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"Analysis of GDP, Unemployment and Inflation rates using mathematical formulas and graphs."

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Abstract: This research paper summarises the process of persistent and appreciable rise in the general price level by the means of mathematical formulas and graphs .The data has been taken from 2008 to 2022. For this we have used different mathematical formulas and have analysed and structured it in the form of a research paper.

KEY WORDS: Money, Inflation, Recession, Business, Economic growth, Economy.

1. INTRODUCTION

In today's busy economy, inflation is basically an increase in the average cost of goods and services. When the average cost rises, each and every unit of currency brings fewer goods and services therefore inflation corresponds to the value of money which can be expressed as a result of number of goods and services that can be bought by one unit of money. For example: if network prices increase more than the usual and exceeds the price of other goods and services , people who use the net frequently will certainly feel an inflation because their personal expense on net is higher than the average expense.

2. INFLATION:

Inflation generally means a particular rate at which the marginal cost of goods and services rises in a period of time .It is important to note some important facts of the definition of inflation:

1. Inflation refers to a process of rising prices and not a state of high prices.

2. It refers to a situation of an appreciable or considerable rise in prices.

3. It should be prolonged in order to be called as inflationary price rise.

4. Inflation does not refer to one time rise in the price level but rather to persistent rise in the price level.

5. It has two categories: 1. Consumer Price Index (CPI). 2. Wholesale Price Index (WPI).

Therefore to maintain this rise it is very important to comprehend different categories of inflation which are as follows;

2.1 DEMAND-PULL INFLATION:

Inflation originating from the demand forces is called demand pull inflation. Although we have a lot of money but too many dollars leads few goods only for example; Rising house prices. Demand pull inflation is one of the most common types of inflation.The Cause of demand pull inflation is when the demand for goods and services exceeds the supply of other goods and services available at the existing prices.

2.2 COST PUSH INFLATION:

In this type of inflation when overall prices increase due to increase in the cost of wages and raw materials.As we know higher the cost of production may lead to the reduction in the aggregate supply that is also the amount of total production in the economy.This type of inflation can also be called as wage-push inflation due its uniqueness in managing the cost of production of the economy.

2.3 INFLATION RATE:

The inflation rate refers to the percentage change in the general price level of goods and services in an economy over a specific period of time, usually measured annually. It is a key economic indicator that quantifies the rate at which prices are

rising within the economy. The inflation rate is commonly expressed as a percentage and is calculated by comparing the Consumer Price Index (CPI) or another price index for two different time periods.

Mathematically, the formula for calculating the inflation rate between two periods is:

Inflation Rate = ((CPI in Current Period - CPI in Previous Period) / CPI in Previous Period) * 100

Inflation Rate			
Sr. No.	Year	India	USA
1	2008	8.4	3.8
2	2009	10.9	-0.4
3	2010	12.0	1.6
4	2011	8.9	3.2
5	2012	9.5	2.1
6	2013	10.0	1.5
7	2014	6.7	4.6
8	2015	4.9	0.1
9	2016	5.0	1.3
10	2017	3.3	2.1
11	2018	3.9	2.4
12	2019	3.7	1.8
13	2020	6.6	1.2
14	2021	5.1	4.7
15	2022	6.7	8.3

2.4 FACTORS AFFECTING INFLATION:

1. Rate of Economic growth: An increase in the rate of economic growth means downward pressure on inflation.

2. Wage growth: The major cause is due to Unemployment.

3. Monetary Growth Rate.

4. Exchange Rate Causes: This happens due to high interest rates, by the bank or the moneylender.

2.5 INFLATION Vs RECESSION:

In simple terms, inflation is the appreciable rise in prices whereas during the phase of recession, there is downward trend in the level of economic activity. It is the falling level of income as well as employment. Inflation is year by year growth and will increase permanent from year to year and will continue to increase so it is very important balance it, on the other hand Recession is a time period when there is either temporally or permanently decrease in monetary units which sometimes can also reduce a person to bankruptcy.

2.6 INFLATION CAN BE CONTROLLED BY:

It is rightly said “You should have a knowledge on Gaining Control over your Money or the Dearth of it will continue to control you”. Hence from the above statement I strongly believe that for controlling inflation one must know the behaviour of Money because doing well with money has little impact on smartness and major impact on how we deal with it.

3. UNEMPLOYMENT:

Unemployment refers to the situation in which individuals above certain age who are willing to work are actively seeking employment but are unable to find suitable jobs to earn their livelihood. It is a crucial economic and social indicator that reflects the state of the labour market within an economy. Unemployment can arise from various factors, including changes in demand for goods and services, shifts in economic activity, technological advancements, and structural changes in industries. Unemployment is a major parameter to know the economic condition of a country.

There are several types of unemployment:

1. Frictional Unemployment
2. Structural Unemployment
3. Cyclical Unemployment
4. Seasonal Unemployment
5. Long Term Unemployment

3.1 UNEMPLOYMENT RATE:

The term unemployment rate is a physical parameter to find the unemployment of country. It is a crucial economic indicator that measures the percentage of labour force that is unemployed and actively seeking employment. It is calculated by dividing the number of unemployed individuals by the total labour force.

Unemployment Rate= (Number of Unemployed/Labour Force)*100

Unemployment Rate			
Sr. No.	Year	India	USA
1	2008	5.4	5.8
2	2009	5.5	9.3
3	2010	5.6	9.6
4	2011	4.4	9.0
5	2012	5.4	8.1
6	2013	5.4	7.4
7	2014	5.4	6.2
8	2015	5.4	5.3
9	2016	5.4	4.9
10	2017	5.4	4.4
11	2018	5.3	3.9
12	2019	5.3	3.7
13	2020	8.0	8.1
14	2021	6.0	5.5
15	2022	7.3	3.7

3.2 UNEMPLOYMENT VS INFLATION:

The relationship between unemployment and inflation is often depicted as the Phillips Curve, which suggests an inverse relationship between the two in the short run. This means that when unemployment is low, inflation tends to be high, and and vice versa. The reasoning behind this idea is that as more people are employed and earning wages, their increased spending can drive up demand for goods and services, potentially leading to price increases. Conversely, when

unemployment is high and many people are out of work, consumer spending is generally lower, which can lead to decreased demand for goods and services. This reduced demand can put downward pressure on prices, potentially resulting in lower inflation or even deflation (negative inflation)

4. GDP(GROSS DOMESTIC PRODUCT):

GDP is the fundamental economic measure or indicator that quantify the total economic output of the country. In simple words, GDP is the income of the whole country combined. GDP of a country can tell you It is the total monetary value of all goods and services within country's borderline.

There are various ways to calculate GDP of a country, some of them are listed:

1. Production Approach(GDP by Production)
2. Income Approach(GDP by Income)
3. Expenditure Approach(GDP by Expenditure)

]GDP can be expressed as:

GDP=Consumption + Investment + Government Spending + (Exports-Imports)

In the simplest words, GDP is the ultimate economic factor that will tell money making factors about a country. Here are top 10 countries according to the GDP and GDP per capita.

Country	GDP (USD Billions)	GDP per Capita (USD Thousand)
USA	26854	80.3
China	19374	13.72
Japan	4410	35.36
Germany	4309	51.38
India	3750	2.6
United Kingdom	3159	46.31
France	2924	44.41
Italy	2170	36.81
Canada	2090	52.72
Brazil	2080	9.67

4.1 GDP GROWTH RATE:

As the name suggest, GDP growth rate is a measure used to quantify country's change in GDP over a specific period of time. GDP growth rate indicates how fast an economy is expanding or contracting over period of time. For ex. India's GDP increased 8.7% over last financial year. Whereas Germany's GDP contracted by 0.4% over last financial year.

GDP Growth Rate			
Sr. No.	Year	India	USA
1	2008	3.09	0.12
2	2009	7.86	-2.60
3	2010	8.50	2.71
4	2011	5.24	1.55
5	2012	5.46	2.28

6	2013	6.39	1.84
7	2014	7.41	2.29
8	2015	8.00	2.71
9	2016	8.26	1.67
10	2017	6.80	2.24
11	2018	6.45	2.95
12	2019	3.87	2.29
13	2020	-5.83	-2.77
14	2021	9.05	5.95
15	2022	7.00	2.06

4.2 GDP V/S INFLATION:

The relationship between GDP and inflation can vary based on the level of inflation and the economic context:

- Low Inflation and Healthy GDP Growth: In many cases, a moderate level of inflation is associated with a healthy growing economy. When inflation is low and stable, it indicates that the economy is operating efficiently, and there is balanced demand and supply. It can also suggest that the central bank's monetary policy is effectively managing inflation. A growing GDP can lead to increased employment, higher incomes, and higher consumption.

- High Inflation and GDP Growth: High inflation can sometimes accompany high GDP growth, especially in developing economies experiencing rapid expansion. This can occur due to increased demand for goods and services, supply bottlenecks, or other factors. However, sustained high inflation can erode consumer purchasing power and create uncertainty, which can negatively impact investment and economic stability.

- Stagflation: As mentioned earlier, stagflation is a rare scenario where high inflation and high unemployment coexist. This situation challenges the traditional understanding of the relationship between GDP growth and inflation. It can occur when the economy faces supply shocks, such as a sudden increase in oil prices, which drive up production costs and cause inflation while simultaneously reducing economic output and employment.

  Policymakers often aim to strike a balance between economic growth and price stability. They use various tools, including monetary policy (such as adjusting interest rates), fiscal policy (government spending and taxation), and regulatory measures to influence both GDP growth and inflation.

4.3 GDP V/S UNEMPLOYMENT:

The relationship between GDP and unemployment can be understood through the concept of the business cycle, which describes the fluctuations in economic activity over time. Here's how these two indicators are related at different stages of the business cycle:

- Boom/Expansion Phase: During this phase, GDP is increasing, and economic activity is robust. As GDP grows, businesses are expanding, and consumer spending is on the rise. This often leads to increased demand for labor, resulting in a decrease in unemployment rates. As more jobs are created, people who were previously unemployed find opportunities for work.

- Peak Phase: At the peak of the business cycle, GDP reaches its highest point, indicating the maximum level of economic activity. Unemployment tends to be at its lowest during this phase, as job opportunities are abundant due to strong economic conditions.

- Recession/Contraction Phase: In this phase, GDP begins to decline, signaling an economic slowdown. As businesses cut back on production and investment, job opportunities decrease, leading to higher

unemployment rates. During a recession, people who were previously employed may lose their jobs, and those who were unemployed may have a harder time finding work.

- Trough Phase: The trough represents the lowest point of the business cycle, indicating the bottom of the economic downturn. Unemployment rates are typically at their highest during this phase as economic activity is at its weakest, and many people are without jobs.

The relationship between GDP and unemployment is not always linear and can be influenced by other factors, such as government policies, technological changes, and global events. Additionally, some level of frictional and structural unemployment is natural even during periods of economic growth, as individuals' transition between jobs or industries.

Policymakers often focus on achieving a balance between promoting economic growth (reflected in rising GDP) and maintaining low levels of unemployment. They may use various tools, such as fiscal and monetary policy, to stimulate economic activity and job creation during periods of downturn and to manage inflationary pressures during periods of expansion.

5. WHY I CHOSE THIS TOPIC:

I have developed keen interest in financial economic crisis during challenging events starting from Covid 19 to Russian-Ukraine war which caused vast drop in economy specifically in asian countries leading to the problem of unemployment and the major problem of bankruptcy which pushed me to write more about this topic as income as well as investment are the key in solving all of these problems. It even helps the economy to beat the rising inflation as inflation, time and debt are truly dependent to each other.

6. GRAPHS, CALCULATIONS AND ANALYSIS:

Methods/formula/techniques to do analysis of the data**:**

a. Correlation:

Correlation is a statistical concept that measures the strength and direction of a relationship between two variables. It helps us understand how changes in one variable are associated with changes in another variable. Correlation does not imply causation; just because two variables are correlated does not mean that changes in one directly cause changes in the other.

Pearson's correlation coefficient, often denoted as "rR" is a statistical measure that quantifies the strength and direction of the linear relationship between two continuous variables. It is a widely used method to assess how closely the data points in a scatter plot follow a straight line. Pearson's correlation coefficient ranges from -1 to 1:

- Positive Correlation (0 to 1): When one variable increases, the other tends to increase as well. The closer the correlation coefficient is to 1, the stronger the positive correlation.
- Negative Correlation (0 to -1): When one variable increases, the other tends to decrease. The closer the correlation coefficient is to -1, the stronger the negative correlation.
- No Correlation (Close to 0): There is little to no linear relationship between the variables. A correlation coefficient close to 0 indicates weak or no linear correlation.

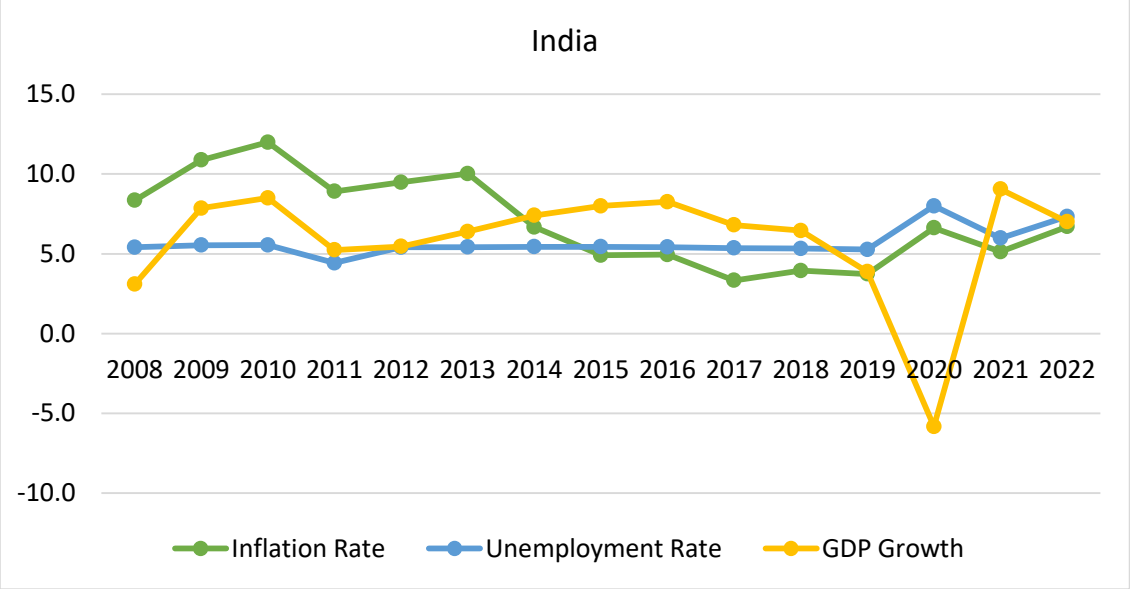
b. Regression:

Regression analysis is a statistical technique used to model the relationship between one or more independent variables (predictors) and a dependent variable (outcome). The goal of regression analysis is to find the best-fitting equation that describes how changes in the independent variables are associated with changes in the dependent variable.

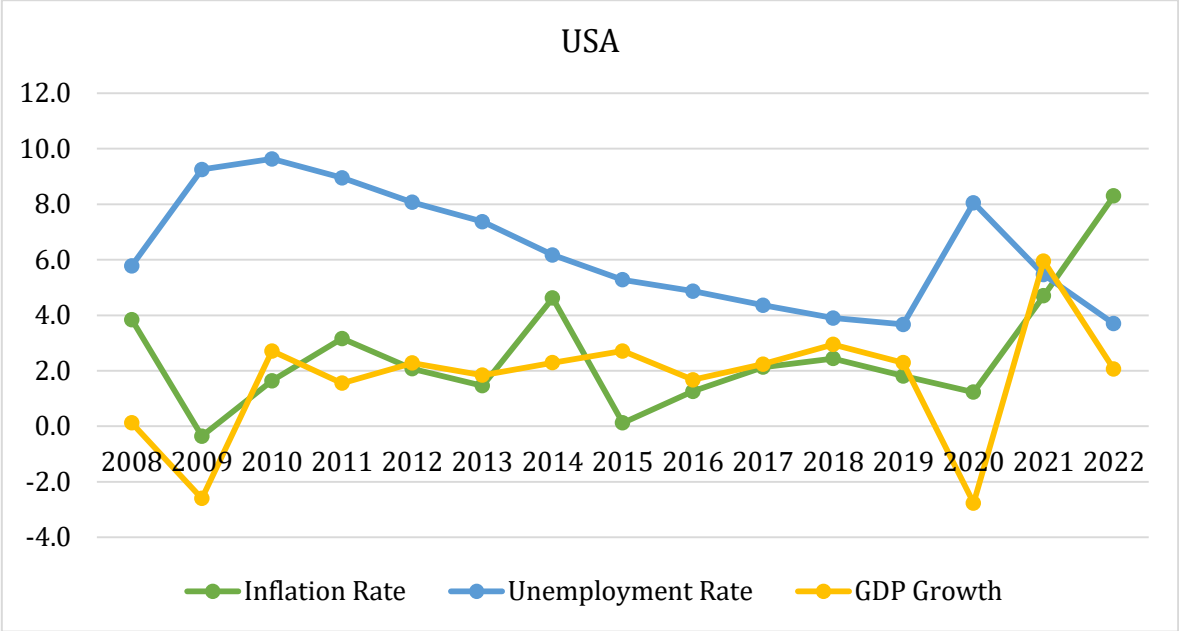
There are different types of regression analysis, each suited for different types of data and relationships:

- Linear Regression: This is the most common type of regression. It's used when there's a linear relationship between the dependent variable and one or more independent variables. The equation is typically in the form of Y = mx + b, where "Y" is the dependent variable, "X" is the independent variable, "m" is the slope, and "b" is the intercept.
- Multiple Regression: This extends linear regression to include multiple independent variables. The equation becomes a bit more complex: Y = b0 + b1X1 + b2X2 + ... + bnXn, where "X1," "X2," etc. are different independent variables, and "b0," "b1," "b2," etc. are coefficients.
- Polynomial Regression: Used when the relationship between variables is not linear but can be approximated by a polynomial equation (e.g., quadratic or cubic).
- Logistic Regression: Used for predicting the probability of a binary outcome (yes/no, 0/1) based on one or more independent variables.
- Exponential Regression: Used when the relationship follows an exponential pattern.
- Time Series Regression: Used for modeling time-dependent data and predicting future values based on past observations.

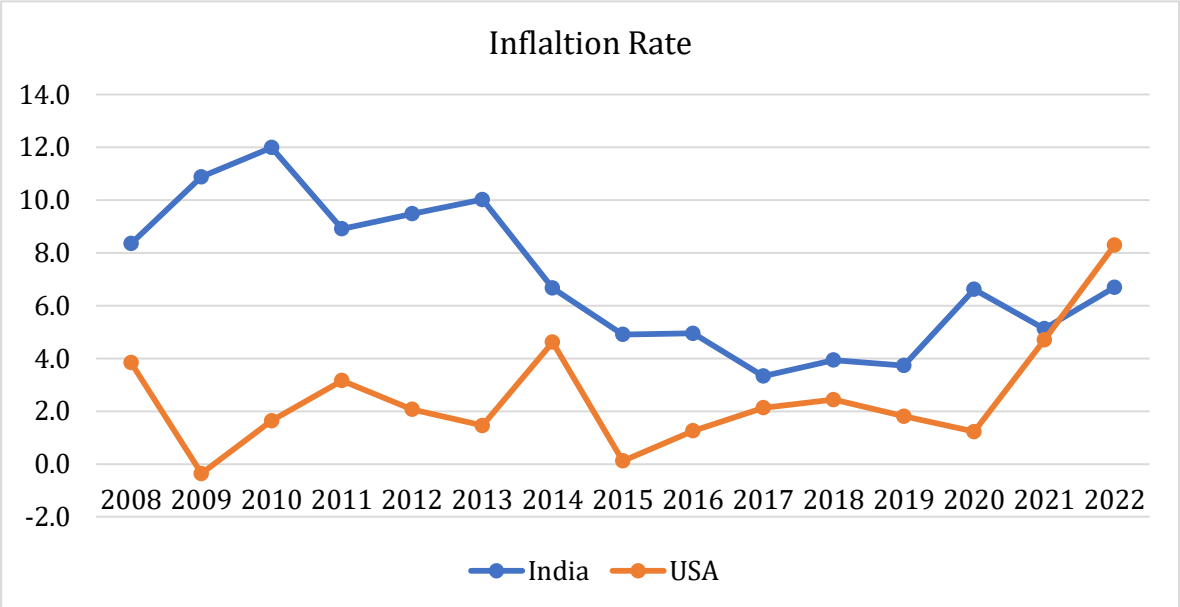
6.1 Inflation Rate, unemployment Rate and GDP Growth Rate of India:



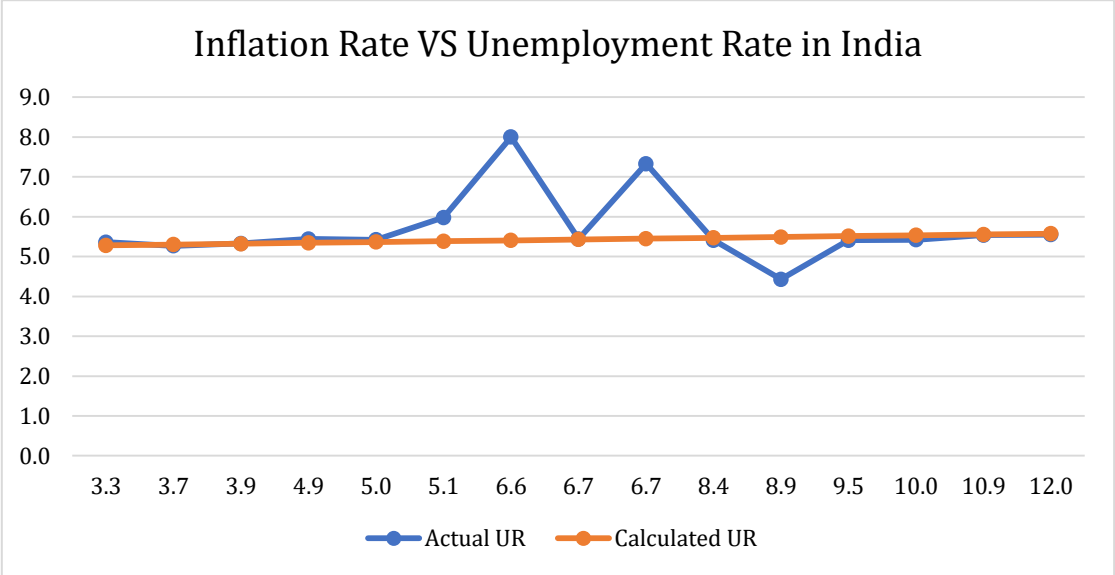
6.2 Inflation Rate, unemployment Rate and GDP Growth Rate of USA:



6.3 Inflation Rate of USA VS Inflation Rate of India:



6.4 Inflation VS Unemployment Rate in India:



Equation of Red line:

Y=5.26+0.021*X

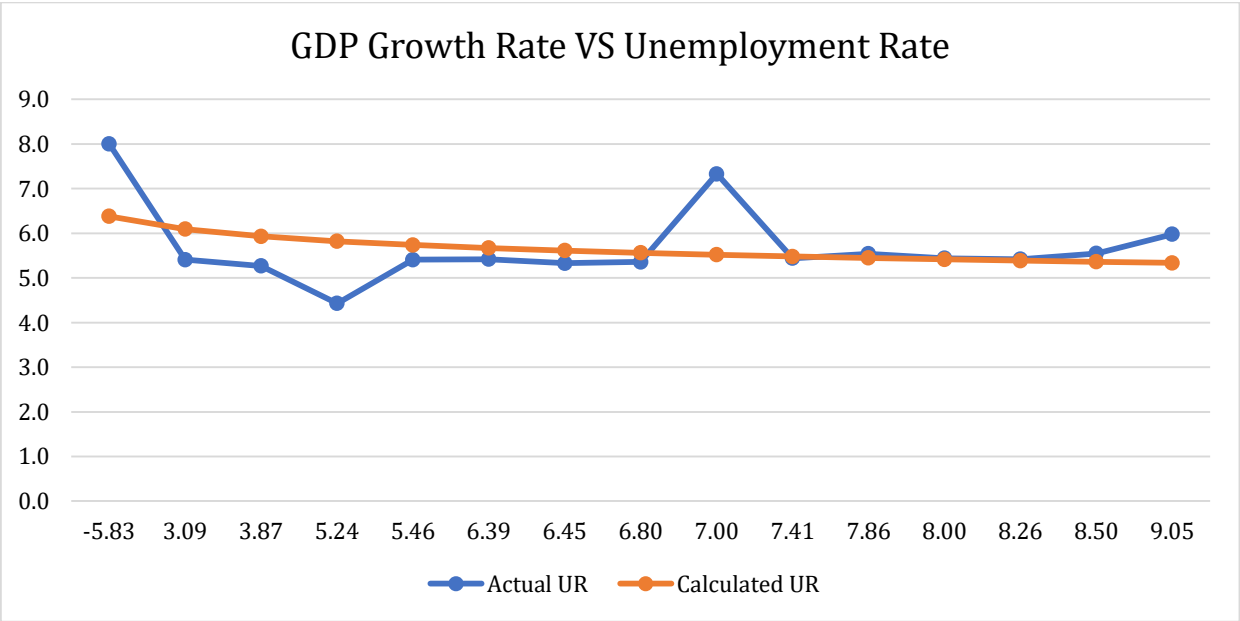
And the correlation coefficient between inflation Rate and Unemployment Rate is 0.78.

We have considered liner regression equation as stated above. For this we have plotted different point and solved this by taking any two random points by method of elimination for solving two simultaneous linear equation. Hence we get the result

A=5.26

B=0.021

6.5 GDP Growth Rate VS Unemployment Rate in India:



Equation of Red line:

Y=6.38*X^ (-0.066)

And the correlation coefficient between inflation Rate and Unemployment Rate is 0.37 .

7. CONCLUSION:

We have studied inflation Rate, Unemployment Rate and GDP Growth Rate of India and USA after drawing different graphs and doing various calculations and analysis, we concluded that there is relation between all the above three. Increased inflation lowers the unemployment and hence increases the GDP or vice versa. We have calculated the relationship between inflation Rate of USA with Inflation Rate of India, secondly inflation rate of India with unemployment rate of India and GDP growth rate of India. All these relationships were studied and analysed and their correlation coefficient from period 2008 to 2022. Our conclusion is that there is high correlation between inflation rate and unemployment rate and moderate relationship between GDP growth rate and unemployment rate of India.

As quoted by Mr. Mukesh Ambani: "Today's India's GDP ranks sixth in the world, can we triple it in next 10 years, **yes we can!!**"

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Some of these books also guided me throughout my research:

- The Psychology of Money
- Economics by DK Sethi and Mrs.U.Andrews

BIOGRAPHIES

Lavanya Sehgal

- *Currently studying in Sat Paul Mittal School, Ludhiana.*
- *Student of Grade Xl.*
- *Scored 91.6% in Grade X.*
- *Cracked DELF A1 as well as A2.*
- *Won various prizes in ART Competitions which are held in school.*
- *Best Zen Artist in 'Art in Himalayas' a wonderful course at Summer Programme in Woodstock School, Mussoorie.*
- *Member of Green Entrepreneurship Community programme, who planted more than 700 plants around the city of Ludhiana.*

Under the guidance of :

Dr. Mamta Jain

- *M.Sc (Mathematics) (Double gold medalist).*
- *-M.Phil (Computer Applications) with honours From University of Roorkee (now IIT Roorkee).*
- *PhD (Mathematics).*
- *Various papers published in international journals.*
- *Former Lead Auditor ISO 9001, ISO -22000 School Accreditation Examiner by QCI.*
- *26 years of teaching experience.*

Er. Raunaq Jain

- *B.E Mechanical Engineering graduate from Thapar Institute of Engineering and Technology.*
- *School Physics Topper.*
- *Mechanical Mentor from session 2019-2020.*
- *Upcoming Data Analyst at Deloitte.*
- *Two research papers published.*