machine products.

Table 5(c): ANOVA for Regression analysis

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	742.562	1	742.562	21.715	.002[b]
	Residual	273.567	8	34.196		
	Total	1016.129	9			

a. Dependent Variable: Machines in USD Billions

b. Predictors: (Constant), Exchange rate in Rupees

To estimate the strength of the relationship between Annual Exchange rates and Exports of Machines, Linear Regression analysis is performed. Through ANOVA in Table 5(c) we can estimate the significant value for the two variables i.e. Annual Exchange rates and Exports of Machines. There is a significant impact of one variable on the other if the significant value is less than 0.05 (Sig < 0.05). Here the

significant value is 0.002 which is less than the maximum amount of 0.05 (Sig 0.00 < 0.05) Hence the null hypothesis is rejected and it can be assumed that there is a significant impact of the Annual Exchange Rates (independent variable) on Exports of Machines (Dependent Variable).

Table 5(d): Regression Analysis between Exchange rates & Exports of Machines

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.855[a]	.731	.697	5.8477

a. Predictors: (Constant), Exchange rate in Rupees

Through the Regression analysis shown in Table 5(d), the estimated R value is 0.855 which indicates a positive correlation i.e. a rise in Annual Exchange rate (independent variable) also results in an even rise in the Exports of Machines (dependent variable). R-Square is used to estimate the proportion of variance in the dependent variable (Exports of Machines) which is caused by the independent variable (Annual Exchange rates). Here the R-Square value is 0.731 i.e. 73.1% which indicates that 73.1% of the variance in the dependent variable (Exports of Machines) can be explained by the independent variable (Annual Exchange Rates).

4. Findings of the Study

In the following study, correlation and regression analyses have been used to estimate the relationship between and estimate the variance of the dependent variable that is caused by the changes in dependent variable. In the study, Annual Exchange Rates of India in Rupees are the independent variable and the dependent variables are Exports of Chemical Products in US Dollars in Billions, Exports of Mineral Products in US Dollars in Billions, Exports of Precious Metals in US Dollars in Billions, Exports of Metals in US Dollars in Billions and Exports of Machines in US Dollars in Billions.

4.1. Findings regarding the relationship between Exchange Rates and Exports of Chemical Products:

From table 1(a) and Graph 1, a clear trend can be seen where, as the Annual Exchange rates (independent variable) increased, there has been an even increase in the exports of Chemical products (dependent variable) which indicates a positive correlation between both the variables. A Pearson Correlation analysis has been performed and the relationship between the independent and dependent variables would be considered to be significant if the calculated Significant value is less than 0.05 (Sig. < 0.05). In this case from table 1(b) the calculated significant value obtained is 0.000 which is less than 0.05 (Calculated Sig. 0.00 < 0.05). Hence the null hypothesis is rejected and it can be concluded that a significant relationship exists between the Annual Exchange rates and Exports of Chemical Products. The correlation values range from -1 to +1, either indicating a positive or a negative relationship. The Pearson Correlation value from table 1(b) is 0.931 which is close to +1 hence the relationship between Annual Exchange rates and Exports of Chemical Products is highly positive i.e. an increase in the independent variable (exchange rates) results in an equal amount of rise in the dependent variable (Exports of Chemical Products).

Further, Linear Regression has been performed to estimate the variance in the dependent variable (Exports of Chemical Products) that is explained by the independent variable (Annual Exchange rates). For regression to be significant, the calculated significant value should be less than 0.05 (Sig < 0.05). From table 1(c) we see that the significant value is 0.00 which is less than 0.05 (Sig 0.00 < 0.05). Hence the null hypothesis is rejected and it can be concluded that there is a significant regression between the Annual Exchange rates and Exports of Chemical Products. From Table 1(d), the Adjusted R-Square value is 0.835 i.e. 83.5% which indicates that 83.5% of the variance in the dependent variable (Exports of Chemical Products) is explained by the independent variable (Annual Exchange Rates).

4.2. Findings regarding the relationship between Exchange Rates and Exports of Mineral Products:
From table 2(a) and Graph 2, a trend cannot be seen between the Annual Exchange Rates (independent variable) and Exports of Mineral Products (dependent variable) which indicates a low or no correlation between Independent Variable (Annual Exchange Rates) and the dependent variable (Exports of Mineral Products). A Pearson Correlation analysis has been performed and the relationship would be considered to be significant if the Significant value is less than 0.05 (Sig. < 0.05). In this case from table 2(b) the calculated significant value is 0.570 which is greater than 0.05 (Calculated Sig. 0.570 > 0.05). Hence the null hypothesis is accepted and it can be concluded that a significant relationship does not exist between the Annual Exchange rates (independent variable) and Mineral Products (dependent variable). The correlation values range from -1 to +1, either indicating a positive or a negative relationship. The Pearson Correlation value from table 2(b) is 0.205 which is positive. Hence the relationship between Annual Exchange rates and Exports of Mineral Products is very insignificant. i.e. an increase in the independent variable (exchange rates) does not result in an equal amount of rise in the dependent variable (Exports of Mineral Products).

Further, Linear Regression has been performed to estimate the variance in the dependent variable (Exports of Mineral Products) that is explained by the independent variable (Annual Exchange Rates). For regression to be significant, the calculated significant value should be less than 0.05 (Sig < 0.05). From table 2(c) we see that the significant value is 0.570 which is greater than 0.05 (Sig 0.570 > 0.05). Hence the null hypothesis is accepted and it can be concluded that there is no significant regression between the Annual Exchange rates and Exports of Mineral Products. From Table 2(d), the Adjusted R-Square value is 0.042 i.e. 4.2% which indicates that 4.2% of the variance in the dependent variable (Exports of Mineral Products) is explained by the independent variable (Annual Exchange Rates) which is extremely low regression.

4.3. Findings regarding the relationship between Exchange rates and Exports of Precious Metals:
From table 3(a) and Graph 3, a trend cannot be seen between the Annual Exchange Rates (independent variable) and Exports of Precious Metals (dependent variable) which indicates a low or no correlation between Independent Variable (Annual Exchange Rates) and the dependent variable (Exports of Precious Metals). Further, a Pearson Correlation analysis has been performed and the relationship would be considered to be significant if the Significant value is less than 0.05 (Sig. < 0.05). In this case from table 3(b) the calculated significant value is 0.395 which is greater than 0.05 (Calculated Sig. 0.395 > 0.05). Hence the null hypothesis is accepted and it can be concluded that a significant relationship does not exist between the two variables which are the Annual Exchange Rates and Exports of Precious metals. The correlation values range from -1 to +1, either indicating a positive or a negative relationship. The Pearson Correlation value from table 3(b) is -0.303 which is negative. Hence the relationship between Annual Exchange rates and Exports of Precious Metals is negative and very insignificant.

Further, Linear Regression has been performed to estimate the variance in the dependent variable (exports of Precious Metals) that is explained by the independent variable (Annual Exchange Rates). For regression to be significant, the calculated significant value should be less than 0.05 (Sig < 0.05). From table 3(c) we see that the significant value is 0.395 which is greater than 0.05 (Sig 0.395 > 0.05). Hence the null hypothesis is accepted and it can be concluded that there is no significant regression between the two variables. From Table 3(d), the Adjusted R-Square value is 0.092 i.e. 9.2% which indicates that 9.2% of the variance in the dependent variable (Exports of Precious Metals) is explained by the independent variable (Annual Exchange Rates) which is extremely low regression.

4.4. Findings regarding the relationship between Exchange rates and Exports of Metals:

From table 4(a) and Graph 4, a clear trend cannot be seen. However, as the Annual Exchange rates (independent variable) increased, there has been an uneven positive increase in the exports of Chemical products (dependent variable) which indicates a moderately positive correlation between both the variables. A Pearson Correlation analysis has been performed and the relationship between the independent and dependent variables would be considered to be significant if the calculated Significant value is less than 0.05 (Sig. < 0.05). In this case from table 4(b) the calculated significant value obtained is 0.038 which is less than 0.05 (Calculated Sig. 0.00 < 0.05). Hence the null hypothesis is rejected and it can be concluded that a significant relationship exists between the Annual Exchange rates and Exports of Metal Products. The correlation values range from -1 to +1, either indicating a positive or a negative relationship. The Pearson Correlation value from table 4(b) is 0.661 which is between 0 and +1 hence the relationship between Annual Exchange rates and Exports of Metal Products is moderately positive i.e. an increase in the independent variable (exchange rates) results in an unequal amount of rise in the dependent variable (Exports of Chemical Products).

Further, Linear Regression has been performed to estimate the variance in the dependent variable (Exports of Chemical Products) that is explained by the independent variable (Annual Exchange rates). For regression to be significant, the calculated significant value should be less than 0.05 (Sig < 0.05). From table 4(c) we see that the significant value is 0.038 which is less than 0.05 (Sig 0.038 < 0.05). Hence the null hypothesis is rejected and it can be concluded that there is a significant regression between the Annual Exchange rates and Exports of Metal Products. From Table 4(d), the Adjusted R-Square value is 0.436 i.e. 43.6% which indicates that 43.6% of the variance in the dependent variable (Exports of Metal Products) is explained by the independent variable (Annual Exchange Rates).

4.5. Findings regarding the relationship between Exchange rates and Exports of Machines:

From table 5(a) and Graph 5, a clear trend can be seen where, as the Annual Exchange rates (independent variable) increased, there has been an even increase in the exports of Machines (dependent variable) which indicates a positive correlation between both the variables. A Pearson Correlation analysis has been performed and the relationship between the independent and dependent variables would be considered to be significant if the calculated Significant value is less than 0.05 (Sig. < 0.05). In this case from table 5(b) the calculated significant value obtained is 0.002 which is less than 0.05 (Calculated Sig. 0.002 < 0.05). Hence the null hypothesis is rejected and it can be concluded that a significant relationship exists between the Annual Exchange rates and Exports of Machines. The correlation values range from -1 to +1, either indicating a positive or a negative relationship. The Pearson Correlation value from table 5(b) is 0.855 which is close to +1 hence the relationship between Annual Exchange rates and Exports of Machines is highly positive i.e. an increase in the independent variable (exchange rates) results in an equal amount of rise in the dependent variable (Exports of Machines).

Further, Linear Regression has been performed to estimate the variance in the dependent variable (Exports of Machines) that is explained by the independent variable (Annual Exchange rates). For regression to be significant, the calculated significant value should be less than 0.05 (Sig < 0.05). From table 5(c) we see that the significant value is 0.002 which is less than 0.05 (Sig $0.002 < 0.05$). Hence the null hypothesis is rejected and it can be concluded that there is a significant regression between the Annual Exchange rates and Exports of Machines. From Table 5(d), the Adjusted R-Square value is 0.731 i.e. 73.1% which indicates that 73.1% of the variance in the dependent variable (Exports of Machines) is explained by the independent variable (Annual Exchange Rates).

4.6. Conclusions Regarding Exchange Rate between Indian Rupee and US Dollar:

Graph 4 - Exchange Rate between Indian Rupee & US Dollar [xxvi](2013-2022)
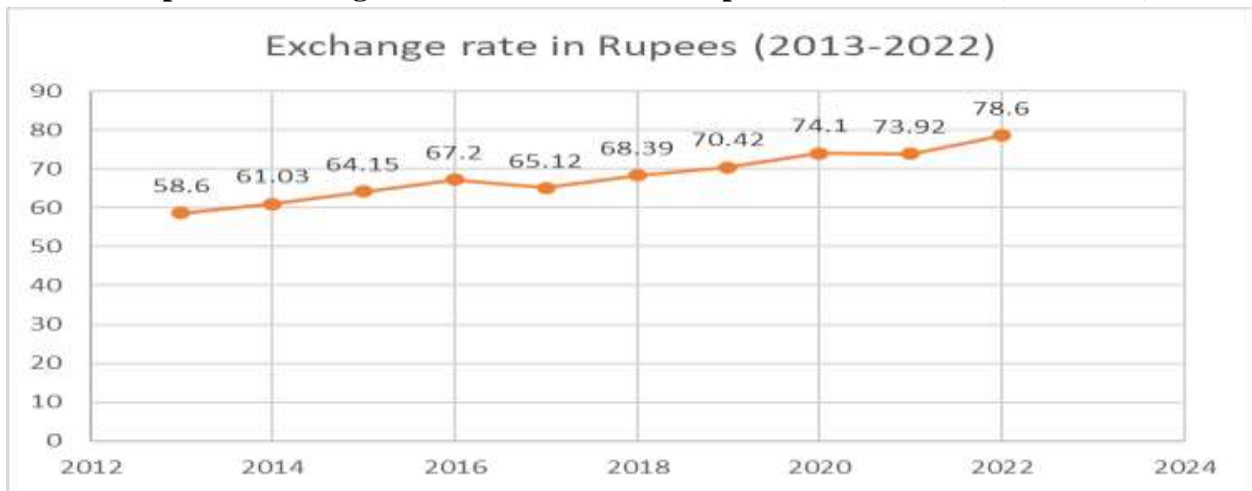
This study took into consideration the annual exchange rates from the time period of 2013 till 2022 i.e. for 10 years. There has been a rise in the exchange rates and this is because of India's trade deficits, global uncertainty which resulted in the increase in the demand for the dollar. The Indian Rupee had been trading at ₹ 83 in September 2013 whereas in 2022 it traded at ₹ 89. Hence it can be assumed that the increase in the exchange rate of the Indian Rupee in regards to the US Dollar is due to the increase in the demand and strength of the US Dollar and not due to the weakening or depreciating of the Rupee[xxvii].

4.7. Conclusions regarding the relationship between Exchange rates and Exports of Chemical Products:

Graph 5 - Exports of Chemical Products from India in USD Billions [xxviii](2013-2022)
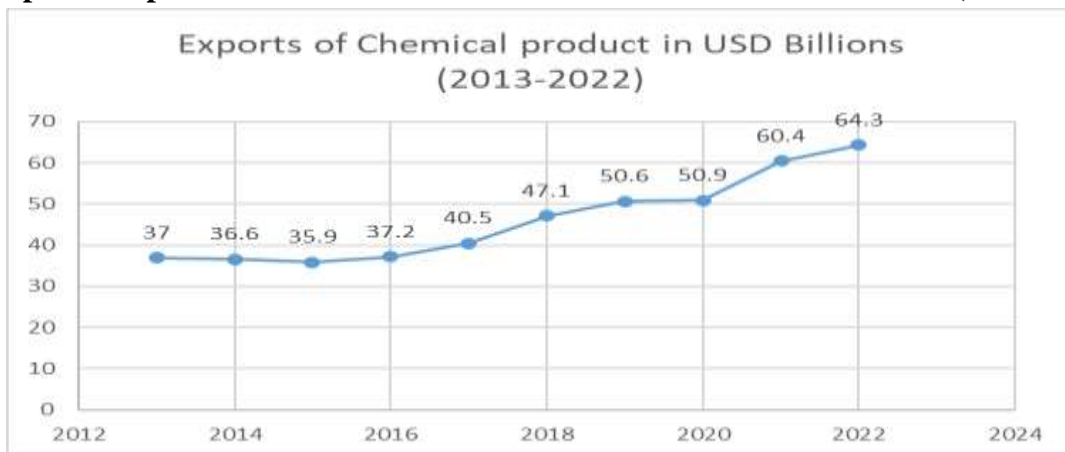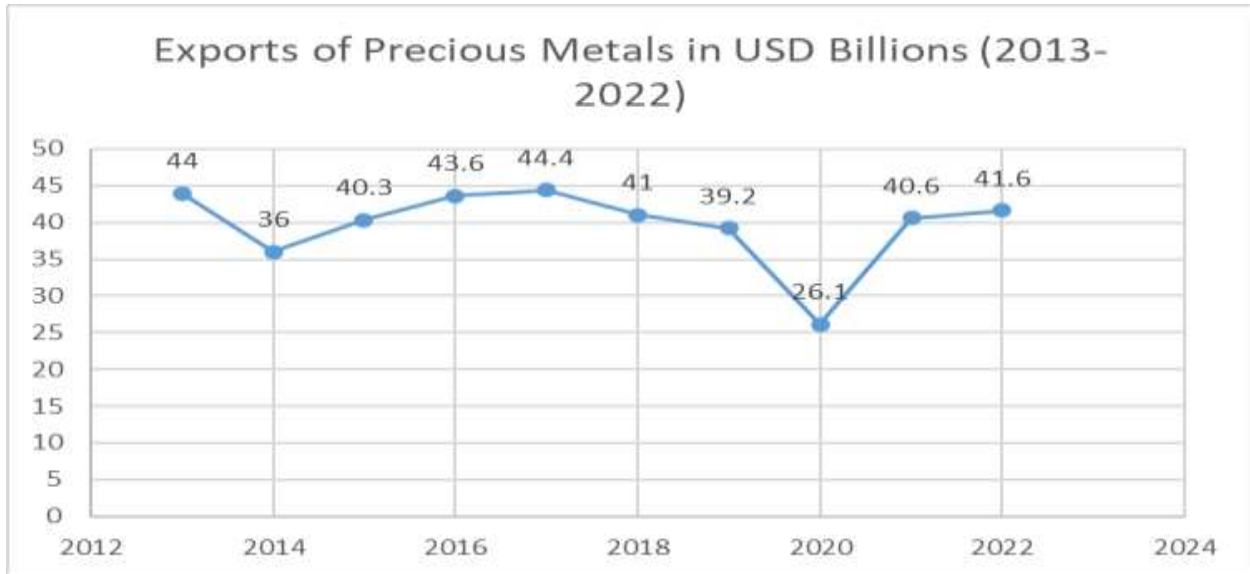

This study aimed at assessing the impact of change in Exchange Rates on Exports of a particular basket of commodities. In this case, the dependent variable taken into consideration is Chemical Products which

include Packaged Medicaments, Nitrogen Heterocyclic Compounds, Pesticides, Cyclic Hydrocarbons, Synthetic Colouring Matter, vaccines, Blood, Antisera and Toxins, Nucleic Acids, Oxygen Amino Compounds, Antibiotics, Essential Oils, Cleaning Products, Beauty Products, Perfumes, Glues, Soap, Hair Products, Shaving Products, Dyes, Enzymes, Waxes etc. By comparing Graph 4 and Graph 5, we see an even rise in the export value of Chemical Products as the exchange rates rise. This indicates a correlation existing between Annual Exchange rates (independent variable) and Exports of Chemical Products (dependent variable). Through the study in Table 1(b) it has been demonstrated that there is a highly positive correlation of 0.931 between the dependent variable (Exports of Chemical Products) and independent variable (Exchange Rates). It has also been estimated through Table 1(d) that a variance 83.5% of variance in the Exports of Chemical Products (dependent variable) is explained by the Annual Exchange Rate (independent variable). Hence it can be concluded that there is a significant impact of Exchange rates (independent variable) on the Exports of Chemical Products.

4.8. Conclusions regarding the relationship between Exchange rates and Exports of Mineral Products:

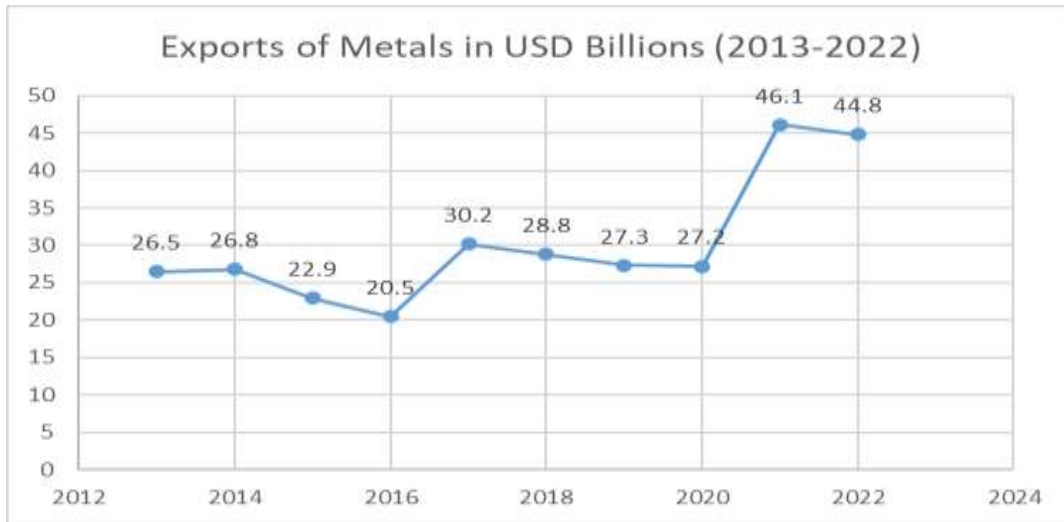**Graph 6 - Exports of Mineral Products from India in USD Billions [xxix](2013-2022)**

This study aimed at assessing the impact of change in Exchange Rates on Exports of a particular basket of commodities. In this case, the dependent variable taken into consideration is Mineral Products which include Refined Petroleum, coal tar oil, Iron Ore, Granite, Electricity, Petroleum Gas, Sulphur, Salt, Coke, Petroleum Coke, Barium Sulphate, Clays, Titanium Ore, Coal Briquettes, Cement, Petroleum Jelly, Quartz etc. From Graph 4 and Graph 6, we can see that there is no trend between the Annual Exchange Rates (independent variable) and Exports of Mineral Products (dependent variable) hence it is concluded that there is limited or no correlation. From Table 2(b), the calculated Significant value is 0.570 which means the null hypothesis is accepted and that there is no significant correlation and regression. The Pearson Correlation value is 0.205 which is insignificant. The R-Square value is 0.042 which is 4.2%. Hence it can be concluded that the regression is also insignificant.

Refined Petroleum and other Petroleum products form a major part of Mineral Product exports and there have been other extraneous variables affecting the exports of such products. Such is the case post 2014, where the exports of Petroleum had decreased due to variations in the global oil prices[xxx]. During 2019-2020, due to the pandemic, the global demand of petroleum and its associated products have decreased as a cause of lockdowns which resulted in a fall in exports and post pandemic, the demand climbed back to its normal rate. Due to the Russian Invasion of Ukraine, the demand for refined Petroleum and Petroleum

Products rose again and during which India imported cheap crude oil from Russia, processed them into Petroleum and other Petroleum based products which were exported to satisfy the global demand which led to a rise in the Exports in 2022.

4.9. Conclusions regarding the relationship between Exchange rates and Exports of Precious metals:

Graph 7 - Exports of Precious Metals from India in USD Billions (2013-2022)

This study aimed at assessing the impact of change in Exchange Rates on Exports of a particular basket of commodities. In this case, the dependent variable taken into consideration is Precious Metals which primarily include Diamonds and Jewellery, followed by Synthetic Reconstructed Jewellery Stones, Precious Stones, Precious Metals Scams, Imitation Jewellery, Gold, Platinum, Pearl Products, Metal-Clad Products, Precious Stone Dust, Silver etc. From Graph 4 and Graph 7, there is no emerging trend between Annual Exchange rates (independent variable) and Exports of Precious Metals (dependent variable). Hence it can be concluded that there is limited or no correlation between Annual Exchange Rates and Exports of Precious Metals. From Table 3(b), the calculated significant value is 0.395 which means that the null hypothesis is accepted and that there is no significant correlation and regression. The Pearson Correlation is -0.303 with which it can be concluded that there is insignificant correlation between Annual Exchange Rates and Exports of Precious Metals. The R-Square value is 0.092 which is 9.2%, hence it can be concluded that there is insignificant regression between Annual Exchange Rates and Exports of Precious Metals.

India's exports of Precious metals consist primarily of Diamonds. This industry had a modest beginning where after the 2000s, in Surat Gujarat, indigenous methods of cutting and polishing left-over diamonds. Later the industry developed and exports grew as well. In 2016-17, India exported 90% of the world's Cut and Polished Diamonds and 75% of the world's polished diamonds. Due to the high supply from India and lack of any other alternative competitors, India's exports of Diamonds have always been high, stable, and forms a significant proportion of the nation's exports. The export value due to these circumstances depends on the demand of that product which had significantly fallen during the pandemic, hence a fall in the exports of these products fell during the same time. These circumstances of a near monopoly also makes changes in exchange rates ineffective in changing the value or volume of exports of Diamonds and in extension the Exports of Precious Metals.

## 4.10. Conclusions regarding the relationship between Exchange rates and Exports of Metals:
Graph 8 - Exports of Metals from India in USD Billions [xxxi](2013-2022)

This study aimed at assessing the impact of change in Exchange Rates on Exports of a particular basket of commodities. In this case, the dependent variable taken into consideration is Metal Products which include Raw Aluminium, Ferroalloys, Hot Rolled Iron, Iron Structures, Raw Zinc, Semi Finished Iron, Other Iron Products, Iron Pipes, Iron Housewares, Raw Lead, Refined Copper, Other Stainless-Steel Bars, Iron Pipe Fittings, Aluminium Foil, Other Aluminium Products etc. By comparing Graph 4 and Graph 8, we see an even rise in the export value of Metal Products as the exchange rates rise unevenly. This indicates a moderate correlation existing between Annual Exchange rates (independent variable) and Exports of Metal Products (dependent variable). Through the study in Table 4(b) it has been demonstrated that there is a moderately positive correlation of 0.661 between the dependent variable (Exports of Metal Products) and independent variable (Exchange Rates). It has also been estimated through Table 4(d) that a variance 43.6% of variance in the Exports of Metal Products (dependent variable) is explained by the Annual Exchange Rate (independent variable). Hence it can be concluded that there is an insignificant impact of Exchange rates (independent variable) on the Exports of Metal Products.

4.11. Conclusions regarding the relationship between Exchange rates and Exports of Machines:
Graph 9 - Exports of Machines from India in USD Billions [xxxii](2013-2022)
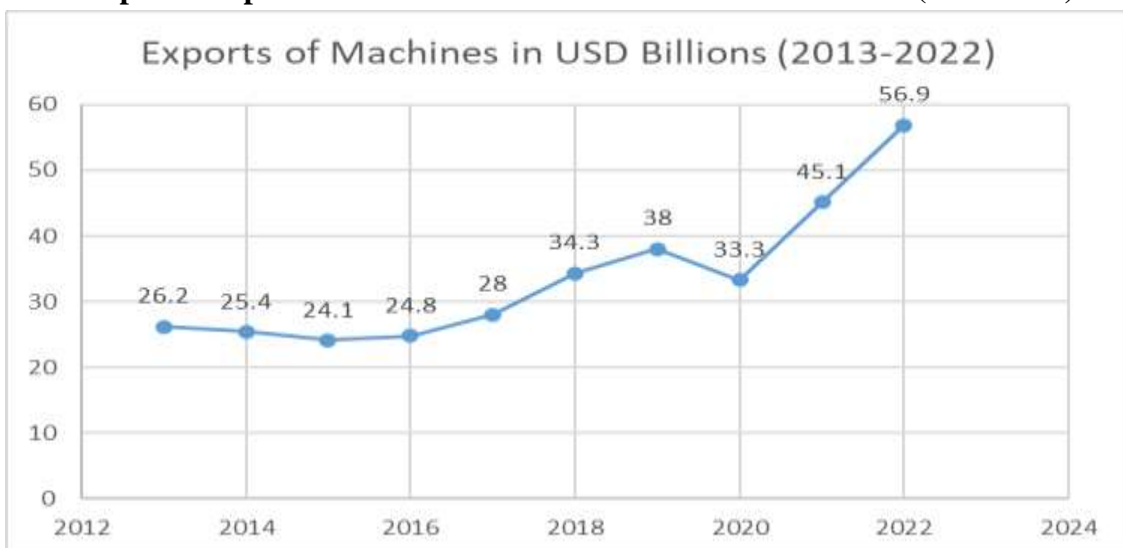
This study aimed at assessing the impact of change in Exchange Rates on Exports of a particular basket of commodities. In this case, the dependent variable taken into consideration is Machines which include Broadcasting Equipment, Electrical transformers, Gas Turbines, Transmissions, Valves, Insulated Wire, Engine Parts, Combustion Engines, Other Engines, Liquid Pumps, Air Pumps, Excavation Machinery, Electric Motor Parts, Centrifuges, Large Construction Vehicles, Electric Batteries, Electric Motors, Ball Bearings etc. By comparing Graph 4 and Graph 9, we see an even rise in the export value of Machines as the exchange rates rise. This indicates a correlation existing between Annual Exchange rates (independent variable) and Exports of Machines (dependent variable). Through the study in Table 5(b) it has been demonstrated that there is a highly positive correlation of 0.855 between the dependent variable (Exports of Machines) and independent variable (Exchange Rates). It has also been estimated through Table 5(d) that a variance of 73.1% of variance in the Exports of Machines (dependent variable) is explained by the Annual Exchange Rate (independent variable). Hence it can be concluded that there is a significant impact of Exchange rates (independent variable) on the Exports of Machines.

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- **Annual Exchange Rates/ Exchange Rates:** According to the International Monetary Fund and International Financial Statistics, on The Word Bank website, the Annual Exchange Rates are the rates determined by the national authorities or legally authorised exchange markets. The calculation is done as annual averages which are calculated from the monthly averages of the local currency in units relative to the US Dollar[xxxiii].
- **Currency Peg:** Currency Peg is a system where the government or a monetary authority of a nation fixes a specific exchange rate of the home currency with a foreign currency. The various types of Currency pegs are Hard peg, Soft peg, Crawling Peg and Basket peg.
- **Chemical Products:** According to The Observatory of Economic Complexity Chemical Products are a basket of commodities which include Packaged Medicaments, Nitrogen Heterocyclic Compounds, Pesticides, Cyclic Hydrocarbons, Synthetic Colouring Matter, vaccines, Blood, Antisera and Toxins, Nucleic Acids, Oxygen Amino Compounds, Antibiotics, Essential Oils, Cleaning Products, Beauty Products, Perfumes, Glues, Soap, Hair Products, Shaving Products, Dyes, Enzymes, Waxes etc[xxxiv].
- **Mineral Products:** According to The Observatory of Economic Complexity Mineral Products are a basket of commodities which include Refined Petroleum, coal tar oil, Iron Ore, Granite, Electricity, Petroleum Gas, Sulphur, Salt, Coke, Petroleum Coke, Barium Sulphate, Clays, Titanium Ore, Coal Briquettes, Cement, Petroleum Jelly, Quartz etc[xxxv].
- **Precious Metals:** According to The Observatory of Economic Complexity Precious Metals are a basket of commodities which primarily include Diamonds and Jewellery, followed by Synthetic Reconstructed Jewellery Stones, Precious Stones, Precious Metals Scraps, Imitation Jewellery, Gold, Platinum, Pearl Products, Metal-Clad Products, Precious Stone Dust, Silver etc[xxxvi].
- **Metals:** According to The Observatory of Economic Complexity Metals are a basket of commodities which primarily include Raw Aluminium, Ferroalloys, Hot Rolled Iron, Iron Structures, Raw Zinc, Semi Finished Iron, Other Iron Products, Iron Pipes, Iron Housewares, Raw Lead, Refined Copper, Other Stainless-Steel Bars, Iron Pipe Fittings, Aluminium Foil, Other Aluminium Products etc[xxxvii].
- **Machines:** According to The Observatory of Economic Complexity Machines are a basket of commodities which primarily include Broadcasting Equipment, Electrical transformers, Gas Turbines, Transmissions, Valves, Insulated Wire, Engine Parts, Combustion Engines, Other Engines, Liquid

Pumps, Air Pumps, Excavation Machinery, Electric Motor Parts, Centrifuges, Large Construction Vehicles, Electric Batteries, Electric Motors, Ball Bearings etc[xxxviii].

- **Exports:** Exports refers to the commodity or a service that is produced in the home country that is sold to a buyer abroad or in a foreign country.
- **Net Exports:** The net exports refer to the value of exports which is obtained by subtracting the Total Exports less Total Imports (Σ Exports - Σ Imports).
- **Significant Value:** Significant value or p value is the probability that the result occurred by chance. This value is compared with a predetermined cutoff to determine whether a test is statistically significant. For this particular study the Significant value should be less than 0.05 (Sig < 0.05)[xxxix].
- **Correlation:** Correlation analysis calculates the variance in one variable that is caused by a change in another variable. It is a statistical method used to measure the linear relationship between two variables and compute their association. The correlation value ranges from -1 to +1. -1 being extremely negative correlation between the two variables where an increase in one variable results in an equal but opposite change in another variable and +1 refers to extremely positive correlation between two variables where an increase in one variable results an equal amount of change in another variable in the same direction[xl].
- **Regression:** Regression is a statistical method that allows one to calculate the impact and examine the relationship between two or more variables. They are used to examine the impact or influence of one or more independent variables on the dependent variable. The R-Square value obtained from the Regression Analysis is used to estimate the impact of the independent variable on the dependent variable and the ideal R-Square value is 0.7 i.e. 70%[xli].

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