

**EFFECT OF CRUDE OIL PRICE FLUCTUATIONS ON MACRO -ECONOMIC FACTORS: EVIDENCE FROM INDIA & CHINA**

**Niharika S**

**Prof. Jayashree Kowtal**

Ramaiah Institute of Management, Bengaluru

Assistant Professor Ramaiah Institute of Management, MS Ramaiah Nagar, Bangalore.

**Abstract:**

This paper analysed the effect of crude oil price fluctuations on the macro-economic factors considering the China and Indian economy. The study covers a period of ten years from 2011-2021 of secondary data consisting the macro-economic factors i.e., GDP, GNP, Real Interest rates, Inflation rates along with one of the crude oil price indexes considered is Brent Index. The objectives of this study are to analyse the relationship between crude oil price and macro-economic factors- INDIA & CHINA. To know the impact level of crude oil price on India and Chinese macro-economic factors. To know and measure the future of Indian and Chinese economy. Python programming have been used to know the descriptive, to check hypothesis by using paired t-test, and also comparative analysis of Indian and Chinese economy. The results of the study indicates whether there exists any relationship with the crude oil price fluctuation and macro-economic factors of both the countries and comparing the performance between them.

**Keywords:** Brent Index, China, India, Macro-economic factors, GDP, GNP, Real Interest, Inflation.

**Introduction:** Oil is a commodity, and as such, it tends to see larger fluctuations in price than more stable investments, such as stocks and bonds. There are several influences on oil prices, a few of which we will outline below.

**OPEC Influences Prices:** OPEC, or the Organization of Petroleum Exporting Countries, is the main influencer of fluctuations in oil prices. OPEC is a consortium that, as of 2021, is made up of 13 countries: Algeria, Angola, Congo, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, the United Arab Emirates, and Venezuela. According to 2018 statistics, OPEC controls almost 80% of the world's supply of oil reserves. The consortium sets production levels to meet global demand and can influence the price of oil and gas by increasing or decreasing production. Before 2014, OPEC vowed to keep the price of oil above \$100 a barrel for the foreseeable future, but midway through that year, the price of oil began to tumble. It fell from a peak of above \$100 a barrel to below \$50 a barrel. OPEC was the major cause of cheap oil in that instance, as it refused to cut oil production, leading to the tumble in prices.

**Supply and Demand Impact:** As with any commodity, stock, or bond, the laws of supply and demand cause oil prices to change. When supply exceeds demand, prices fall; the inverse is also true when demand outpaces supply. The dramatic drop in oil prices in 2014 has been attributed to lower demand for oil in Europe and China, coupled with a steady supply of oil from OPEC. The excess supply of oil caused oil prices to fall sharply. While supply and demand impact oil prices, it is actually oil futures that set the price of oil. A futures contract for oil is a binding agreement that gives a buyer the right to buy a barrel of oil at a set price in the future. As spelled out in the contract, the buyer and seller of the oil are required to complete the transaction on a specific date.

**Natural Disasters:** Natural disasters are another factor that can cause oil prices to fluctuate. For example, when Hurricane Katrina struck the southern U.S. in 2005, affecting almost 20% of the U.S. oil supply, it caused the price per barrel of oil to rise by \$13.56. In May 2011, the flooding of the Mississippi River also led to oil price fluctuation.

**Political Instability:** From a global perspective, political instability in the Middle East causes oil prices to fluctuate, as the region accounts for the lion's share of the worldwide oil supply. For example, in July 2008, the price of a barrel of oil reached \$128 due to the unrest and consumer fear about the wars in both Afghanistan and Iraq.

**Production Costs and Storage:** Production costs can cause oil prices to rise or fall as well. While oil in the Middle East is relatively cheap to extract, oil in Canada in Alberta's oil sands is more costly.<sup>10</sup> Once the supply of cheap oil is exhausted, the price could conceivably rise, if the only remaining oil is in the tar sands. U.S. production also directly affects the price of oil. With so much oversupply in the industry, a decline in production decreases overall supply and increases prices. In February 2020 the U.S. had an average daily production level of approximately 12.7 million barrels of oil.<sup>11</sup> That average production, while volatile, can trend downward.

Consistent weekly drops put upward pressure on oil prices as a result. Oil diverted into storage has grown exponentially, and key hubs have seen their storage tanks filling up rather quickly. As of mid-April 2020, the storage hub at Cushing holds roughly 60 million barrels—with a total capacity of 76 million barrels.

**Interest Rate Impact:** While views are mixed, the reality is that oil prices and interest rates have some correlation between their movements. However, they are not tightly correlated. In truth, many factors affect the direction of both interest rates and oil prices. Sometimes those factors are related, sometimes they affect each other, and sometimes there's no rhyme or reason to what happens. One of the basic theories stipulates that increasing interest rates raise consumers' and manufacturers' costs, which reduces the amount of time and money people spend driving. Fewer people on the road translates to less demand for oil, which can cause oil prices to drop. In this instance, we'd call this an inverse correlation. By this same theory, when interest rates drop, consumers and companies are able to borrow and spend money more freely, which drives up demand for oil. The greater the usage of oil, the more consumers bid up the price. Another economic theory proposes that rising or high-interest rates help strengthen the dollar against other countries' currencies. When the dollar is strong, American oil companies can buy more oil with every U.S. dollar spent, ultimately passing the savings onto consumers. Likewise, when the value of the dollar is low against foreign currencies, the relative strength of U.S. dollars means buying less oil than before. This, of course, can contribute to oil becoming costlier to the U.S., which consumes 20% of the world's oil.

#### **Review literature:**

- 1. Zhenhua Liu et al., (2019)** The China's crude oil futures market (INE market), as it was first launched in late March of 2018, quickly draws much attention from global investors. In reference to the high frequency data, this research explores how well this new product reacts efficiently to international influences and to what extent it can be integrated with traditional benchmarks, such as WTI and Brent. The multivariate GARCH models are employed to capture the cross-market time-varying correlations, return and volatility spillovers, which are modified by incorporating the detected structural breaks in the return dynamics to improve the accuracy of model estimates. Empirical results indicate a strong integration of INE market with these international benchmarks.
- 2. Feng He et al., (2022)** This study considers the scaled principal component analysis (sPCA) method to forecast oil price volatility, and compare it with two commonly used dimensionality reduction methods: principal component analysis (PCA) and partial least squares (PLS). By combining the simple autoregressive model with the three dimensionality reduction methods, we obtain several interesting and notable findings. First, the model with the sPCA diffusion index performs substantially better than the competing models based on the out-of-sample  $R_{OOS}^2$  test. Moreover, the model with the sPCA diffusion index consistently demonstrates superior forecasting power compared with the other models under different macroeconomic conditions (e.g., business cycle recessions and expansions, high- and low-volatility levels, and the COVID-19 pandemic). The findings of the study are strongly robust to various robustness tests, such as alternative forecasting window sizes and different lags of model selection.
- 3. Muhammad Umar et al., (2021)** This paper applies the quantile Granger causality test, to explore whether the economic policy uncertainty (EPU) is affected by the crude oil price (COP) shocks in BRICS countries. The empirical results of the causal link present asymmetrical features, such that when the oil markets experience supply shocks, there is a positive influence on the EPU in China, India and Brazil. Moreover, a declining COP has an impact on the EPU in Russia and South Africa. The findings are consistent with the real business cycle model of the oil price shocks, under the influence of the channels that determine the supply and demand. The BRICS EPU also has an impact on the oil market, but their degree of significance varies, and is related to the demand for oil. Understanding the relationship between EPU and oil markets in BRICS countries can assist policymakers to rebalance of the energy landscape, and also aid in the stabilization of national economies.
- 4. Roman Ferrer et al., (2020)** This paper extends the literature on the relationship between oil price shocks and financial markets by examining the effect of oil shocks on the sovereign bond markets of a large number of advanced and emerging economies and exploring the impact of oil shocks on the degree of connectedness among international financial markets.

It also shows that oil price shocks serve as a driver of connectedness patterns across global financial markets, although the effect on connectedness depends on the nature of the oil market shock and the economic characteristics of the countries. Overall, the findings highlight the role of crude oil as a driver of not only of return dynamics in global stock and bond markets, but also of global financial connectedness patterns.

**5. Ulf Henning Richter et al., (2019)** This paper proposes the effect of oil price shocks on the Russian economic indicators using time series for the period 1991-2016 year to cover all of oil price shocks. The vector autoregressive and the Dickey-Fuller test were utilized to investigate the long-run and the short-run relationships between variables. From the results shows that one of the most important external impact factors is the world price of oil. The research suggests a positive and significant long-term relationship between oil prices and Russian GDP dynamics.

**6. Muhammad Syukur et al., (2019)** Since the beginning of the new order government up to now, Indonesia's economic development constantly influences by fluctuation in fuel oil price. This paper aims to know the impact of fuel oil price change on economic growth, inflation, and poverty in Indonesia using vector auto regression method. The occurred shock towards fuel price increase had a negative impact on economic growth and would continue in a long term, permanently. It is an indication that an increase in fuel price causes a slow economic growth. In addition, an increase in fuel price also had a positive impact on inflation and it continued in a long term. Moreover, an increase in fuel price also had positive impact on poverty in a short term. It indicated that an increase in fuel price caused an increase in the number of poor populations in Indonesia in a short term. The result indicated that an increase in fuel price, generally, gave negative impact on Indonesia's economy.

**7. Khalid Ahmed et al., (2019)** This study examines the impact of oil price shocks on key macroeconomic variables (i.e., real GDP, interest rate, inflation and exchange rate) for five SAARC countries (i.e., India, Pakistan, Bangladesh, Sri Lanka and Bhutan). For this purpose, we adopt contemporary macroeconomic policy modeling tool called impulse response function (IRF) and forecast error variance decomposition method (FEVDM) in the structural vector auto regression (SVAR) setting using time series data. The results of co integration test confirms the long-run equilibrium relationship between all the underlying variables. However, the empirical findings of IRF explained significant variation among all underlying macroeconomic variables in response to exogenous oil price shocks at different time horizons. It means the macroeconomic factors are sensitive to even small oil price shocks and possess various socio-economic implications in the region. The results of FEVDM evidence that each country in a study group responds differently to oil price shocks, it corresponds their independent policies, macroeconomic fundamentals, sector constructions and heterogeneity across the countries.

**Statement of problem:** There are limited number of studies on this topic; But no comprehensive literature was focused on comparing the effect of crude oil price fluctuations with the macroeconomic factors of one among the largest economies which are China and India. Therefore, it impels the author to try and do analysis on the subject and therefore contribute to the distributed literature. This study intends to examine and consider the crude oil prices from BRENT crude oil index before pandemic, during the pandemic and other major events like Russia & Ukraine war by assessing the effect on both the countries.

**Objectives of the study:**

- To analyse the relationship between crude oil price and macro-economic factors-INDIA & CHINA.
- To know the impact level of crude oil price on India and Chinese macro-economic factors.
- To know and measure the future of Indian and Chinese economy.

**Scope of the study:**

India and China were subjected to a lot of changes and developments in their economies right from the initiation of the pandemic, during and verge of the edge in pandemic. In the course of this period crude oil price fluctuation is the one of factor that majorly effected the macroeconomic factors in both the countries which aided to trail the study furthermore by considering the Brent index which is the leading global price benchmark for Atlantic basin crude oils. It is used to set the price of two-thirds of the world's internationally traded crude oil supplies and analysing the impact among the countries.

A 10-year data of Brent index is considered from the period of 2011 to 2021 and also the 10-year data according to the financial calendars of both the countries China (Jan-Dec) & India (March-April).

**Hypothesis:**

**HO:** There is no impact of crude oil price fluctuation and macro-economic factors- INDIA&CHINA.

**H1:** There is impact of crude oil price fluctuation and macro-economic factors -INDIA&CHINA.

**Methodology of the study:**

**Type of research:** Quantitative Research using both analytical and descriptive designs in the study.

**Sources of data:** Secondary data

**Plan of Analysis:** Descriptive statistics, Paired t-test, comparative analysis.

**Tools & techniques used:** Python programming have been used for the entire plan of analysis.

**Limitations of the Study:**

- This study considers only macroeconomic factors to compare between India and China even having other outliers.
- The study is limited to selecting the fluctuations of oil prices according to BRENT index which might slightly differ from other indexes
- This research work has been conducted for a limited period.
- All the limitations, related to statistical tools used, are applicable to the present study also.

**Data Analysis:**

**Macro-economic factors and Brent index data of CHINA for 10 years**

CHINA					
Year	Brent Index	GDP	GNI	INTEREST RATES	Inflation rates
2021	70.86	17458.04	17574.24	3.9	0.98
2020	41.96	14,722.70	14,880.75	3.7	2.42
2019	64.28	14,279.90	14,519.06	3.02	2.90
2018	71.34	13,894.80	13,371.98	0.82	2.07
2017	54.71	12,310.40	12,111.24	0.11	1.59
2016	45.13	11,233.30	11,398.88	2.9	2.00
2015	53.03	11,061.60	10,894.02	4.35	1.44
2014	98.97	10,475.70	10,246.60	4.52	1.92
2013	108.6	9,570.41	9,193.81	3.76	2.62
2012	111.6	8,532.23	8,006.06	3.59	2.62
2011	111.3	7,551.50	6,783.87	-1.4	5.55

From the above-mentioned table, we can see the 4 macro-economic factors i.e., Gross Domestic Product (GDP), Gross National Income (GNI), Interest rates, Inflation rates are compared with the crude oil price index that is Brent Index which is stated in \$/barrel for 10 years. We can observe that there is subsequent increase in GDP, GNI from 2011-2021 of China. The other factors which are interest rates and inflation rates also possesses some impact on the crude oil price fluctuations which are discussed hereafter in detail by applying various analytical methods and elucidating their further correlation.

**Descriptive analysis of China**

Input Code:

```
import pandas as pd
import numpy as np
import warnings

Brent=pd.read_excel(r"/content/drive/MyDrive/PYTHON FILES/index.xlsx")Brent[0:11]
```

```
import pandas as pd
```

```
df = pd.read_excel("/content/drive/My Drive/PYTHON FILES/index.xlsx") df[['bi','gdp','GNI','Inflation rate','Interest rate']].describe()
```

	bi	gdp	GNI	Inflation rate	Interest rate
<b>count</b>	11.000000	11.000000	11.000000	11.000000	11.000000
<b>mean</b>	75.606364	11917.325455	11725.500909	2.373636	2.660909
<b>std</b>	27.152568	2958.412949	3201.181210	1.198143	1.938264
<b>min</b>	41.960000	7551.500000	6783.870000	0.980000	-1.400000
<b>25%</b>	53.870000	10023.055000	9720.205000	1.755000	1.860000
<b>50%</b>	70.860000	11233.300000	11398.880000	2.070000	3.590000
<b>75%</b>	103.765000	14087.350000	13945.520000	2.620000	3.830000
<b>max</b>	111.570000	17458.040000	17574.240000	5.550000	4.520000

From the above table we can see the descriptive statistics of the China’s macro-economic factors along with the Brent Index. We have considered data for 10 years from 2011-2021.

**Brent index:** The mean value for 10 years is 75.606 which is the average price of crude oil in those years and the standard deviation is 27.152 which means that spread from mean ranges from - 27.152 to +27.152. The minimum price of the crude oil is 41.96 which was in the year 2020 and the maximum value is 111.57 which was in the year 2012.

**GDP:** The mean value for 10 years is 11917.32 which is the average value of Gross domestic product and the standard deviation is 2958.41 which means that spread from ranges from - 2958.41 to +2958.41. The minimum value of the GDP is 7551.50 which was in the year 2011 and the maximum value is 17458.04 which was in the year 2021.

**GNI:** The mean value for 10 years is 11725.50 which is the average value of Gross national income and the standard deviation is 3201.18 which means that spread from ranges from - 3201.18 to +3201.18. The minimum value of the GNI is 6783.87 which was in the year 2011 and the maximum value is 17574.24 which was in the year 2021.

**Inflation rate:** The mean value for 10 years is 2.373% which is the average value of Inflation rate and the standard deviation is 1.198% which means that spread from ranges from -1.198% to +1.198%. The minimum value of the Inflation rate is 0.98% which was in the year 2021 and the maximum value is 5.55% which was in the year 2011.

**Real Interest rates:** The mean value for 10 years is 2.66% which is the average value of Interest rates and the standard deviation is 1.93% which means that spread from ranges from -1.93% to +1.93%. The minimum value of the Interest rate is -1.4% which was in the year 2011 and the maximum value is 4.52% which was in the year 2014.

**GDP of China:**

Input code:

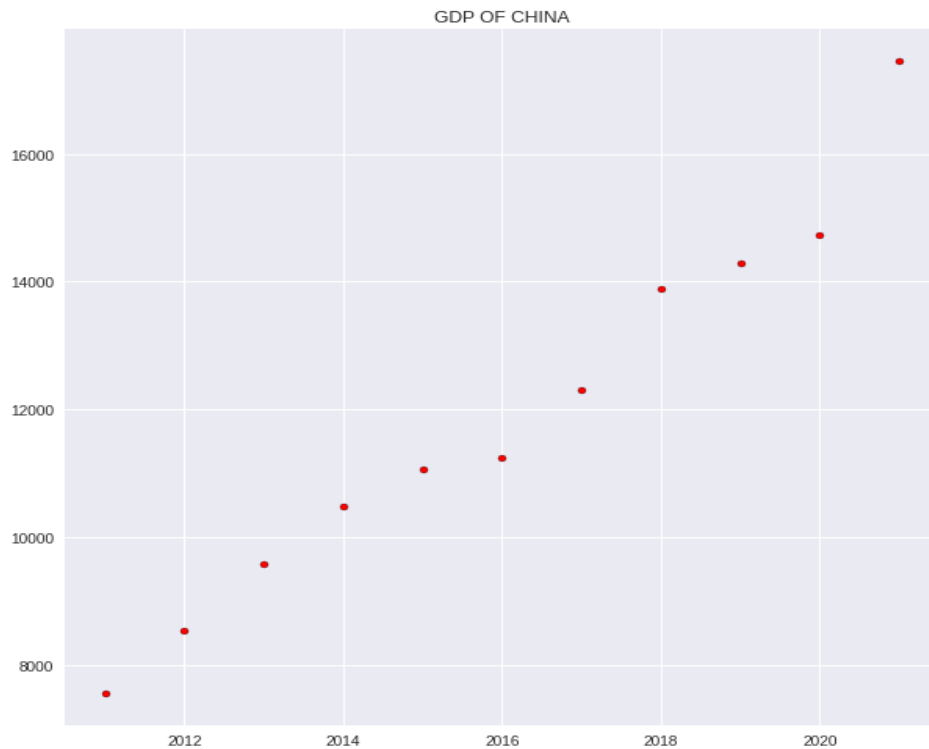
```
x = list(df['Year'])
```

```
y = list(df['gdp']) plt.figure(figsize=(10,10))plt.style.use('seaborn')
```

```
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("GDP OF CHINA")
```

```
plt.show()
```

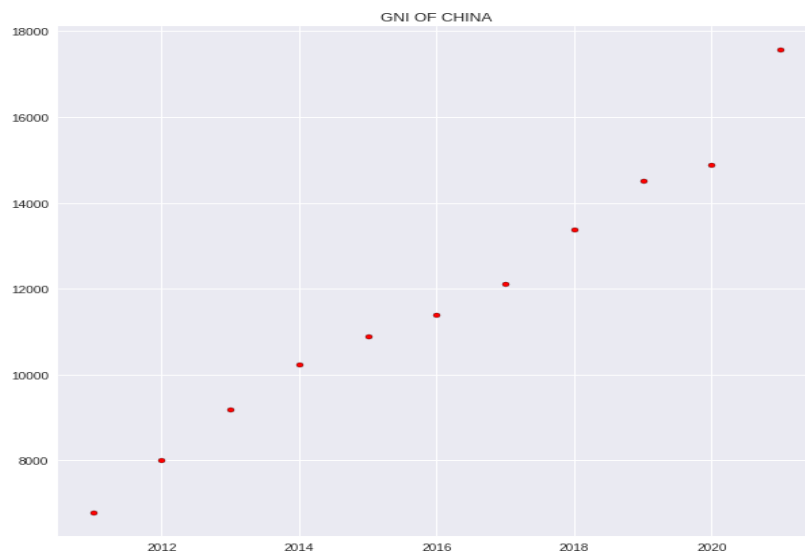
We can observe from the below graph that there is a positive increasing trend in the 10 years span from 2011-2021 in the GDP of China where the recent GDP in the fiscal year of 2021 was 17458.04 billion dollars amidst the effect of Global pandemic all over the world. Being one of the biggest economies of the world GDP value of China represents 13.04% of the world economy. According to econometric models the predicted GDP of China in 2022 is 16700 billion dollars.



**GNI OF CHINA:**

Input Code:

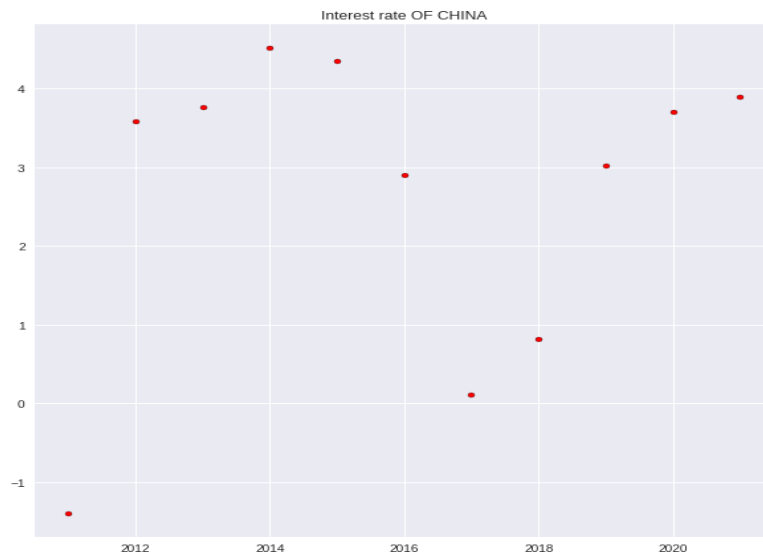
```
x = list(df['Year'])  
y = list(df['GNI']) plt. figure(figsize=(10,10))plt.style.use('seaborn')  
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("GNI OF CHINA")  
plt.show()
```



We can observe from the above graph that there is an increasing positive trend in the 10 years span from 2011-2021 in the Gross National Income of China where the recent GNI of the fiscal year 2021 was 17574.24 billion dollars. As we know that GDP is directly proportional to GNI if GDP is showing an increasing positive trend, then GNI also increases.

**Interest rates of China**

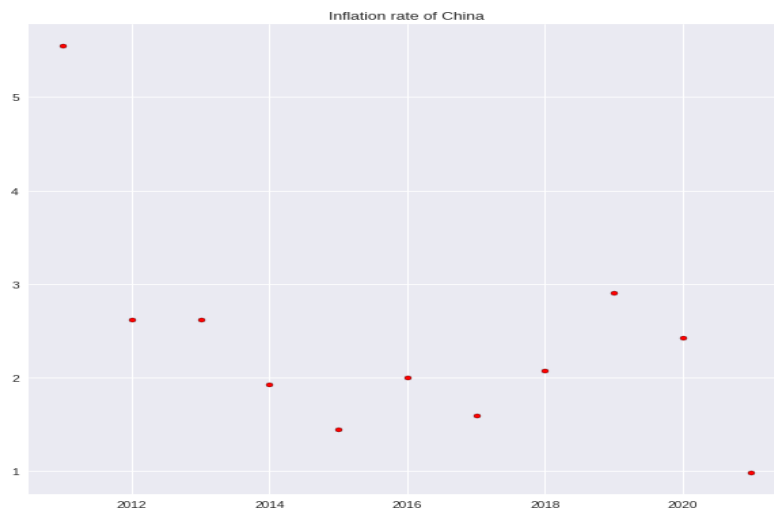
```
x = list(df['Year'])
y = list(df['Interest rate'])plt.figure(figsize=(10,10)) plt.style.use('seaborn')
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("Interest rate OF CHINA")
plt.show()
```



We can observe from the above graph that there is no trend in the interest rates pattern it indicates randomness in the graph which is probably due to the effect of various factors in the economic growth as we know that the change in the interest rates depends upon the currency appreciation/depreciation and capital outflows. The recent interest rate of the fiscal year 2021 is 3.9% but according to the world bank data the present interest rate of year 2022 is 2.85%.

**Inflation Rates of CHINA**

```
x = list(df['Year'])
y = list(df['Inflation rate'])plt.figure(figsize=(10,10)) plt.style.use('seaborn')
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("Inflation rate of China")
plt.show()
```



We can observe from the above graph that the inflation rates seem in high -low changing pattern. The inflation rate for 10 years from 2011-2021 was maximum high during 2011 which is 5.5% rest of the years it was not exceeding more than 3%. Even during the pandemic when the consumption was more inflation rates were slightly stable. According to the National Bureau of Statistics of China annual inflation rate is at 2.1% in 2022, unchanged from April's five month high figure and compared with market forecasts of 2.2%.

**Macro-economic factors and Brent Index data of India for 10 years:**

INDIA					
Year	BrentIndex	GDP	GNI	REAL INTEREST RATE	INFLATIONRATES
2022	102.54	3000.05	2946.45	4.4	6.04
2021	70.86	2850.35	2763.02	4.56	4.87
2020	41.96	2,622.98	2,625.44	4.34	6.62
2019	64.28	2,870.50	2,894.03	5.7	3.72
2018	71.34	2,701.11	2,714.03	5.51	3.95
2017	54.71	2,651.47	2,439.59	5.33	3.33
2016	45.13	2,294.80	2,226.42	6.23	4.95
2015	53.03	2,103.59	2,097.60	7.56	4.91
2014	98.97	2,039.13	2,021.00	6.7	6.65
2013	108.56	1,856.72	1,941.12	3.87	11.06
2012	111.57	1,827.64	1,870.99	2.47	9.31
2011	111.26	1,823.05	1,704.43	1.32	8.86

From the above-mentioned table, we can see the 4 macro-economic factors i.e., Gross Domestic Product (GDP), Gross National Income (GNI), Interest rates, Inflation rates are compared with the crude oil price index that is Brent Index which is stated in \$/barrel for 10 years. We can observe that there is an increase in GDP, GNI from 2011-2021 of India but in comparison with China; India's progress regarding the growth macro-economic factors is minimal even considering the major events of pandemic and war among Russia and Ukraine. The other factors which are interest rates and inflation rates also possesses some impact on the crude oil price fluctuations which are discussed hereafter in detail by applying various analytical methods and elucidating their further correlation.

**India data using python code:**

Input code:

```
import pandas as pd
import numpy as np

import scipy.stats as stats
BI=pd.read_excel(r"/content/drive/MyDrive/PYTHON FILES/Brent index final_India.xlsx")

BI.head(13)
```



**Descriptive Statistics of India:**

```

import pandas as pd
import numpy as np
import scipy.stats as stats
BI=pd.read_excel(r"/content/drive/MyDrive/PYTHON FILES/Brent index final_India.xlsx")
BI.head(13)

```

	Year	Brent Index	GDP	GNI	REAL INTEREST RATE	INFLATION RATES
0	2011.0	111.26	1823.05	1704.43	1.32	8.86
1	2012.0	111.57	1827.64	1870.99	2.47	9.31
2	2013.0	108.56	1856.72	1941.12	3.87	11.06
3	2014.0	98.97	2039.13	2021.00	6.70	6.65
4	2015.0	53.03	2103.59	2097.60	7.56	4.91
5	2016.0	45.13	2294.80	2226.42	6.23	4.95
6	2017.0	54.71	2651.47	2439.59	5.33	3.33
7	2018.0	71.34	2701.11	2714.03	5.51	3.95
8	2019.0	64.28	2870.50	2894.03	5.70	3.72
9	2020.0	41.96	2622.98	2625.44	4.34	6.62
10	2021.0	70.86	2850.35	2763.02	4.56	4.87
11	2022.0	102.54	3000.05	2946.45	4.40	6.04

Input code:

```

import pandas as pd

df = pd.read_excel("/content/drive/MyDrive/PYTHON FILES/Aniljith M G/Br ent index final_India.xlsx")

df[['Brent Index','GDP','GNI','REAL INTEREST RATE','INFLATION RATES']].describe()

```

From the above table we can see the descriptive statistics of the India’s macro-economic factors along with the Brent Index. We have considered data for 11 years from 2011-2022.

**Brent index:** The mean value for 10 years is 77.850 which is the average price of crude oil in those years and the standard deviation is 27.031 which means that spread from mean ranges from - 27.031 to +27.031. The minimum price of the crude oil is 41.96 which was in the year 2020 and the maximum value is 111.57 which was in the year 2012.

**GDP:** The mean value for 10 years is 2386.78 which is the average value of Gross domestic product and the standard deviation is 444.209 which means that spread from ranges from - 444.209 to +444.209. The minimum value of the GDP is 1823.05 which was in the year 2011 and the maximum value is 3000.05 which was in the year 2022.

**GNI:** The mean value for 10 years is 2353.67 which is the average value of Gross national income and the standard deviation is 430.55 which means that spread from ranges from -430.55 to +430.55. The minimum value of the GNI is 1704.43 which was in the year 2011 and the maximum value is 2946.45 which was in the year 2022.

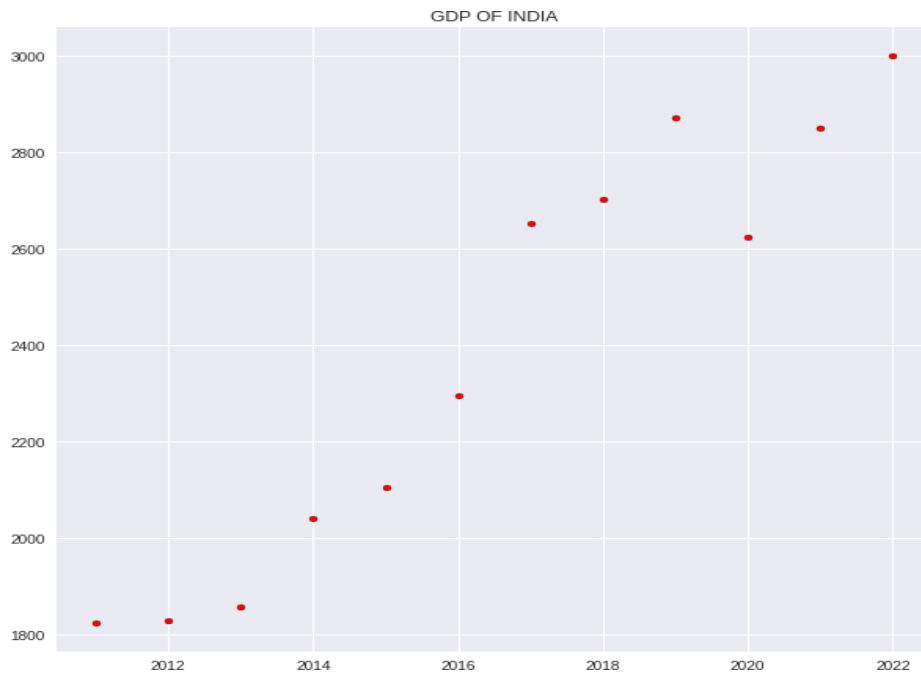
**Inflation rate:** The mean value for 11 years is 6.189% which is the average value of Inflation rate and the standard deviation is 2.434% which means that spread from ranges from -2.434% to +2.434%. The minimum value of the Inflation rate is 3.33% which was in the year 2017 and the maximum value is 11.06% which was in the year 2013.

**Real Interest rates:** The mean value for 10 years is 4.83% which is the average value of Interest rates and the standard deviation is 2.34% which means that spread from ranges from -2.34% to +2.34%. The minimum value of the Interest rate is 1.32% which was in the year 2011 and the maximum value is 7.56% which was in the year 2015.

**GDP of India**

Input code:

```
import pandas as pd
import matplotlib.pyplot as plt
x = list(BI['Year'])
y = list(BI['GDP'])
plt.figure(figsize=(10,10))plt.style.use('seaborn')
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("GDP OF INDIA")
plt.show()
```

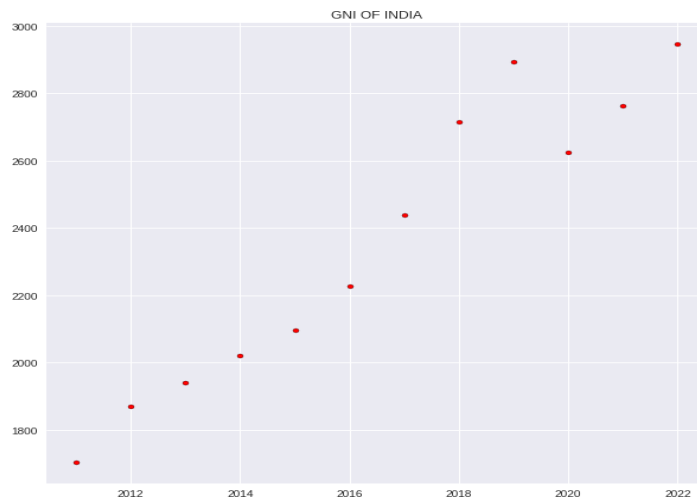


We can observe from the above graph that there is a positive increasing trend in the 10 years span from 2011-2021 in the GDP of India but the amount of increase in GDP every year is comparatively less than China. The recent GDP in the fiscal year of 2021 was 2850.35 billion dollars amidst the effect of Global pandemic all over the world. Being one of the biggest economies of the world GDP value of India represents 2.32% of the world economy. According to econometric models the predicted GDP of India in 2022 is 3000.05 billion dollars.

**GNI of India**

Input code:

```
x = list(BI['Year'])
y = list(BI['GNI'])
plt.figure(figsize=(10,10))plt.style.use('seaborn')
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("GNI OF INDIA")
plt.show()
```



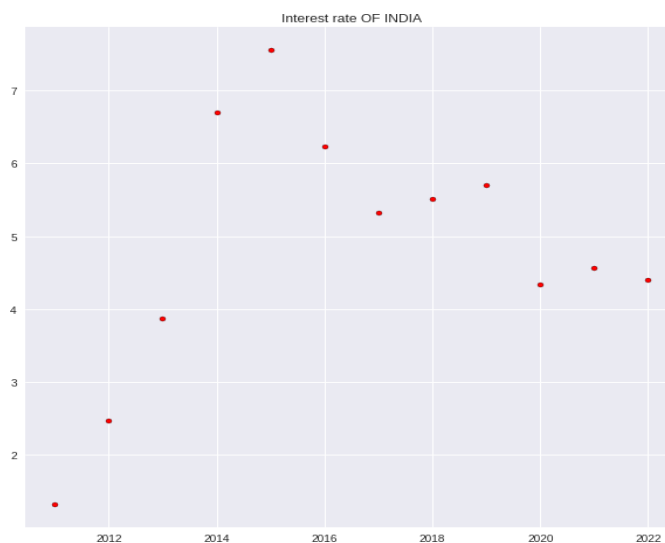
We can observe from the above graph that there is a positive increasing trend in GNI for 10 years since 2011-2021. But in 2020 there was a dip in the GNI as we can see from the above graph. The recent GNI of the fiscal year 2022 is 2946.45 billion dollars. As we know that GDP is directly proportional to GNI if GDP is showing an increasing positive trend, then GNI also increases.

**Interest rates of India:**

Input code:

```
x = list(BI['Year'])
y = list(BI['REAL INTEREST RATE'])
plt.figure(figsize=(10,10))plt.style.use('seaborn')
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("Interest rate OF INDIA")
plt.show()
```

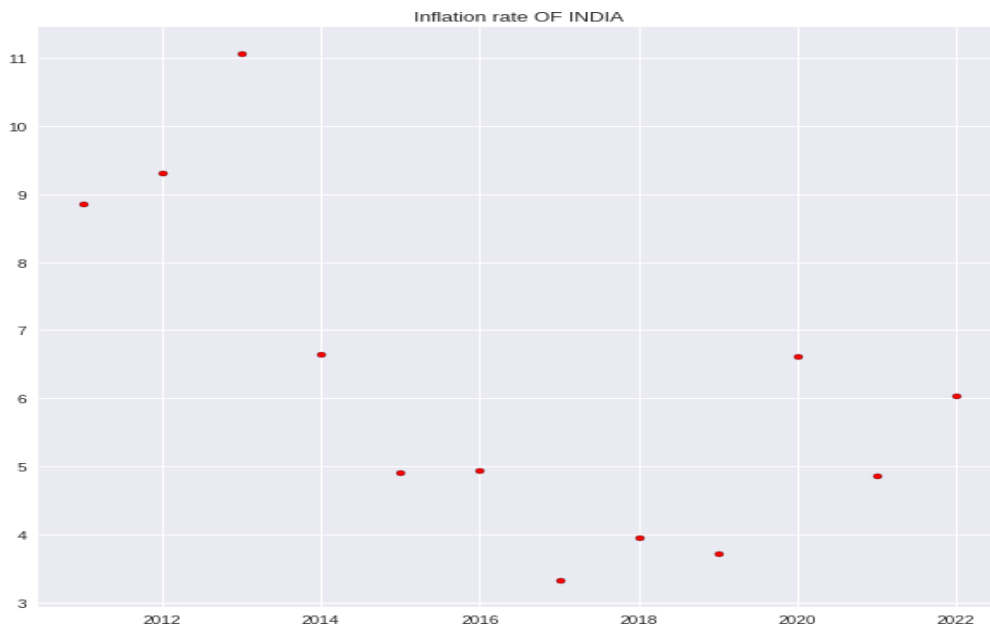
We can observe from the below graph that there is no trend in the interest rates pattern it indicates randomness in the graph which is probably due to the effect of various factors in the economic growth as we know that the change in the interest rates depends upon the currency appreciation/depreciation and capital outflows. The recent interest rate of the fiscal year 2021 is 4.51% but according to the world bank data the present interest rate of year 2022 is 4.40%.



**Inflation rates of India**

Input code:

```
x = list(BI['Year'])
y = list(BI['INFLATION RATES'])
plt.figure(figsize=(10,10))plt.style.use('seaborn')
plt.scatter(x,y,marker=".",s=100,edgecolors="black",c="red")plt.title("Inflation rate OF INDIA")
plt.show()
```



We can observe from the above graph that the inflation rates does not follow any trend. The inflation rate for 10 years from 2011-2021 was maximum high during 2013 which is 11.04%. Due to the global pandemic when the consumption was increased there was disrupt in inflation rate stability. According to Ministry of Statistics and Programme Implementation the annual inflation rate in India edged down to 7.04% as of may 2022 from an 8 year high of 7.79% in the previous month as there was an increase in the consumer prices by 0.94%.

**Hypothesis Testing:**

**Paired sample T-test using Python:**

Here paired sample T-test is used to check the correlation between the macro-economic factors and Brent Index of China & India.

**T-test for China macro-economic factors and Brent IndexHypothesis 1:**

HO: There is a NO significant relationship between Brent Index and GDP of China H1: There is a significant relationship between Brent Index and GDP of China Input code:

```
from scipy import stats stats.ttest_rel(df['Brent Index'], df['GDP'])
```

Output: Ttest\_relResult(statistic=-17.47754979650673,pvalue=2.2581006323179412e-09)

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $2.2581 \times 10^{-09}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and GDP of China. Here Brent index is the independent variable and the GDP of China is the dependent variable.

**Hypothesis 2:**

HO: There is NO significant relationship between Brent Index and GNI of China. H1: There is a significant relationship between Brent Index and GNI of China.

Input code:

```
from scipy import stats
stats.ttest_rel(df['Brent Index'], df['GNI'])
```

Output:

```
Ttest_relResult(statistic=-17.7877157177363, pvalue=1.8722305298791286e-09)
```

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $1.8722 \times 10^{-09}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and GNI of China. Here Brent index is the independent variable and the GNI of China is the dependent variable.

**Hypothesis 3:**

HO: There is No significant relationship between Brent Index and Real Interest rates of China.

H1: There is significant relationship between Brent Index and Real Interest rates of China. Input code:

```
from scipy import stats
```

```
stats.ttest_rel(df['Brent Index'], df['REAL INTEREST RATE'])
```

Output:

```
Ttest_relResult(statistic=8.988981215941939, pvalue=2.121431479952129e-06)
```

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $2.121 \times 10^{-06}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and Real interest rates of China. Here Brent index is the independent variable and the Real interest rates of China is the dependent variable.

**Hypothesis 4:**

HO: There is no significant relationship between the Brent Index and Inflation rates of China H1: There is significant relationship between the Brent Index and Inflation rates of China.

Input code:

```
from scipy import stats
```

```
stats.ttest_rel(df['Brent Index'], df['INFLATION RATES'])
```

Output:

```
Ttest_relResult(statistic=9.811278039658381, pvalue=8.94044257510082e-07)
```

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $8.9404 \times 10^{-07}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and inflation rates of China. Here Brent index is the independent variable and the inflation rates of China is the dependent variable.

**T-test for India macro-economic factors and Brent Index:**

**Hypothesis 1:**

HO: There is no significant relationship between the Brent Index and GDP of India. H1: There is significant relationship between the Brent Index and GDP of India.

Input code:

```
Before=pd.DataFrame(BI,columns=['Brent Index']) After=pd.DataFrame(BI,columns=['GDP'])
stats.ttest_rel(Before,After)
```

Output:

```
Ttest_relResult(statistic=array([-17.4775498]),pvalue=array([2.25810063e-09]))
```

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $2.2581 \times 10^{-09}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and GDP of India. Here Brent index is the independent variable and the GDP of India is the dependent variable.

**Hypothesis 2:**

HO: There is no significant relationship between the Brent Index and GNI of India. H1: There is significant relationship between the Brent Index and GNI of India.

Input code: `Before= pd. Data Frame (BI,columns=['Brent Index']) After=pd. Data Frame(BI,columns=['GNI']) stats. ttest_rel(Before,After)`

Output:

`Ttest_relResult(statistic=array([-17.78771572]),pvalue=array([1.87223053e-09]))`

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $1.8722 \times 10^{-09}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and GNI of India. Here Brent index is the independent variable and the GNI of India is the dependent variable.

**Hypothesis 3:**

HO: There is no significant relationship between the Brent Index and the Real Interest rates of India.

H1: There is significant relationship between the Brent Index and the Real Interest rates of India.

Input code:

`Before=pd.DataFrame(BI,columns=['Brent Index'])`

`After=pd.DataFrame(BI,columns=['REAL INTEREST RATE'])stats.ttest_rel(Before,After)`

Output: `Ttest_relResult(statistic=array([8.98898122]),pvalue=array([2.12143148e-06]))`

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $2.1214 \times 10^{-06}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and Real Interest rates of India. Here Brent index is the independent variable and the Real Interest rates of India is the dependent variable.

**Hypothesis 4:**

HO: There is no significant relationship between the Brent Index and Inflation rates of India. H1: There is significant relationship between the Brent Index and Inflation rates of India.

Input code:

`Before=pd.DataFrame(BI,columns=['Brent Index']) After=pd.DataFrame(BI,columns=['INFLATION RATES'])stats.ttest_rel(Before,After)`

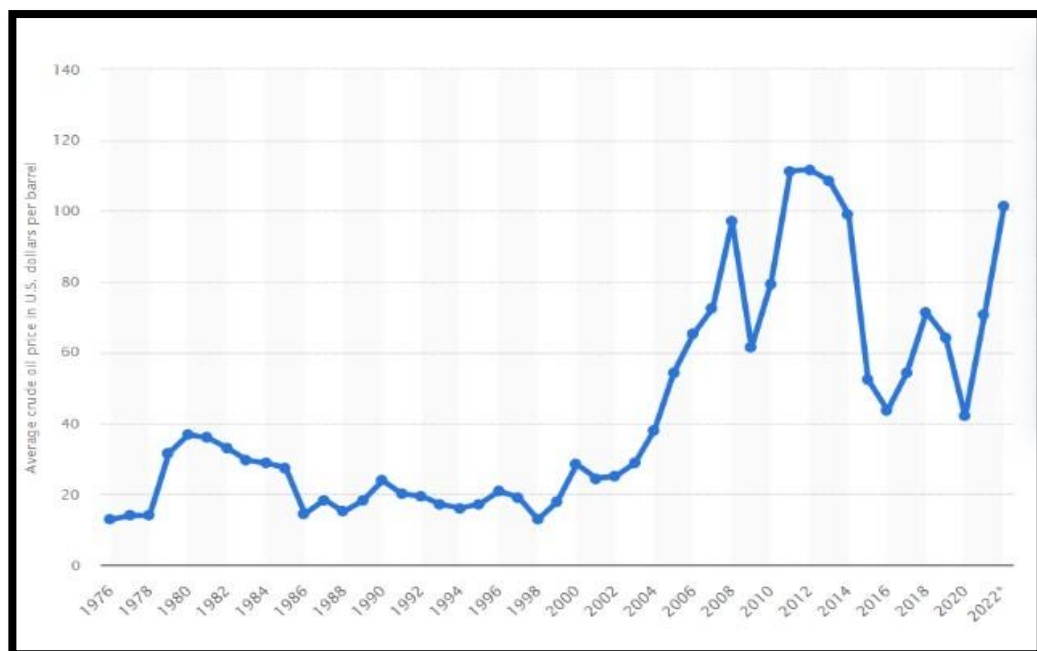
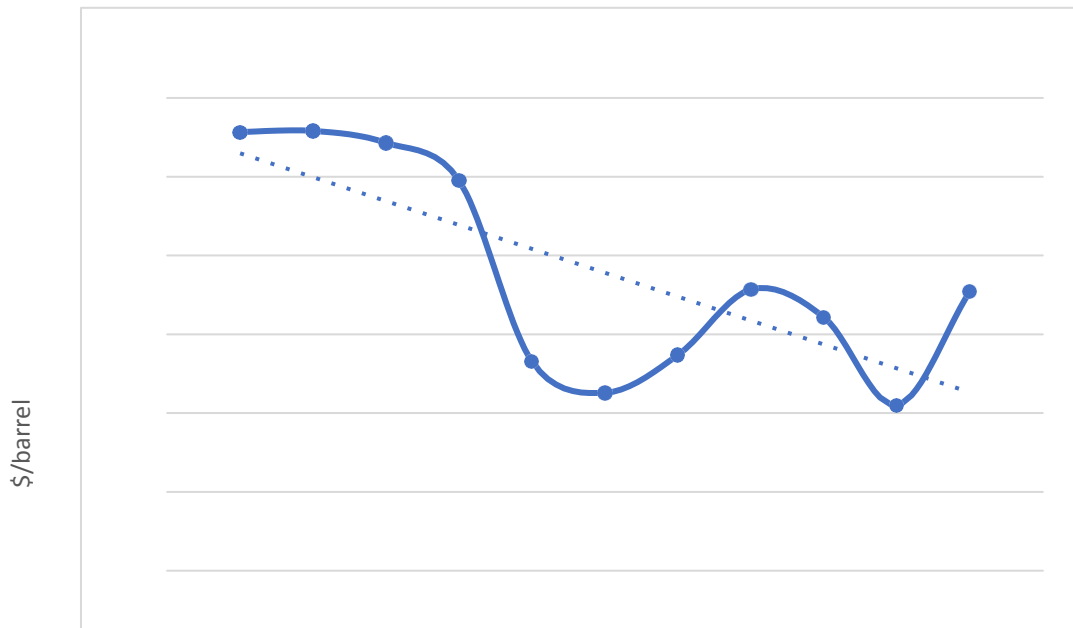
Output: `Ttest_relResult(statistic=array([9.81127804]),pvalue=array([8.94044258e-07]))`

**INTERPRETATION:**

From the above T-test results we can see that the p-value is less than 0.05 which is  $8.940 \times 10^{-07}$  hence we can reject the null hypothesis and accept the alternate hypothesis that shows there is a significant relationship between Brent index and Inflation rates of India. Here Brent index is the independent variable and the Inflation rates of India is the dependent variable.

**COMPARATIVE ANALYSIS OF MACRO-ECONOMIC FACTORS BETWEEN INDIA AND CHINA**

**Brent Index**

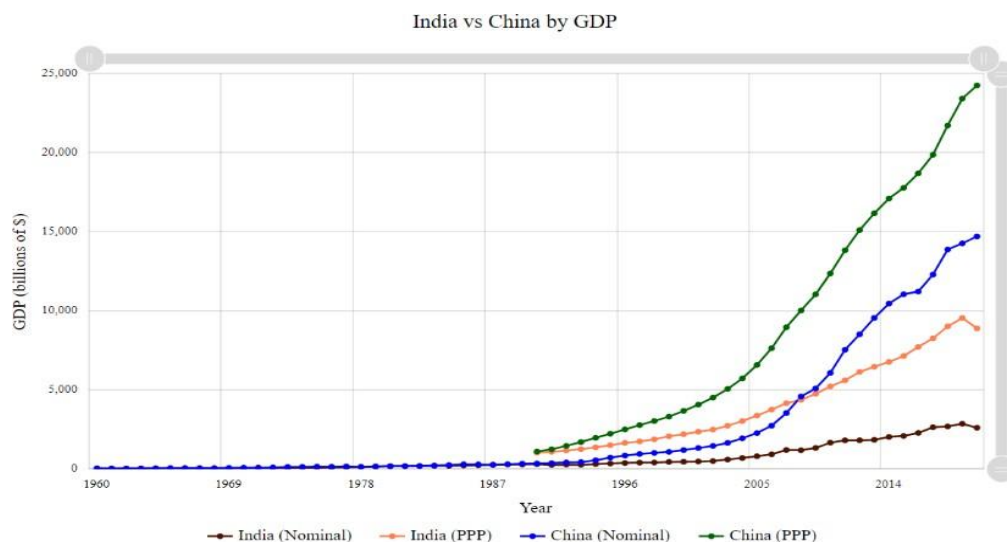
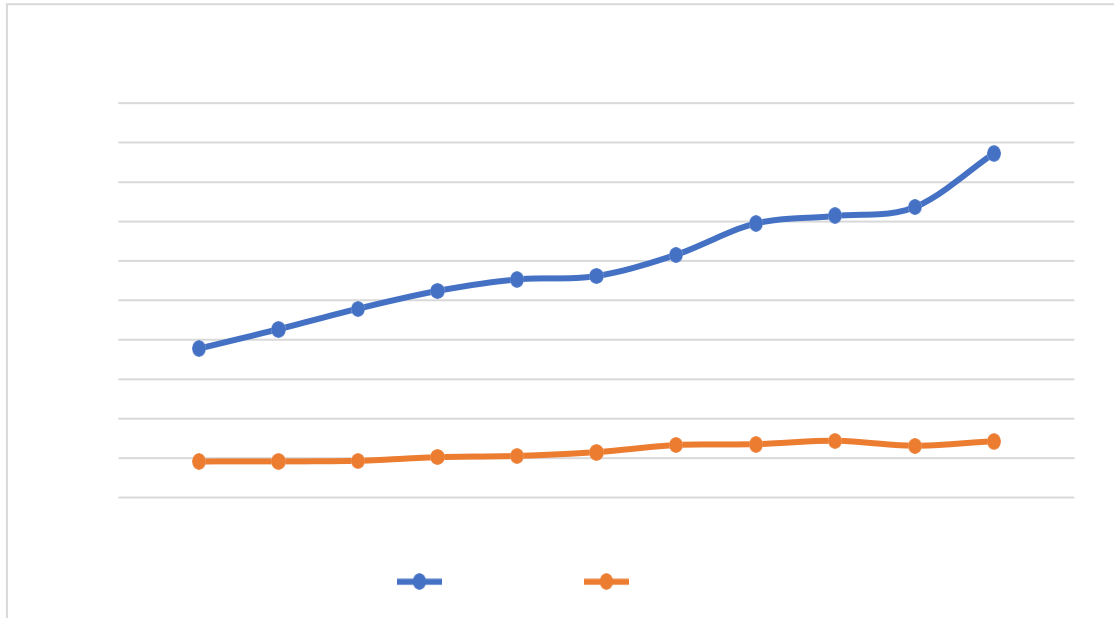


**INTERPRETATION:**

As we know that we have considered one among the Crude oil price index that is Brent crude index to see crude oil price fluctuations impact on the macro-economic factors of the China and India. From the above graph we can see the price of crude oil from 2011-2022. We can see the declining trend in the prices of crude oil where the maximum price was in 2012 i.e., 111.57 which was due to the significant drop in Libyan production and fears of more instability in the other countries pushed the price of oil over \$100 a barrel in New York trading. The weakened US Dollar resulted in a spike to \$112/barrel. and the minimum price was in 2020 i.e.,

41.96. The average annual price of Brent crude oil climbed to 101.37 U.S. dollars per barrel as of April 2022. This is over 30 U.S. dollars higher than the annual average in 2021 and comes in the wake of an energy supply shortage that began gripping Europe in late 2021, as well as concerns over oil supply bottlenecks following the Russia-Ukraine war. Brent is the world's leading price benchmark for Atlantic basin crude oils. Crude oil is one of the most closely observed commodity prices as it influences costs across all stages of the production process and consequently alters the price of consumer goods as well.

**GDP comparison of China & India**





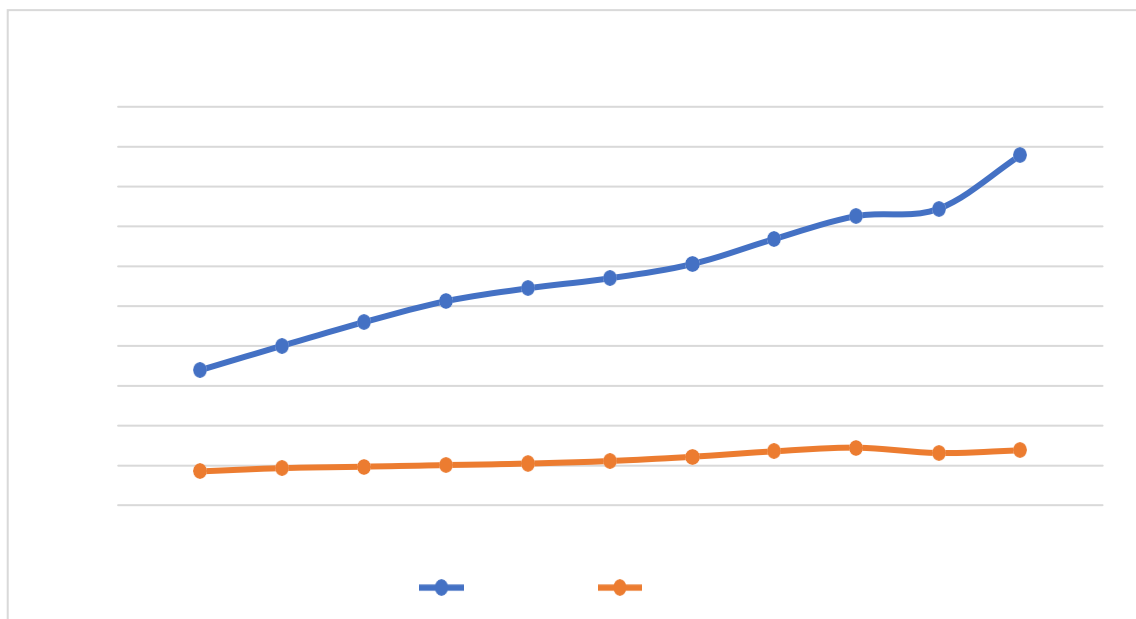
**INTERPRETATION:**

China and India are the two emerging economies in the world. As of 2021, China and India are the 2nd and 5th largest economies in the world, respectively, on a nominal basis. Among Asian countries, China and India together contribute more than half of Asia's GDP. In 1987, the GDP (Nominal) of both countries was almost equal; even in ppp terms, China was slightly ahead of India in 1990. Now in 2021, China's GDP is 5.46 times higher than India. On a ppp basis, the GDP of China is 2.61x of India. China crossed the \$1 trillion mark in 1998, while India crossed nine years later in 2007 on an exchange rate basis. From 1961 to 2019, China grew by more than 10% in 22 years while India never. GDP growth rate was negative in five and four years for China and India, respectively.

China presents as a country where high GDP growth is driven by the scale of expansion of economic freedom, rather than its final level (which is still low). While economic reforms might explain some of the differences, China outpaced India because:

- (1) The economy was privatized faster;
- (2) Prices were released faster;
- (3) The labour market underwent much deeper reforms;
- (4) The economy was opened up to international trade and foreign direct investment (FDI) faster and to a greater extent; and
- (5) The state's fiscal position was drastically limited, and fiscal competition among China's provinces was introduced.

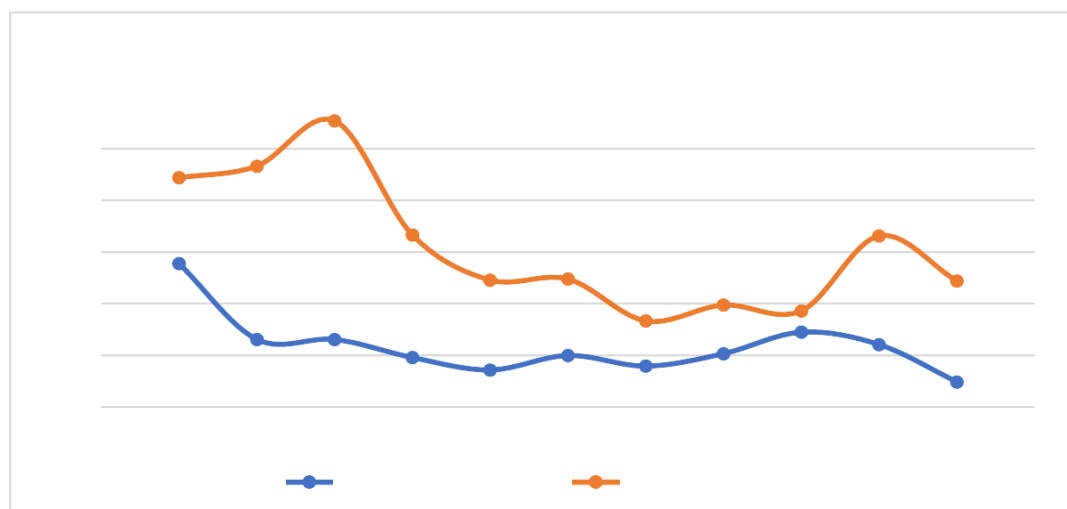
**GNI Comparison of China and India**



**INTERPRETATION:**

Gross national income (GNI) is GDP less net taxes on production and imports, less compensation of employees and property income payable to the rest of the world plus the corresponding items receivable from the rest of the world. India was richer than China in 1990. In 2021, China is almost 5.4 times richer than India on the nominal and 2.58 times richer in the ppp method. The per capita rank of China and India is 63rd and 147th, respectively, in nominal. The per capita rank of China and India is 76th and 130th, respectively, in ppp. From the above graph between the comparison of GNI of China and India we can observe that there is positive increasing trend in GNI of China. By 2015, China ranked 96th among 214 economies with available statistics, 44.6% from the top as the country stepped into the upper-middle-income phase and is at a critically strategic stage to build a moderately prosperous society in all aspects. The basic plan for the next step is to enter the high-income phase and successfully become a high-income country within the next decade through overcoming the “middle income trap”. Whereas if we observe the GNI of India its showing quite linear progress which is not greater than China.

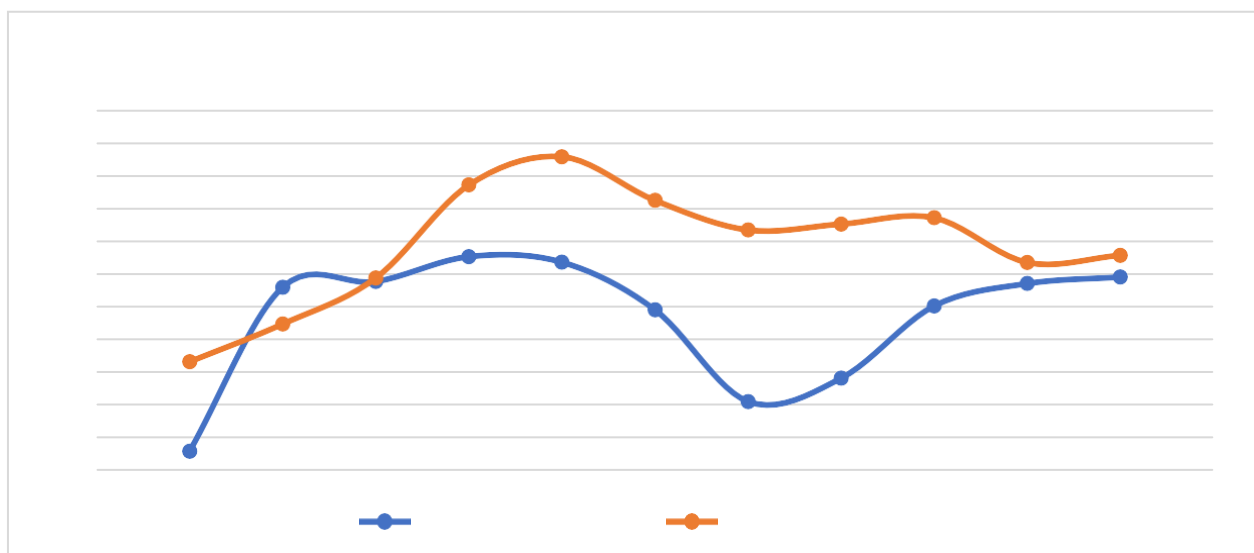
**Inflation rate comparison of China and India**



**INTERPRETATION:**

We can observe from the above graph that the inflation rates of India are greater in all the years from 2011-2021 compared to China. The maximum inflation of China is 5.5% in 2011 where as the maximum inflation rate of India is 11.06% in 2013. But in 2022, according to Bloomberg economic analysts India is experiencing something similar to China’s cost-push inflation, where higher input prices are the main factor pushing up the cost of goods and services. Concern about Indian inflation have triggered a recent selloff in shorter-maturity rupee bonds, a trend that may accelerate if the prices try to increase.

**Real Interest rates comparison of India and China**



**INTERPRETATION:** We can observe from the above graph that until 2013 interest rates of both China and India were parallel not with greater difference which shows interest rates of China in 2013 is 3.77% and for India is 3.86% but in later on years interest rates of India is greater than China. The maximum interest rate of India was in 2015 which is 7.56% where China’s was 4.35%.

The interest rate offered for two years to less than three years has been revised to 5.50 percent. On June 8, 2022, the Reserve Bank of India (RBI) raised repo rates by 50 basis points during its monetary policy meeting. In just over a month, the central bank has raised rates by a total of 90 basis points.

Interest rates of China in 2022 is revised to 3.7%. The People's Bank of China held steady its key rates for corporate and household loans at May fixing, but slashed the mortgage referencerate for the second time this year, amid a slowdown in the Chinese economy due to worst COVID-19 outbreak in more than two years, a property crisis, and weak loan demand. The one-year LPR was kept unchanged at 3.7% after cuts of 5 and 10 bps in December and January, while the five-year LPR was trimmed by 15 bps, the most since a revamp of the rate in 2019, to 4.45%. Recently, Chinese financial authorities allowed commercial banks to reduce the lower limit of interest rates on home loans by 20 bps, based on the corresponding tenor of benchmark LPRs for buying of first homes. The loan guidance came after the central bank data showing new bank loans in China plunged to their lowest in more than four years in April.

**Findings:**

**CHINA**

**GDP:** We can observe from the graph that there is a positive increasing trend in the 10 years span from 2011-2021.

**GNI:** We can observe from the graph that there is an increasing positive trend in the 10 years span from 2011-2021.

**INTEREST RATES:** We can observe from the graph that there is no trend in the interest rates pattern it indicates randomness in the graph which is probably due to the effect of various factors in the economic growth.

**INFLATION RATES:** We can observe from the graph that the inflation rates seem in high - low changing pattern. The inflation rate for 10 years from 2011-2021 was maximum high during 2011 which is 5.5% rest of the years it was not exceeding more than 3%.

**HYPOTHESIS TEST:**

T-test has been conducted by using python programming to check whether there is any significant impact of Brent crude index on the macro-economic factors of China. from the results we got to know that the significant p-value of all the 4 macro-economic factors i.e., GDP, GNI, INFLATION RATES, INTEREST RATES is less than 0.05.

<b>PAIRED T-TEST FOR HYPOTHESIS TESTING</b>	<b>BRENT INDEX (ALTERNATE HYPOTHESIS)</b>	<b>BRENT INDEX (NULL HYPOTHESIS)</b>
<b>GDP</b>	ACCEPTED	REJECTED
<b>GNI</b>	ACCEPTED	REJECTED
<b>REAL INTEREST RATES</b>	ACCEPTED	REJECTED
<b>INFLATION RATES</b>	ACCEPTED	REJECTED

**INDIA**

**GDP:** We can observe from the graph that there is a positive increasing trend in the 10 years span from 2011-2021 in the GDP of India but the amount of increase in GDP every year is comparatively less than China.

**GNI:** We can observe from the graph that there is a positive increasing trend in GNI for 10 years since 2011-2021. But in 2020 there was a dip in the GNI as we can see from the graph.

**INTEREST RATES:** We can observe from the graph that there is no trend in the interest rates pattern it indicates randomness in the graph which is probably due to the effect of various factors in the economic growth.

**INFLATION RATES:** We can observe from the graph that the inflation rates do not follow any trend. The inflation rate for 10 years from 2011-2021 was maximum high during 2013 which is 11.04%.

**HYPOTHESIS TESTING:**

T-test has been conducted by using python programming to check whether there is any significant impact of Brent crude index on the macro-economic factors of India. from the results we got to know that the significant p-value of all the 4 macro-economic factors i.e., GDP, GNI, INFLATION RATES, INTEREST RATES is less than 0.05.

<b>PAIRED T-TEST FOR HYPOTHESIS TESTING</b>	<b>BRENT INDEX (ALTERNATE HYPOTHESIS)</b>	<b>BRENT INDEX (NULL HYPOTHESIS)</b>
<b>GDP</b>	ACCEPTED	REJECTED
<b>GNI</b>	ACCEPTED	REJECTED
<b>REAL INTEREST RATES</b>	ACCEPTED	REJECTED
<b>INFLATION RATES</b>	ACCEPTED	REJECTED

**Conclusion:**

The purpose of this study is to identify the effect of cruel oil price fluctuation on the macro- economic factors of both the countries China and India. For this study as it is mentioned one of the crude oil price index Brent crude index was considered to know the impact on the economic factors of both the countries. As per the stated purpose python programming is used for the analysis of data and for the hypothesis testing to check the impact between the factors.

This study has satisfied all the objectives that have been stated. From the data collected for 10 years from 2011 to 2021 it measures the performance of the Indian and Chinese economy with respect to the crude oil prices. We also found out from the paired sample t-test that there is an impact of crude oil price on the macro- economic factors i.e., on GDP, GNI, Interest rates, Inflation rates for both the countries India, China.

We found from the comparative analysis of the macro-economic factors of China and India that performance of the Chinese economy is evidently better than the Indian economy due to the various reasons mentioned in the detailed analysis. Some of the future prospects along with the predicted values analysed by various economists have also been mentioned which might encourage the better performance for both the economies. Hence, we can declare from this that the study has satisfied all the objectives as stated and can be concluded that there exists an effect of crude oil price fluctuation on the macro-economic factors.

This study also has some limitations that the impact level of the crude oil price on the macro-economic factors is calculated by considering some of the macro-economic factors which would be accurate only to certain extent. This study is also conducted for the particular time- frame.

**References:**

- IOSR Journal of Economics and Finance (IOSR-JEF) e-ISSN: 2321-5933, p-ISSN: 2321-5925. Volume 8, Issue 3 Ver. I (May. - June. 2017), PP 51-54 [www.iosrjournals.org](http://www.iosrjournals.org)
- International Journal of Management Volume 11, Issue 03, March 2020, pp. 408-418. Article ID: IJM\_11\_03\_043 Available online at <http://www.iaeme.com/ijm/issues.asp?JType=IJM&VType=11&IType=3>
- Ushus-Journal of Business Management 2018, Vol. 17, No. 3, 27-38 ISSN 0975-3311| <https://www.proquest.com/openview/7d740796e700c819d52b474b354b7e34/1?pq-ri-gsite=gscholar&cbl=499079>
- <https://tradingeconomics.com/>
- <https://data.worldbank.org/indicator/FR.INR.RINR?end=2020&locations=CN-IN&start=1978&view=chart>
- <https://scholar.google.com/>

- Shipra Maurya, M Thenmozhi(2020)- “Crude Oil Volatility Transmission Across Food Commodity Markets: A Multivariate BEKK-GARCH Approach”.  
<https://journals.sagepub.com/doi/abs/10.1177/0972652720927623>
- Guiwu Wei et al., (2019)-“Oil price fluctuation, stock market and macroeconomic fundamentals: Evidence from China before and after the financial crisis”.
- <https://www.statista.com/markets/>
- <https://www.macrotrends.net/charts/energy>
- Donia Aloui Stéphane Goutte et al., -“COVID 19's impact on crude oil and natural gas S&P GS Indexes”.
- Hailing Li et al.,(2020)-“The pass-through effects of oil price shocks on China's inflation: A time-varying analysis”.
- <https://data.worldbank.org/indicator/FR.INR.RINR?end=2020&locations=CN-IN&start=1978&view=chart>
- Umar Bala, Lee Chin (2018)- “Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries”.
- Nicholas M et al., (2020)- “Asymmetric effect of oil price on economic growth: Panel analysis of low-income oil-importing countries”.
- [https://en.wikipedia.org/wiki/2011%E2%80%932013\\_world\\_oil\\_market\\_chronology](https://en.wikipedia.org/wiki/2011%E2%80%932013_world_oil_market_chronology)
- Roman Ferer, Reza Demirer(2020)-“Oil price shocks, global financial markets and their connectedness”.
- <https://economictimes.indiatimes.com/>
- <https://www.sciencedirect.com/science/article/pii/S0140988318302767>
- Feng Hua wen(2021)-“Asymmetric impacts of oil price uncertainty on Chinese stock returns under different market conditions: Evidence from oil volatility index”.