



MACROECONOMICS PROJECT

Topic:

*Verification of the Phillips curve through
actual application on real data*

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OBJECTIVE

An Empirical and Time Series
Analysis of the Functioning of
the
Phillips Curve

INTRODUCTION

Economics, often referred to as the "dismal science," is not just about numbers and graphs. It's about understanding how our economy works, and two key factors that impact our financial well-being are inflation and unemployment. In this report, we will explore these concepts and the fascinating relationship between them through the Phillips Curve.

What is a Phillips curve?

Think of the Phillips Curve as a kind of balancing act in the economy. It's a concept that helps us understand the trade-off between two essential economic factors: inflation and unemployment. In other words, it helps answer questions like, "When people are getting jobs, does it make prices go up?" or "If prices are rising, does it mean more people are working?" The Phillips curve shows that there's often an inverse relationship between these two. When unemployment is low, inflation tends to be higher, and when unemployment is high, inflation is usually lower.

What is inflation?

Inflation is like a gentle rise in the cost of things over time. Inflation means your money doesn't buy as much as it used to. But a little bit of inflation is actually good for the economy because it encourages spending and investing. However, when prices rise too quickly, it can hurt people's savings and make planning for the future harder.

What is unemployment?

Unemployment, on the other hand, is about people who are looking for work but can't find a job. It's like a seesaw because when unemployment goes down, it means more people are working, which is great for individuals and the economy. But if too many people are out of work, it can lead to financial hardship and slow down the economy.

So, the Phillips Curve helps us understand the delicate balance between these two factors. If we push too hard to get everyone employed, inflation might go up. If we focus too much on keeping inflation low, unemployment could rise.

In this report, we will take a closer look at how this balancing act plays out in the real world, specifically in the United States, China, and India. We'll examine the data on inflation rates and unemployment rates in these countries to see if the Phillips curve idea holds true.

By the end of this report, we hope to shed light on whether the Phillips Curve still matters in today's world and how it might help policymakers make decisions that affect our jobs, our money, and our future. Let's dive into this fascinating world of economics and explore the intriguing relationship between inflation, unemployment, and the Phillips Curve.

INTRODUCTION

In the pursuit of understanding the complex interplay between economic factors, this report embarks on a comprehensive analysis of the historical relationship between inflation and unemployment trends over the past three decades. Our approach encompasses various facets of data analysis and economic modeling to shed light on this intricate relationship.

This report unfolds as follows:

1. Methodology and Data:

- In the Methodology and Data section, we delve into the techniques and data sources that underpin this analysis. We elucidate the procedures employed to gather, clean, and structure our data, ensuring its reliability and consistency. Additionally, we outline the statistical methodologies used to develop our models and assessments.

2. Data Brief:

- The Data Brief section provides a concise overview of the historical dataset, encompassing the variables of interest - inflation and unemployment. We offer insights into the temporal scope, geographical focus, and any data considerations that influenced our analysis.

3. Summary Statistics:

- In the Summary Statistics section, we present a comprehensive view of our dataset, offering key statistical metrics and insights into the central tendencies and variations in inflation and unemployment rates. This provides a foundational understanding of the data's behavior and trends.

4. Comparative Analysis:

- The Comparative Analysis section takes a deep dive into the historical relationships between unemployment and inflation. We examine the patterns, correlations, and potential trade-offs that have characterized these two crucial economic indicators. Drawing upon principles of intermediate macroeconomics, we explore the significance of these trends and their implications.

5. Hypothesis Testing:

- In the given report we will mainly only talk about the relation found between the samples of data that has been collected. Thus to verify that the relation that we found in the sample isn't an exception and is actually followed by the population statistics as well, we will do hypothesis testing to check our findings.

INTRODUCTION

6. Policy Recommendations:

- Building on the insights derived from our analysis, the Policy Recommendations section offers guidance for policymakers and stakeholders. We discuss strategies to address the challenges and opportunities presented by the historical data, highlighting potential policy measures to promote economic stability and well-being.

7. Data Trends:

- In the Data Trends section, we uncover long-term trends and dynamics in inflation and unemployment. By applying advanced data visualization techniques and time series analysis, we provide an in-depth look at the evolution of these economic variables over the past three decades, discerning underlying patterns and deviations.

As we navigate through these sections, we aim to provide a comprehensive understanding of the relationship between inflation and unemployment while equipping readers with actionable insights and policy recommendations. The journey ahead promises a deeper insight into the ever-evolving dynamics of these economic indicators, essential elements of economic well-being.

Let us begin with a detailed exploration of our methodology and data, setting the stage for a comprehensive analysis of inflation and unemployment trends.

In this study we go over a comparative study between four countries-

A low income country- Venezuela

A lower middle income country- India

An upper middle income country- China

An upper income country- The US

We will have a deeper look into the US economy since it is a developed nation and thus has the most stable economy out of all the countries in our study. This will include a timeline based study in which we will focus our analysis within the different years and the things that could have lead upto them.

METHODOLOGY & DATA SOURCE

The present study has been analysed using descriptive statistics, which includes mean, median, maximum and minimum values, variance, standard deviation, skewness, kurtosis, percentiles, correlation, etc. testing to examine the relationship between the variables.

Variance is a measure of the spread or dispersion of a set of data points. It quantifies how much individual data points deviate from the mean. In other words, it provides a numerical value that indicates how much the data values are scattered around the mean.

Standard Deviation is another measure of the dispersion or variability of data. It is closely related to variance but is expressed in the same units as the original data.

Kurtosis measures the "tailedness" of the probability distribution of a dataset. In simpler terms, it indicates how data is distributed in the tails (extreme values) of the distribution compared to a normal distribution. Positive kurtosis indicates heavy tails, while negative kurtosis suggests light tails.

Skewness measures the asymmetry of the probability distribution of a dataset. It indicates whether the data is skewed to the left (negatively skewed), skewed to the right (positively skewed), or approximately symmetric.

METHODOLOGY & DATA SOURCE

The inflation data used in the analysis has been collected from the World Bank's "Cross country database of inflation" may 2023 issue, while the unemployment data has been collected from the World Bank's data repository using the meta data on World Development Index. Some of the data was taken in the form of excel, while the rest was obtained straightaway from the website using web scrapping techniques in python.

The data collected has been verified using the figures available IMF's "Access to macroeconomic and financial data" dataset.

Thus the study is carried out using secondary data with data from China, India and the USA.

Dependent Variable: Inflation rate

Independent Variable: Unemployment rate

I have used Microsoft Excel, Python and R to analyse, visualize and examine findings of the data. Further in python, libraries such as pandas, numpy, matplotlib and seaborn have been used in order to carry out hypothesis testing on the data collected.

The hypothesis test was conducted to ensure that our findings were not for a particular sample, but for the population.

DATA

CHINA

	Inflation	Unemployment
1991 [YR1991]	3.582364	2.37
1992 [YR1992]	6.374114	2.37
1993 [YR1993]	14.626211	2.69
1994 [YR1994]	24.25699	2.9
1995 [YR1995]	16.791231	3.0
1996 [YR1996]	8.313148	3.12
1997 [YR1997]	2.786472	3.23
1998 [YR1998]	-0.773187	3.24
1999 [YR1999]	-1.401475	3.25
2000 [YR2000]	0.347816	3.26
2001 [YR2001]	0.719123	3.8
2002 [YR2002]	-0.731975	4.24
2003 [YR2003]	1.127606	4.58
2004 [YR2004]	3.824636	4.49
2005 [YR2005]	1.776413	4.52
2006 [YR2006]	1.649437	4.43
2007 [YR2007]	4.816768	4.35
2008 [YR2008]	5.925247	4.59
2009 [YR2009]	-0.728167	4.72
2010 [YR2010]	3.175331	4.53
2011 [YR2011]	5.553897	4.55
2012 [YR2012]	2.619521	4.58
2013 [YR2013]	2.621052	4.6
2014 [YR2014]	1.921645	4.63
2015 [YR2015]	1.437022	4.65
2016 [YR2016]	2.0	4.56
2017 [YR2017]	1.558	4.47
2018 [YR2018]	2.07	4.31
2019 [YR2019]	2.903	4.56
2020 [YR2020]	2.419422	5.0
2021 [YR2021]	0.9	4.55
2022 [YR2022]	1.973576	4.886

INDIA

	Inflation	Unemployment
1991 [YR1991]	13.870254	6.737
1992 [YR1992]	11.787817	6.815
1993 [YR1993]	6.326885	6.798
1994 [YR1994]	10.247934	6.83
1995 [YR1995]	10.224888	7.014
1996 [YR1996]	8.977145	7.181
1997 [YR1997]	7.164259	7.279
1998 [YR1998]	13.230844	7.487
1999 [YR1999]	4.669818	7.709
2000 [YR2000]	4.009429	7.77
2001 [YR2001]	3.779289	7.957
2002 [YR2002]	4.297167	8.102
2003 [YR2003]	3.805864	8.36
2004 [YR2004]	3.767236	8.531
2005 [YR2005]	4.246352	8.7
2006 [YR2006]	5.796513	8.625
2007 [YR2007]	6.372883	8.536
2008 [YR2008]	8.349267	8.354
2009 [YR2009]	10.882353	8.384
2010 [YR2010]	11.989394	8.319
2011 [YR2011]	8.858355	8.168
2012 [YR2012]	9.31245	8.095
2013 [YR2013]	10.907642	8.037
2014 [YR2014]	6.353195	7.981
2015 [YR2015]	5.872425	7.915
2016 [YR2016]	4.941025	7.842
2017 [YR2017]	3.602	7.733
2018 [YR2018]	4.86	7.65
2019 [YR2019]	4.762	6.51
2020 [YR2020]	6.623437	10.195
2021 [YR2021]	4.890086	7.713
2022 [YR2022]	5.90043	7.33

USA

	Inflation	Unemployment
1991 [YR1991]	4.234963	6.8
1992 [YR1992]	3.028823	7.5
1993 [YR1993]	2.951657	6.9
1994 [YR1994]	2.607439	6.12
1995 [YR1995]	2.805418	5.65
1996 [YR1996]	2.931208	5.45
1997 [YR1997]	2.337688	5.0
1998 [YR1998]	1.552281	4.51
1999 [YR1999]	2.188026	4.22
2000 [YR2000]	3.376854	3.99
2001 [YR2001]	2.826172	4.73
2002 [YR2002]	1.586034	5.78
2003 [YR2003]	2.270094	5.99
2004 [YR2004]	2.677238	5.53
2005 [YR2005]	3.392745	5.08
2006 [YR2006]	3.225942	4.62
2007 [YR2007]	2.852678	4.62
2008 [YR2008]	3.8391	5.78
2009 [YR2009]	-0.355549	9.25
2010 [YR2010]	1.64004	9.63
2011 [YR2011]	3.156847	8.95
2012 [YR2012]	2.069331	8.07
2013 [YR2013]	1.464838	7.37
2014 [YR2014]	1.622224	6.17
2015 [YR2015]	0.118625	5.28
2016 [YR2016]	1.261581	4.87
2017 [YR2017]	2.136	4.36
2018 [YR2018]	2.44	3.9
2019 [YR2019]	1.812	3.67
2020 [YR2020]	1.233584	8.05
2021 [YR2021]	4.697859	5.35
2022 [YR2022]	8.0028	3.611

VENEZUELA

	Inflation	Unemployment
1991 [YR1991]	34.19643	9.45
1992 [YR1992]	31.412636	7.69
1993 [YR1993]	38.119324	6.6
1994 [YR1994]	60.795322	8.56
1995 [YR1995]	59.964439	10.24
1996 [YR1996]	99.824364	11.77
1997 [YR1997]	50.099033	11.16
1998 [YR1998]	35.780045	11.15
1999 [YR1999]	23.578207	14.53
2000 [YR2000]	16.213863	13.99
2001 [YR2001]	12.532879	13.04
2002 [YR2002]	22.428154	16.17
2003 [YR2003]	31.090387	16.78
2004 [YR2004]	21.746723	15.07
2005 [YR2005]	15.95413	10.66
2006 [YR2006]	13.647938	8.61
2007 [YR2007]	18.698582	7.28
2008 [YR2008]	30.36801	6.25
2009 [YR2009]	27.073694	6.1
2010 [YR2010]	28.166582	7.11
2011 [YR2011]	26.079266	6.9
2012 [YR2012]	21.064177	6.6
2013 [YR2013]	40.592159	7.54
2014 [YR2014]	62.140121	6.865
2015 [YR2015]	121.397255	6.077
2016 [YR2016]	254.391006	5.32
2017 [YR2017]	438.117	5.05
2018 [YR2018]	65374.08	5.02
2019 [YR2019]	19906.023438	5.092
2020 [YR2020]	2355.15	7.53
2021 [YR2021]	1588.51314	6.471
2022 [YR2022]	200.914	5.328

VARIABLES

1] INFLATION RATE:

Inflation is a fundamental economic concept that describes the rate at which the general level of prices for goods and services in an economy rises, resulting in a decrease in the purchasing power of a currency. It's a measure of how much the cost of living has increased over a specified period, and it is typically expressed as an annual percentage.

In this study we assume inflation rate to be a dependent variable since it is affected by the unemployment rate.

To go to grass root level, we know that $W = P_e \cdot f(u, z)$.

Here-

W is wage

P_e is expected price level(+)

u is unemployment rate(-)

z is catchall variables(+).

When the unemployment rate decreases, the bargaining power of trade unions increases and thus they demand higher wages. To accommodate this increase in production cost, the firms raise the prices. Thus causing the inflation rate.

This shows that the inflation rate is dependent on the unemployment rate and is related negatively.

That is a decrease in unemployment rate causes an increase in the inflation rate and vice versa.

2] UNEMPLOYMENT RATE:

The unemployment rate is a critical economic indicator that measures the percentage of the labor force in a country that is actively seeking employment but is currently without a job. It is an important metric for understanding the health of an economy, the availability of job opportunities, and the overall well-being of the workforce.

Key Concepts in Understanding the Unemployment Rate:

1. **Labor Force:** The labor force consists of people who are either employed or actively seeking employment. It excludes individuals who are not seeking work, such as retirees, full-time students, and people who have given up on finding a job.

2. **Types of Unemployment:**

- **Frictional Unemployment:** This type of unemployment occurs when individuals are temporarily between jobs or entering the workforce for the first time. It's often seen as a normal part of a dynamic job market.
- **Structural Unemployment:** This type is caused by a mismatch between the skills and qualifications of job seekers and the requirements of available job openings. Structural unemployment can be more persistent and challenging to address.

As discussed earlier, unemployment rate is an independent variable and is negatively related to inflation rate.

SUMMARY STATISTICS

CHINA

Inflation Rate

Unemployment Rate

Mean	3.888	Mean	4.03
Median	2.244	Median	4.48
Standard Deviation	5.403	Standard Deviation	0.7933
Sample Variance	29.199	Sample Variance	0.6295
Kurtosis	6.6195	Kurtosis	-0.7098
Range	25.658	Range	2.63
Minimum	-1.4012	Minimum	2.37
Maximum	24.2569	Maximum	5
Sum	120.528	Sum	124.93
Count	31	Count	31

Correlation	-0.4715
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STATISTICAL RELEVANCE

CHINA

It can be seen that the Chinese economy had an average inflation rate of 3.88%. Though not perfect, it is still a very good avg since the rise in prices was under control.

But it was not a smooth ride since we can see that the variance of the data is quite high. This means that the instead of having a constant 3.88% inflation rate, some years experienced nearly 24% inflation rates while some had negative inflation rates.

Similarly the average unemployment rate is 4.03%, but unlike inflation the deviation in unemployment was very low and thus a near constant unemployment rate was observed.

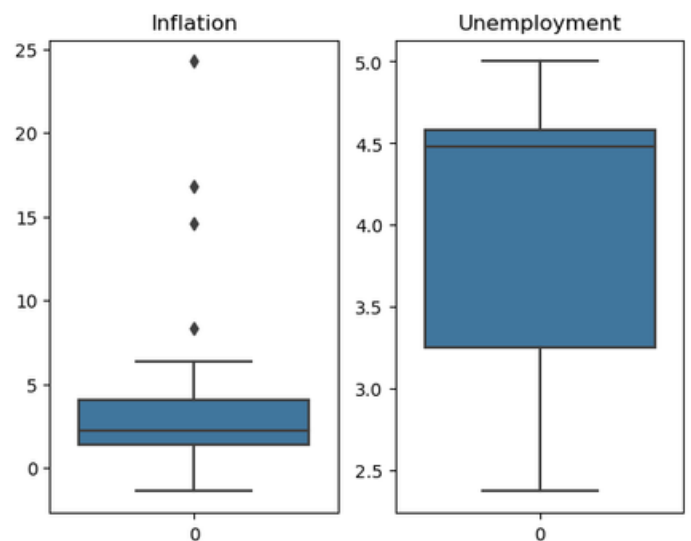
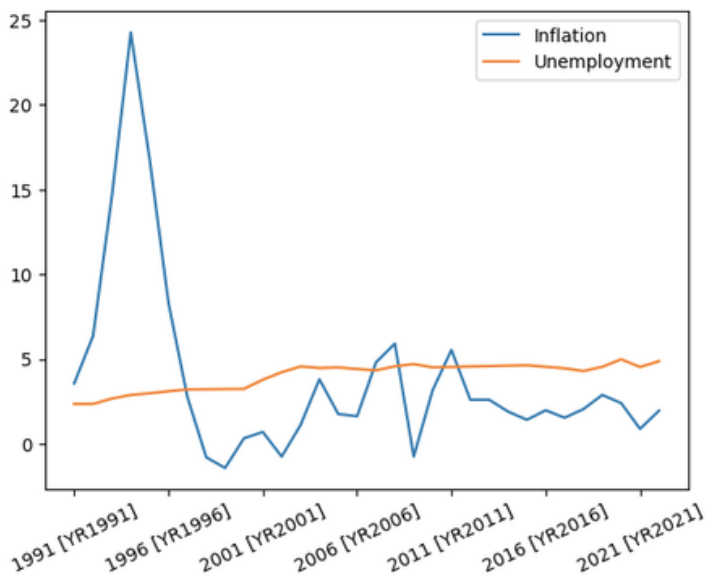
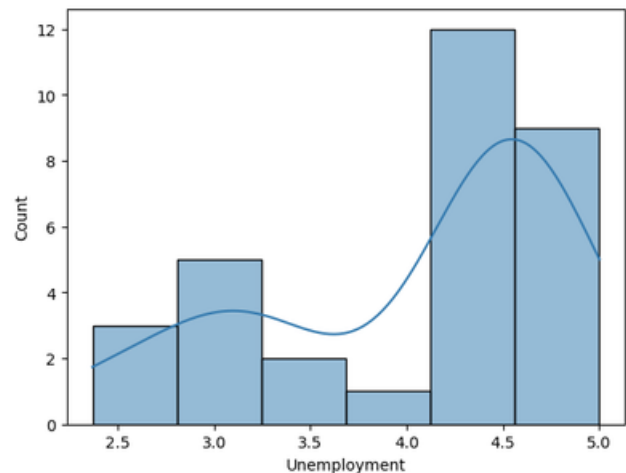
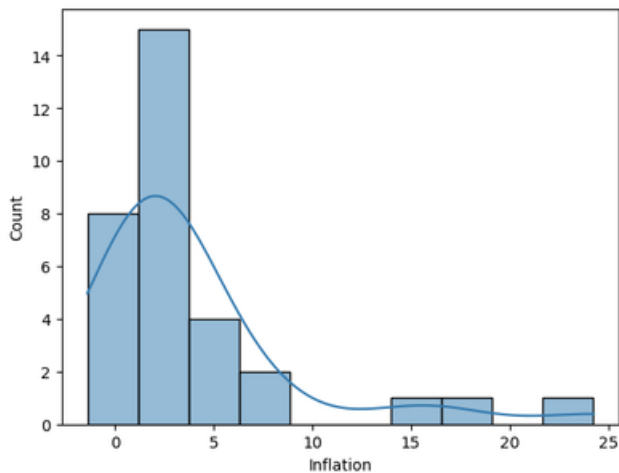
As we can see that the $\text{mean} > \text{median}$ for inflation, it means that the inflation rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

On the other hand we can see that the $\text{mean} < \text{median}$ for unemployment, it means that the unemployment rate is negatively skewed. It means that the data might have outliers towards the lower side, or just some low values in general.

Since the inflation rate has a very high excess kurtosis, we can tell that the data is heavily peaked and has a leptokurtic distribution, while the unemployment rate has a highly negative kurtosis, meaning that the data isn't that peaked and has a platykurtic distribution.

CHINA

Inflation and Unemployment

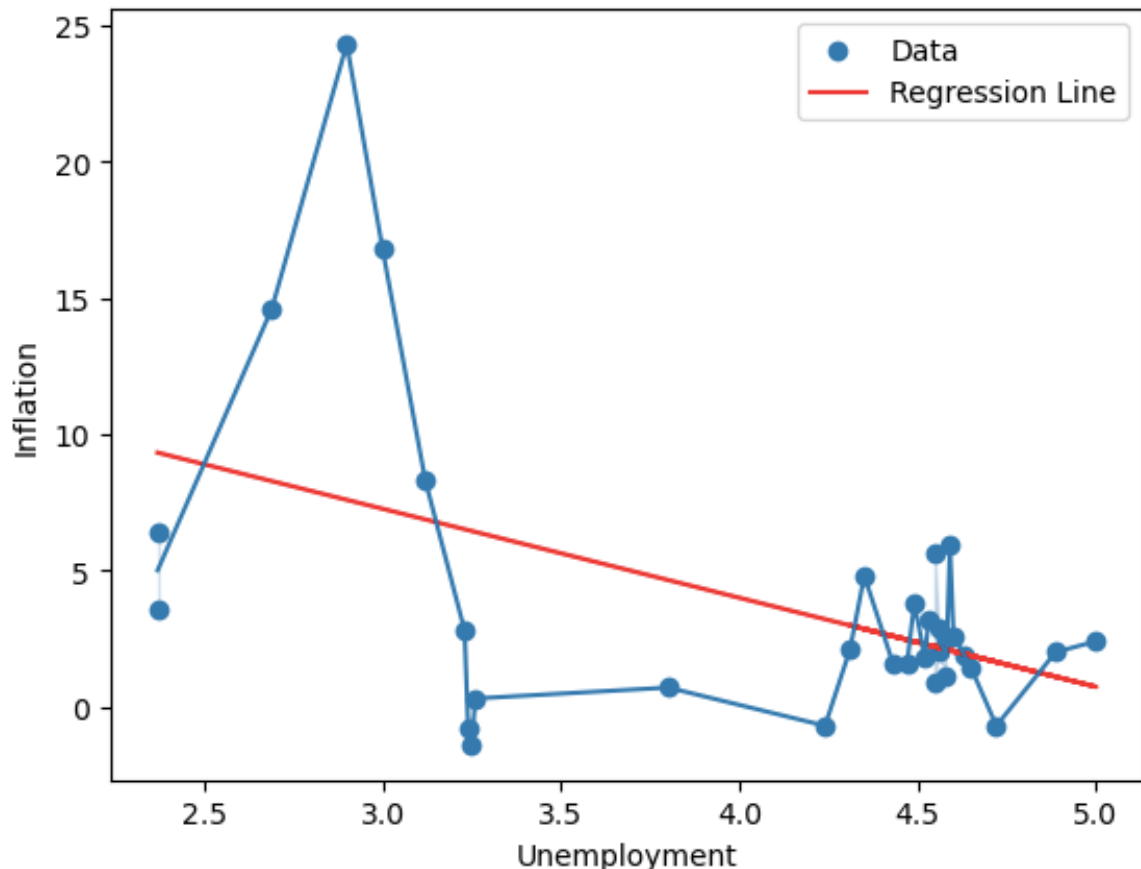


It can be seen from the given graphs that the inflation rate is positively skewed while the unemployment rate is negatively skewed. Thus fitting our expectations based on the given data.

It is also seen that the inflation rate is a lot more volatile compared to the unemployment rate.

CHINA

Phillips Curve



Here is the Phillips curve for China. Though not exactly what was expected, the curve still represents the basic nature of inflation rate and unemployment rate, that there is an inverse relationship between unemployment and inflation. We can see that even though the inflation changes a lot, the unemployment does not change as much and thus instead of getting the perfect curve we get a rather jumbled curve.

Based on the correlation of the data, that is -0.471 we can conclude that there is moderate negative correlation between the two variables.

SUMMARY STATISTICS

INDIA

Inflation Rate

Unemployment Rate

Mean	7.2087	Mean	7.8330
Median	6.34004	Median	7.8785
Standard Deviation	3.0782	Standard Deviation	0.7467
Sample Variance	9.4756	Sample Variance	0.5576
Kurtosis	-0.7701	Kurtosis	1.9043
Range	10.0682	Range	3.6850
Minimum	3.602	Minimum	6.51
Maximum	13.8702	Maximum	10.1950
Sum	223.4697	Sum	243.8203
Count	31	Count	31

Correlation	-0.26408
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STATISTICAL RELEVANCE

INDIA

It can be seen that the Indian economy had an average inflation rate of 7.20%. It is a really high inflation rate, since the sweet spot for inflation is believed to be between 2-4%. But it was not a smooth ride since, though the inflation rate for India is a lot more stable compared to China, we can see that the variance of the data is still quite high. It has a lower range than the Chinese inflation rate, 10.06 lower to be precise.

Similarly the average unemployment rate is 7.83%, but unlike inflation the deviation in unemployment was very low and thus a near constant unemployment rate was observed. But here it was observed that contrary to the Chinese the Indian economy had higher variance in unemployment rate.

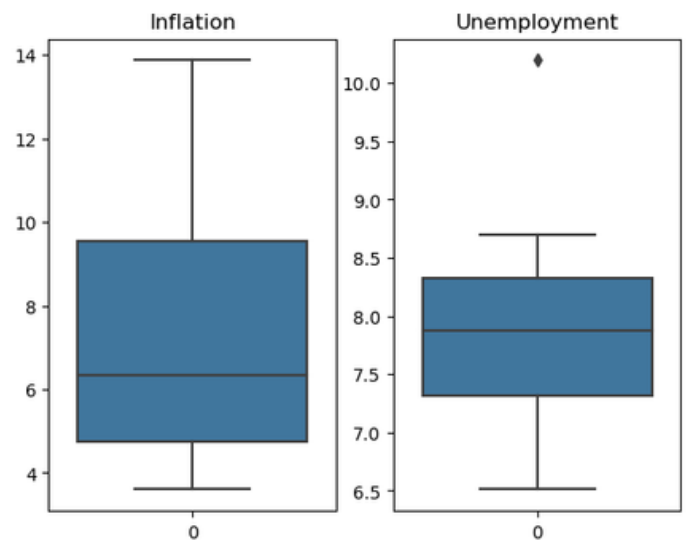
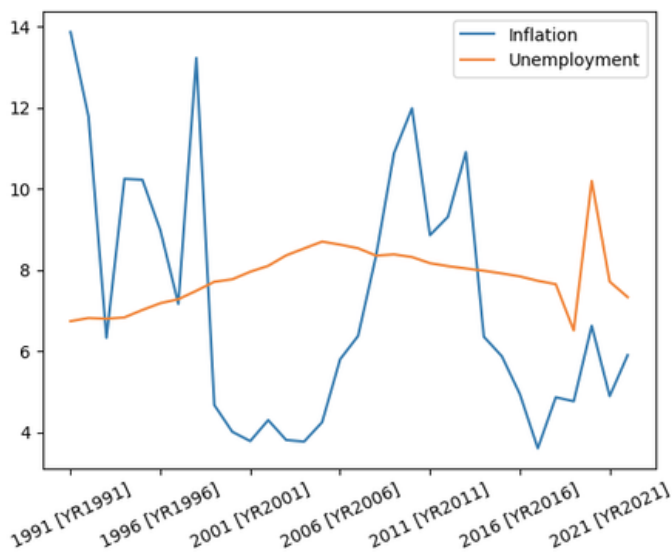
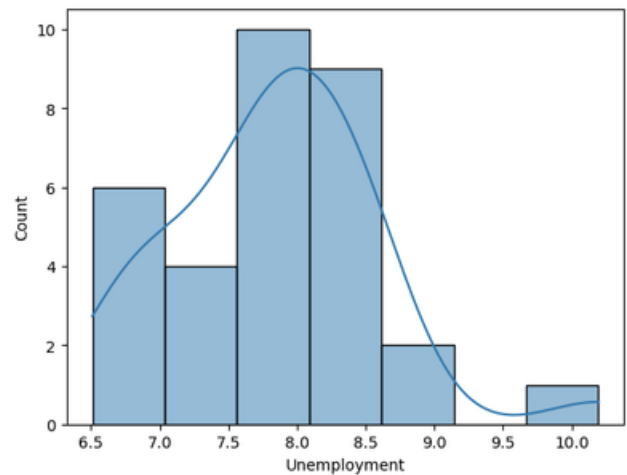
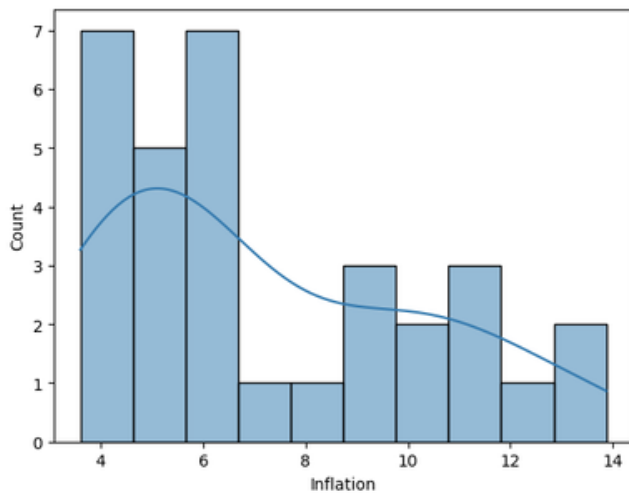
As we can see that the $\text{mean} > \text{median}$ for inflation, it means that the inflation rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

On the other hand we can see that the $\text{mean} < \text{median}$ for unemployment, it means that the data is negatively skewed. It means that the data might have outliers towards the lower side, or just some low values in general.

Since the inflation rate has negative excess kurtosis, we can tell that the data isn't that peaked and has a platykurtic distribution, while the unemployment rate has a highly positive kurtosis, meaning that the data is peaked and has a leptokurtic distribution.

INDIA

Inflation and Unemployment

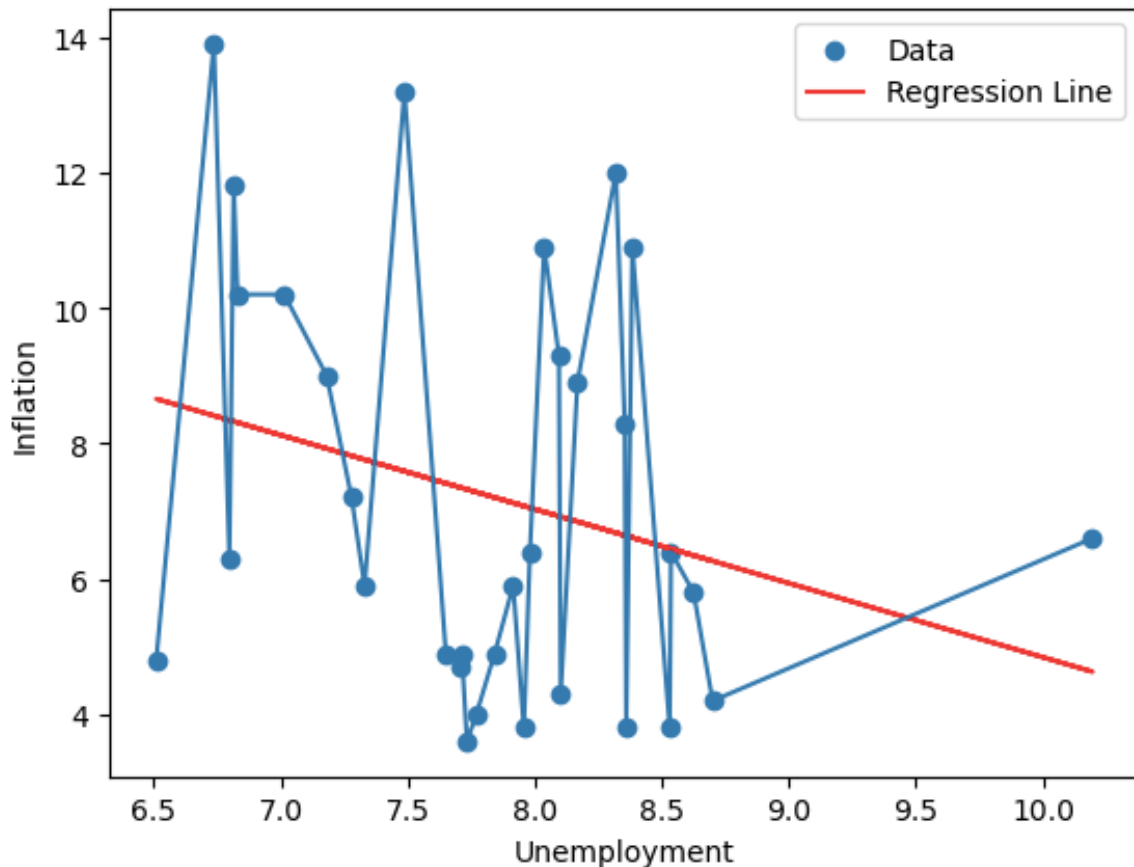


It can be seen from the given graphs that the inflation rate is positively skewed while the unemployment rate is slightly positively skewed.

It is also seen that the inflation rate is a lot more volatile compared to the unemployment rate.

INDIA

Phillips Curve



Here is the Phillips curve for India. Though not exactly what was expected, the curve still represents the basic nature of inflation rate and unemployment rate, that there is an inverse relationship between unemployment and inflation. We can see that even though the inflation changes a lot, the unemployment does not change as much and thus instead of getting the perfect curve we get a rather jumbled curve.

Based on the correlation of the data, that is -0.264 we can conclude that there is weak negative correlation between the two variables.

SUMMARY STATISTICS

USA

Inflation Rate

Unemployment Rate

Mean	2.5620	Mean	5.8375
Median	2.5273	Median	5.4901
Standard Deviation	1.45471	Standard Deviation	1.6421
Sample Variance	2.1161	Sample Variance	2.6967
Kurtosis	1.4547	Kurtosis	1.6421
Range	8.3583	Range	6.0192
Minimum	-0.3555	Minimum	3.611
Maximum	8.0028	Maximum	9.6302
Sum	79.422	Sum	180.9625
Count	31	Count	31

Correlation	-0.3322
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STATISTICAL RELEVANCE

USA

It can be seen that the American economy had an average inflation rate of 2.56%. This is the perfect inflation rate since at this point the unemployment rate is under control while the rise in prices is also not too much.

Compared to India and China, this situation is much better since it even allows the unemployment rate to be reduced a bit without having major consequences.

Similarly the average unemployment rate is 5.83%, but unlike inflation the deviation in unemployment was very low and thus a near constant unemployment rate was observed. But contrary to India and China, the US observed a much more radical and volatile unemployment rate.

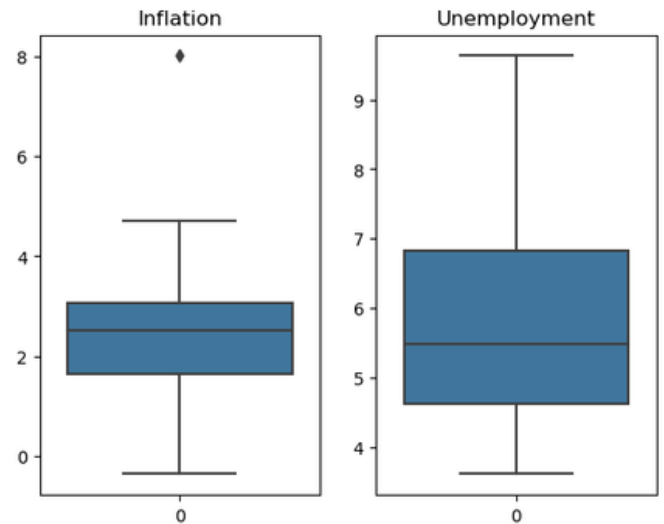
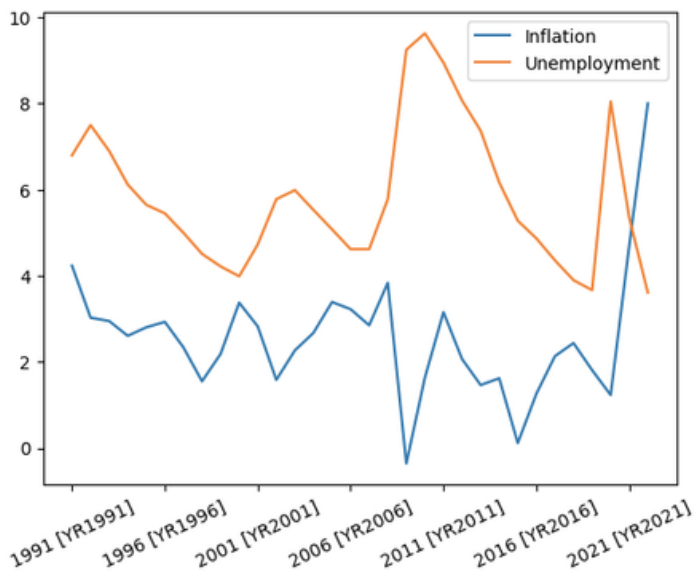
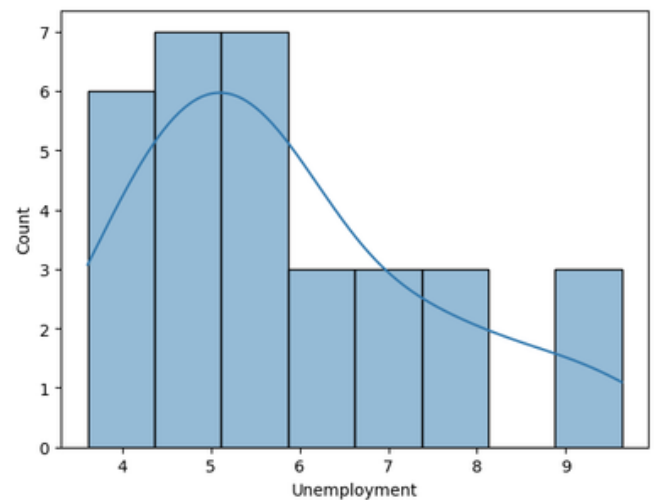
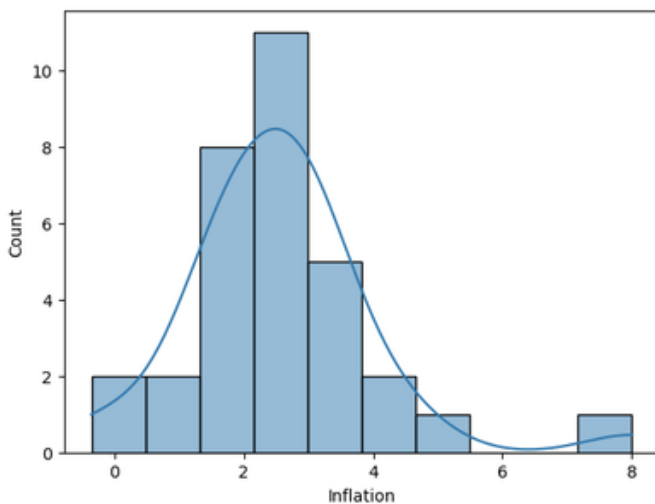
As we can see that the mean > median for inflation, it means that the inflation rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

On the other hand we can see that the mean > median for unemployment, it means that the unemployment rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

Since the inflation rate has a very high excess kurtosis, we can tell that the data is heavily peaked and has a leptokurtic distribution, while the unemployment rate has a highly positive kurtosis, meaning that the data is peaked and has a leptokurtic distribution.

USA

Inflation and Unemployment

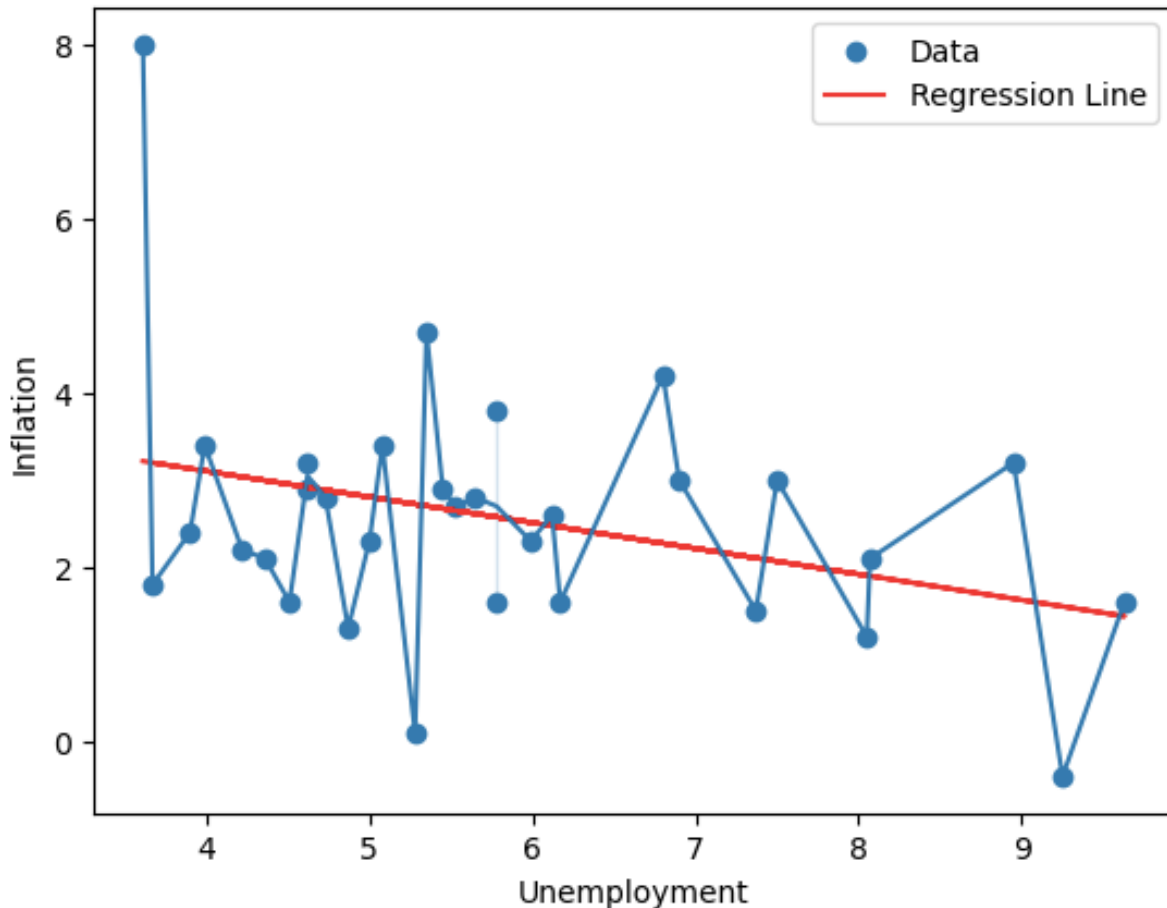


It can be seen from the given graphs that the inflation rate is nearly normal while the unemployment rate is positively skewed.

It is also seen that the inflation rate is a lot more volatile compared to the unemployment rate.

USA

Phillips Curve



Here is the Phillips curve for USA. Though not exactly what was expected, the curve still represents the basic nature of inflation rate and unemployment rate, that there is an inverse relationship between unemployment and inflation. We can see that instead of getting the perfect curve we get a rather jumbled curve.

Based on the correlation of the data, that is -0.33 we can conclude that there is moderate negative correlation between the two variables.

A Deeper Delve into The USA

Since the US is a developed nation and has the most stable economy out of all the countries taken in our analysis, we are going to dive deeper into its analysis in order to get a better understanding of the working of the Phillips curve with an in depth analysis of the economy.

We are going to divide the timeline into 5 parts in order to understand all the socio-political reasons that may have played a part.

The Post Cold War era: 1991-2000

Dot Com and Housing Bubble Formation: 2000-2007

After effects of the Housing Bubble: 2007-2011

Rebuilding Process: 2011-2019

Covid: 2019-2022

The Post Cold War era: 1991-2000

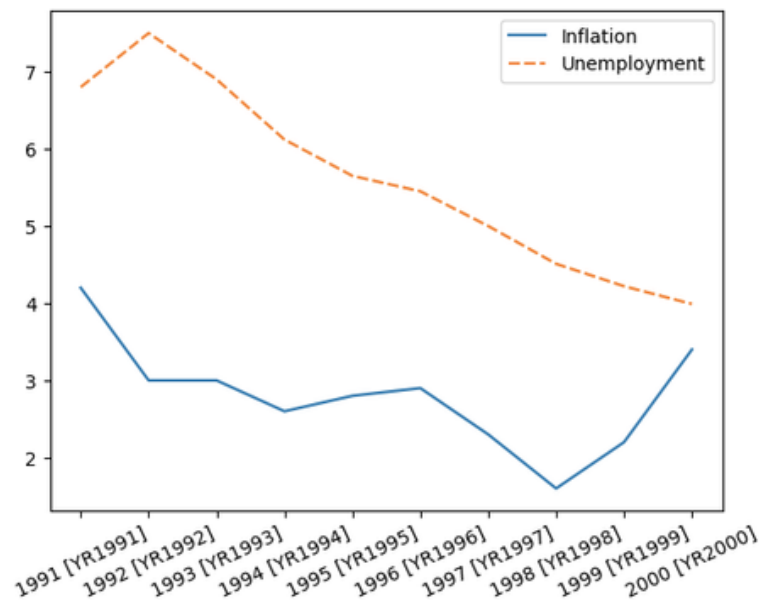
The Cold war had ended in 1991, the war led to an artificial inflation being created in the US since the money supply had increased a lot, but instead of the money being available to the public it was mostly circulated in government institutions in order to finance moves against the Soviet union.

It can be seen that the data has a correlation of 0.478. This is completely opposite to what is expected, it happened simply due to the fact that we are analysing a time in which the US economy was unstable.

A Deeper Delve into The USA

Instead of having a negative correlation, it can be seen that the data has a moderately high positive correlation.

This was so because as soon as the war ended the US decreased its money supply in high amounts while at the same time the money that was being spent on espionage up until now was being spent on development. Thus both the inflation and unemployment simultaneously decreased, leading to positive correlation in the data.



Dot Com and Housing Bubble Formation: 2000-2007

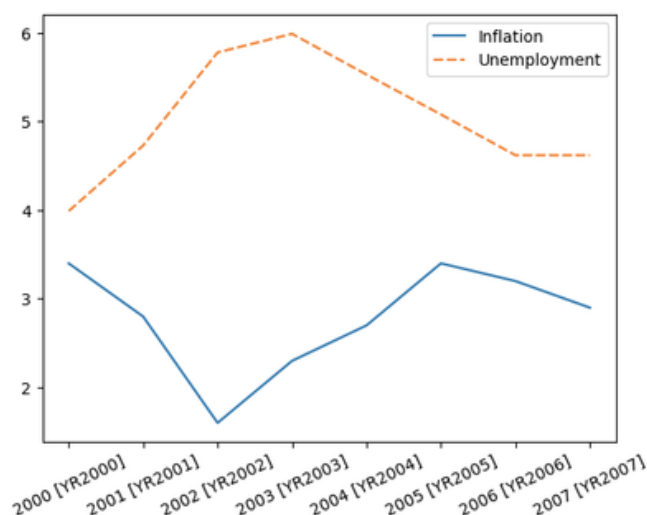
In the duration of 2000-2007, the US economy had started functioning as normal and had a quick pace of development. In this duration, the development was majorly lead by two things. The dotcom bubble and the Housing Bubble had created a false high for the economy.

A Deeper Delve into The USA

The dot-com bubble was a speculative bubble that occurred in the late 1990s and early 2000s. It was characterized by a surge in the stock prices of many internet-based companies, particularly those in the technology and e-commerce sectors. This was due to the fact that investors were overly optimistic about the internet's transformative power and its potential to disrupt traditional businesses.

The housing bubble was yet another speculative bubble that emerged in the early to mid-2000s, primarily in the United States but with global implications. It was characterized by a rapid rise in home prices, driven by factors such as lax lending practices, easy access to mortgage credit, and increased demand for housing.

In this duration the correlation of both the data sets was highly negative, as anticipated as per the Phillips curve. -0.762 to be precise. This was due to the fact that in this time the economy was relatively stable with steady growth.



A Deeper Delve into The USA

After effects of the Housing Bubble: 2007-2011

In the mid 2000s the dot com bubble burst. The bubble burst as investors began to doubt the sustainability of these high valuations, leading to a significant stock market crash. Many dot-com companies went bankrupt, and stock markets experienced a sharp decline.

Along with this the housing bubble also burst in 2007-2008, precipitating a global financial crisis known as the Great Recession. The burst was triggered by a wave of mortgage defaults, leading to financial market turmoil and a severe economic downturn.

Both of these factors combined led to severe economic turmoil and the economy became increasingly unstable.



A Deeper Delve into The USA

In this duration, once again the data is as per what was expected since we have a negative correlation between the unemployment and inflation rate. A correlation of -0.672 to be precise.

As we can see from the above graph that during this period a number of people lost their jobs due to sudden contraction in the market sizes. This further lead to a reduced demand for good since everyone was scared of the uncertainty that was standing about the job market, this reduced the price level in the economy and the inflation rate.

Rebuilding Process: 2011-2019

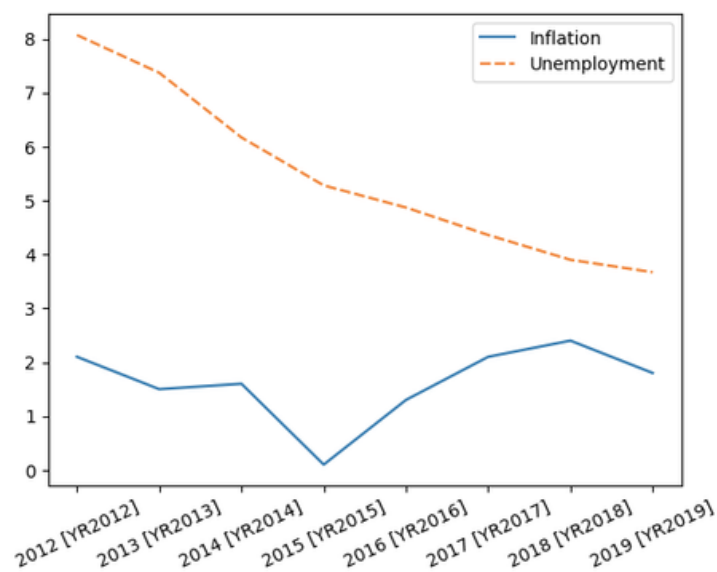
After the previously experienced economic turmoil, the economists in the US focused on returning the economy to its prior state and thus focused on rebuilding policies that would help reduce the unemployment rate that had reached an all time high during the earlier period.

It was seen that for after about 3 years of struggle, the US economy started making constant gains with a near constant reduction in unemployment rate and a constant increase in the inflation rate.

The only abnormality was seen in the year 2015 where the inflation rate become super low.

A Deeper Delve into The USA

This happened for a number of reasons, but the most major one was that petrol, a common commodity used by nearly every citizen had become very cheap in the year. This was majorly caused by two reasons, one that the US had a high production of oil in the year of 2014 and 2015, and that the policies made by OPEC in the year further dropped the prices.



During these years, once again the data was as expected, even though the degree of negative correlation was low, there was still a negative correlation as stated by the Phillips Curve. The exact negative correlation that was faced during these years was -0.076 .

A Deeper Delve into The USA

Covid: 2019-2022

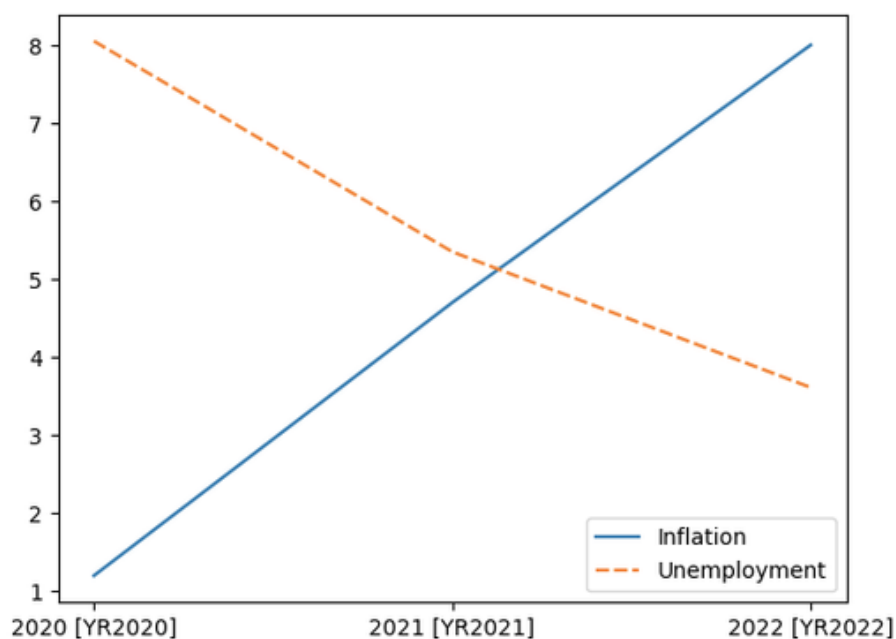
The COVID-19 pandemic, which emerged in early 2020, had a profound and multifaceted impact on the U.S. economy, significantly affecting unemployment and inflation rates.

To tackle the virus, lockdowns were immediately placed throughout the country. This severely increased the unemployment rate in the country for the first 3 quarters, but before the end of the year a number of favourable government policies were rolled out that not only helped fight the previously high level of unemployment, but also helped reduce the number earlier seen. But another factor that artificially lowered the unemployment rate was that a number of people decided to try something new at the time, and thus the number of people who were self employed sky rocketed during this period. The increase was a whopping 1.9 Million people who were now self employed.

On the other hand, inflation had a steady increase through the three years, this was mostly due to two reasons. One was that the lockdowns had severely damaged the supply lines throughout the country because of which an artificial shortage of goods was created. Simultaneously people had also started hoarding goods due to fear that the shortage may last

A Deeper Delve into The USA

a very long time and thus they wanted to stay ahead of problems by ensuring that they had enough to sustain themselves. Thus this panic buying of good also caused a increase in price by burdening the already struggling supply of goods.



As we can see from the above graph, during this time the economy nearly perfectly followed the Phillips curve having. near perfect correlation of -0.994.

Thus from this study of the US we can conclude that the Phillips curve is followed at all times in an economy, even huge economic turmoil. The only time it is not actually followed through is when the economy is recovering from such events since at those times stagflation can be experienced in the economy in a pursuit to get steady development in the country.

SUMMARY STATISTICS

VENEZUELA

Inflation Rate

Unemployment Rate

Mean	2845.629	Mean	8.937
Median	34.988	Median	7.535
Standard Deviation	11939.789	Standard Deviation	3.5008
Sample Variance	142558578.794	Sample Variance	12.256
Kurtosis	26.304	Kurtosis	-0.358
Range	65361.593	Range	11.763
Minimum	12.532	Minimum	5.022
Maximum	65374.082	Maximum	16.785
Sum	88214.499	Sum	277.046
Count	31	Count	31

Correlation	-0.2692
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STATISTICAL RELEVANCE

VENEZUELA

We can see that since Venezuela is a developing country with a lot of economic uncertainties, their data is completely different to the other 3 countries that we have seen so far.

Venezuela experienced a much higher inflation rate in general compared to China, India and the US and had some extreme outliers as well. For example 65374% inflation rate. Thus it goes without saying that the data has a very high variance, a variance of 142558578.794 to be precise. Since we have already talked about the high outliers, we know for a fact that the data is going to be positively skewed.

Unlike the inflation rate, the unemployment rate is relatively stable and has a much smaller variance. None the less Venezuela still has the highest unemployment rate out of all the countries part of this study.

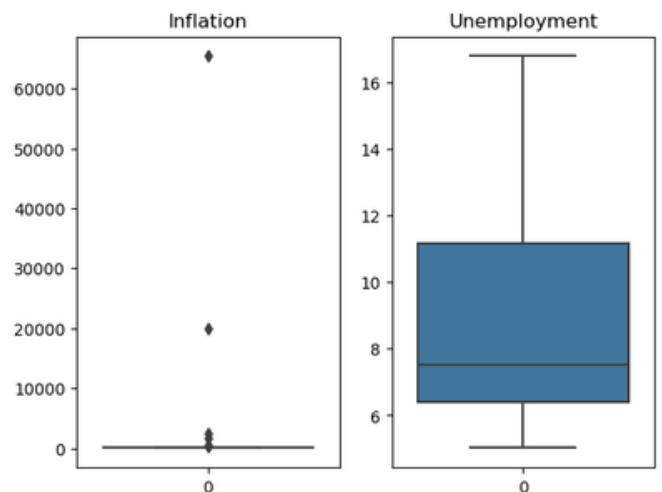
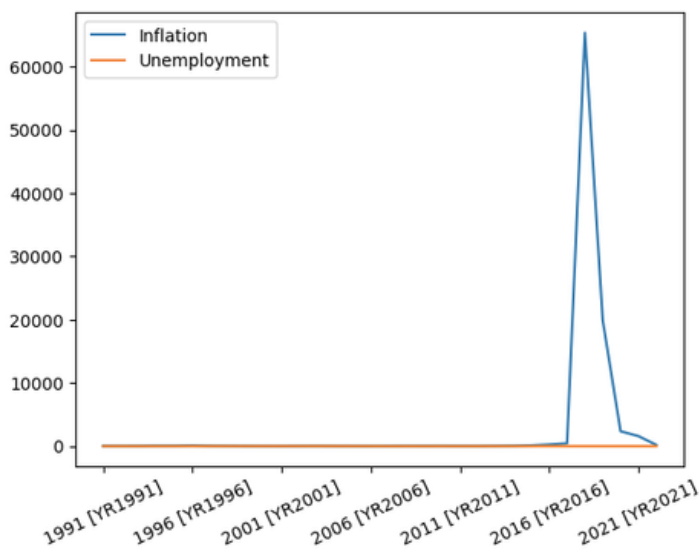
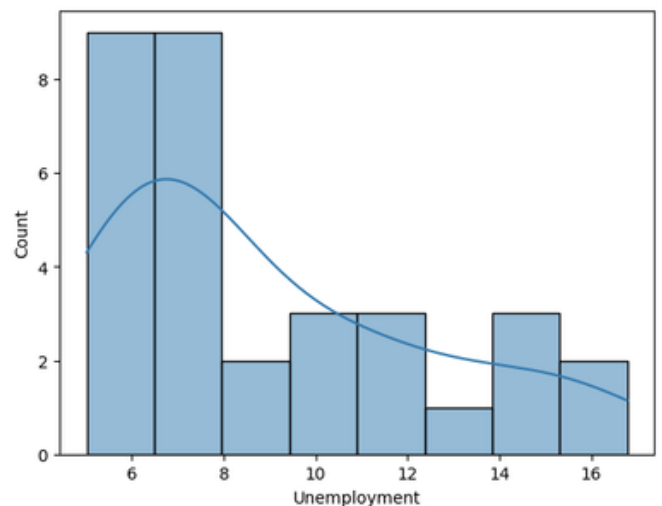
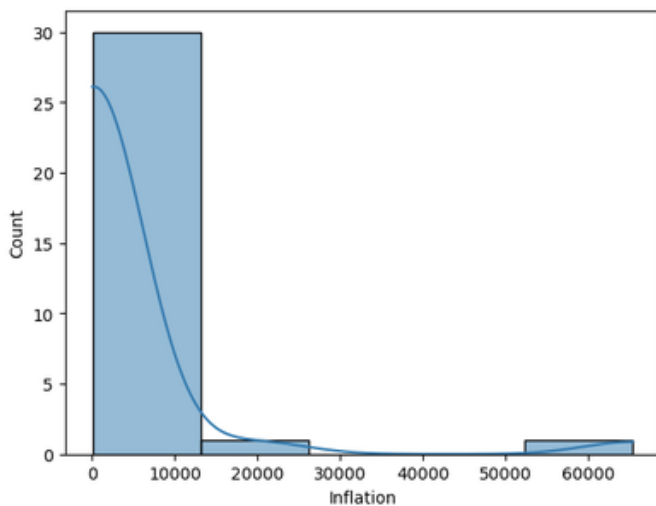
Similar to the inflation rate, the unemployment rate is also positively skewed due to the fact that $\text{mean} > \text{median}$.

From kurtosis we can see that the inflation rate is highly peaked since most of the data lies in the lower half while there are only a few observations that actually lie above 1000%.

We can see that there is a negative correlation between the two variables, this indicates the negative relation between them. Thus showing that the Phillips curve works since this is the relation described by it.

VENEZUELA

Inflation and Unemployment

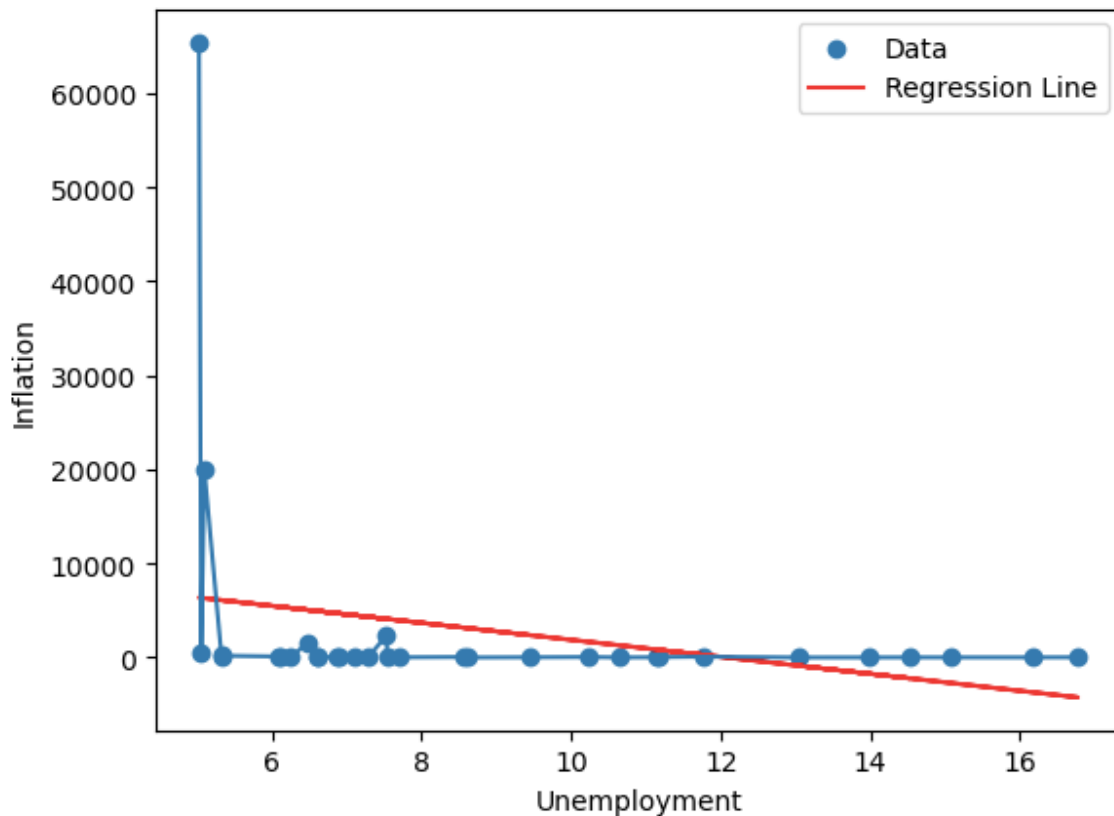


It can be seen from the given graphs that the inflation rate and the unemployment rate are both positively skewed.

It is also seen that the inflation rate is a lot more volatile and has a number of outliers compared to the unemployment rate.

VENEZUELA

Phillips Curve



Here is the Phillips curve for Venezuela. Though not exactly what was expected, the curve still represents the basic nature of inflation rate and unemployment rate, that there is an inverse relationship between unemployment and inflation. We can see that even though the inflation changes a lot, the unemployment does not change as much and thus instead of getting the perfect curve we get a rather jumbled curve.

Based on the correlation of the data, that is -0.26 we can conclude that there is weak negative correlation between the two variables.

COMPARATIVE ANALYSIS

Inflation Rate:

The United States has the most stable and desirable inflation rate among the three countries. India's rate is high and exhibits more variance compared to the US, while China's inflation rate, although better than India's, still experiences very large variances. And Venezuela is out of the loop since its inflation rate is the highest in the world.

Unemployment Rate:

China has lower and more stable unemployment rates compared to India and the United States. India's unemployment rate, although relatively constant, is higher and negatively skewed, suggesting the presence of outliers with lower unemployment rates. For the US, the variance in unemployment rate is very high, namely due to high effect of the housing crisis. Venezuela has a low variance in unemployment when compared to its inflation.

Kurtosis:

The kurtosis data supports the observation that India's inflation rate is more uniform, but its unemployment rate has heavier tails. In contrast, China's inflation rate has more extreme values, while its unemployment rate is less peaked. For the US, both are highly peaked.

In summary, the United States maintains a stable economy with near desirable inflation and unemployment rates. India has high inflation, with a relatively constant but high unemployment rate. China has worse inflation stability, with low and stable unemployment, but its inflation data exhibits more extreme values. These differences can be attributed to various economic, social, and political factors in each country.

HYPOTHESIS TESTING

Until now when we talk about correlation between the two variables, we talk about the correlation coefficient r , the measure summarizes the strength of a linear relationship in samples only. If we obtained a different sample, we would obtain different correlations, and therefore potentially different conclusions. But we want to draw conclusions about populations, not just samples. To do so, we have to conduct a hypothesis test.

Thus we will carry out hypothesis test for the population correlation coefficient using the Pearson correlation coefficient (r). The Pearson correlation coefficient (r) is the most common way of measuring linear correlation. It is a number between -1 and 1 that measures the strength and direction of the relationship between two variables. It is calculated through the following formula-

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

The Pearson correlation coefficient can also be used to test whether the relationship between two variables is significant. The Pearson correlation of the sample is r . It is an estimate of ρ (ρ), the Pearson correlation of the population. Knowing r and n (the sample size), we can infer whether ρ is significantly different from 0 .

HYPOTHESIS TESTING

We are performing a lower tailed t-test for at 5% level of significance to check whether there is a correlation in the of inflation and unemployment of US at population level as opposed to sample.

Null hypothesis (H_0): $\rho = 0$

Alternative hypothesis (H_a): $\rho < 0$

Here if the null hypothesis is rejected - It implies that the Phillips curve has been verified and that the inflation and unemployment rate are negatively correlated.

If null hypothesis is not rejected- it implies that the hypothesis that the inflation rate and unemployment rate are not correlated is true. It would imply that the findings in our study are exceptional due to that sample taken by us, and that the population data does follow the same.

We find that the Pearson correlation coefficient (r) is -0.334.

Calculating the t value-
$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}}$$

We get the t value as -1.9370

Now for the critical value of t, using significance value (α) as 0.05 and 30 degrees of freedom, we find t^* as 2.0423.

HYPOTHESIS TESTING

```
Pearson Correlation Coefficient (r): -0.3334  
P-value: 0.0622  
T-statistic: -1.9370  
Degrees of Freedom: 30  
Critical t-value at alpha = 0.05: 2.0423  
Fail to reject the null hypothesis: There is no significant correlation.
```

The above data has been generated using python

Since the t value is smaller than the critical value, the relationship is statistically insignificant ($p > \alpha$). The data allows us to reject the alternate hypothesis and provides support for the null hypothesis.

Therefore we conclude that the relationship that we found in the study is not true and is an exceptional case. Hence verified that the nature of the Phillips curve is not held true for a stable economy.

Since we used the data obtained for US, thus we can say that for a relatively stable economy and a developed country the inverse relation between the inflation rate and the unemployment rate does not follow.

DATA TRENDS

We can see that for all four of the countries the Phillips curve follows mostly. That is, it can be seen that for nearly each iteration either one of the variable decreases while the other rises.

Thus we can conclude that the Phillips Curve is applicable to the real world.

The few times that we find that the inverse relation is not being followed, we can see that there is some sort of event that can explain the abnormality.

For example, in 2007-8 it was observed in all three countries that both inflation and unemployment rose. This was due to the 2008 housing crisis that not only caused prices to soar high but also caused a number of people to lose their jobs. But as soon as the bubble burst, it was observed that inflation quickly decreased while unemployment increased.

Similarly it was observed in all three of the countries in 2020 that both inflation and unemployment rose. It was due to the effects of the corona virus. Lockdowns were imposed in order to curb the spread of the virus, due to this supply lines were disrupted which caused the prices to rise and since people could no longer go to their offices, a number of people who could not do their jobs remotely ended up losing them.

DATA TRENDS

And again in 2022, a sudden rise in prices was found. This was mostly contributed towards by the Russia Ukraine war since a lot of fuel is exported from both the countries, 12% to be exact. The war disrupted the supply of this oil for quite some time, after which a number of sanctions were also dropped upon the country. This was enforced by the US and its allies, but not India. This explains why the increase in inflation rate in India was not as severe as the other countries in this study. None the less the war still caused inflation in India as well since due to the war Russia also reduced its imports from India.

But it is seen that the currently predicted inflation rates for the year of 2023 is lower than those expected prior to the war, this is because as of now Russia is supplying oil to India at a rate a lot lower than the OPEC did. Thus increasing Indian imports of oil from Russia from 2% to 27%.

Another important trend that was identified from the data was that changes in inflation are a lot more than changes in unemployment. The range over which the unemployment rate varied was nearly one third of the inflation rate in all four of the countries.

POLICY RECOMMENDATIONS

As we can see from our study, inflation is a necessary evil. If there is no inflation then unemployment will skyrocket, thus this situation cannot be left unchecked. According to Okun's law, there is a negative relationship between output and unemployment.

$$\frac{y - y^*}{y^*} = -\beta(u - u^*)$$

Here y is actual GDP, y^* is potential GDP, β is Okun coefficient, u is unemployment in the current year and u^* is unemployment in the previous year.

Thus we can see that when the unemployment is low (inflation is high), we have a high rate of development. So having inflation is not only necessary for having lower unemployment rates, it is also required for having a good growth rate in the economy. It is so since due to both supply and demand, on the demand side when more people are employed in an economy, the number of income earners is also higher, thus the demand is higher. Raising prices and inflation. On the supply side when more people are employed, their bargaining power is higher and thus they can negotiate higher wages. To match the increased wages/ cost of production the firms increase the prices of the good produced, thus raising inflation.

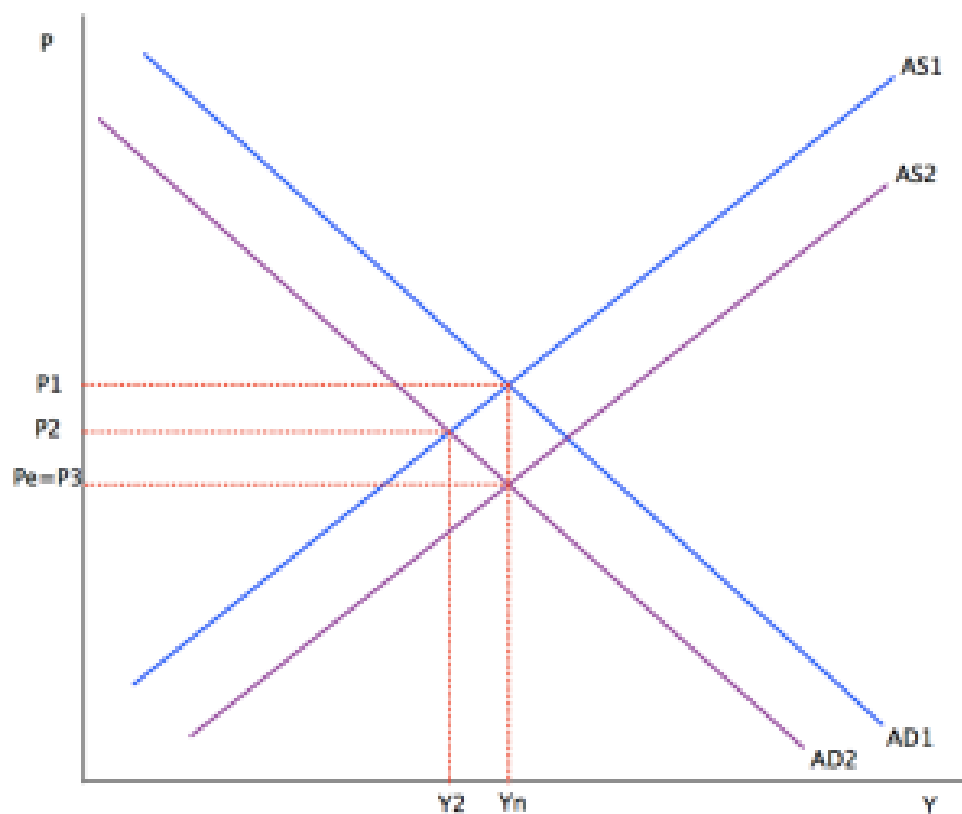
As per studies it is believed that an inflation rate of 2-4% is good for a healthy economy. Thus most economies try to get their unemployment rate to a point where they can maintain this level of inflation. This is called NAIRU, or the Non Accelerating Inflation Rate of Unemployment.

As long as the unemployment in the economy is above the NAIRU level, theoretically there will be no increase in the inflation rate. Thus maintaining the NAIRU allows us to maintain a steady inflation rate along with a steady growth rate.

POLICY RECOMMENDATIONS

From the data we can see that China is somewhat near the inflationary sweet spot and thus can be left the way it is. But for India and the US, it is observed that the inflation rate is greater than 6%.

For the US, we can straightaway go for deflationary policies since the unemployment level is under control and thus a decrease in the inflation rate can be accommodated. Thus it is recommended that the government reduce its spending along with transfer payments and increase taxes. Basically reduce the money supply.

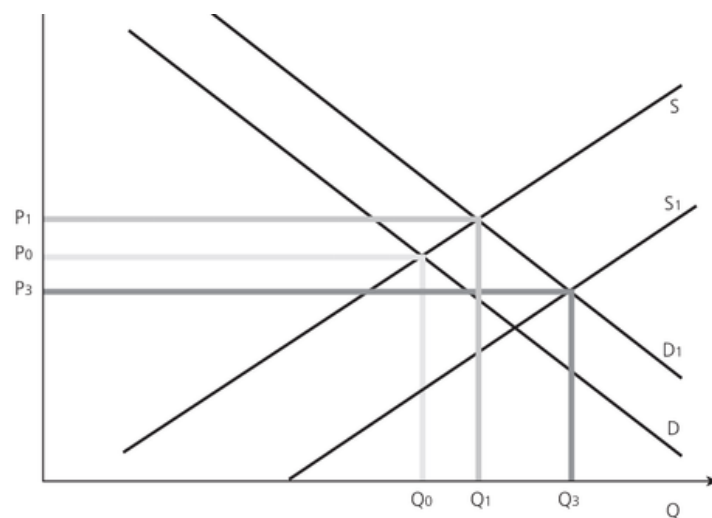


POLICY RECOMMENDATIONS

In the case of India, a different approach will be required to lower the inflation rate since the unemployment rate is also very high(7.33%).

Lowering both unemployment and inflation rates simultaneously can be a challenging task because these two economic indicators have conflicting relationships as seen in this report. Reducing unemployment typically involves stimulating economic growth, which can put upward pressure on prices and potentially lead to inflation. Conversely, controlling inflation may require tightening monetary or fiscal policies, which can slow down economic growth and potentially lead to higher unemployment.

Thus it is necessary to ensure that monetary and fiscal policies are coordinated to achieve a balance between controlling inflation and supporting economic growth. Improving the ease of doing business can attract both domestic and foreign investment, this would lead to job creation and economic growth. We basically need to come up with policies that allow us to shift the AD and AS curves towards the right, but the degree of change in AS should be more. This will allow us to decrease unemployment while also decreasing inflation.



In case of Venezuela, the inflation is very high while the unemployment is at an acceptable level, thus it vital that deflationary policies are taken up in order to reduce the inflation at any cost.

CONCLUSION

We can see that in the short run the the nature of the Phillis curve is a lot more visible. In the short run, there can be a trade-off between inflation and unemployment, but in the long run, this relationship tends to break down. In the long run, factors such as expectations, labor market dynamics, and potential output play a more significant role in determining inflation.

In relatively stable economies with low levels of inflation and consistent economic conditions, the Phillips curve may provide a reasonable approximation of the trade-off between inflation and unemployment. However, in more unstable or volatile economies, this relationship may not hold as well.

In the past 30 years these were the only major times when any of the four countries experienced stagflation, apart from this there were only a few instances in which both the unemployment and inflation increased and were mostly due to local reasons.

Stagflation occurs when an economy experiences stagnant economic growth, high unemployment and high price inflation. This scenario, of course, directly contradicts the theory behind the Phillips curve.

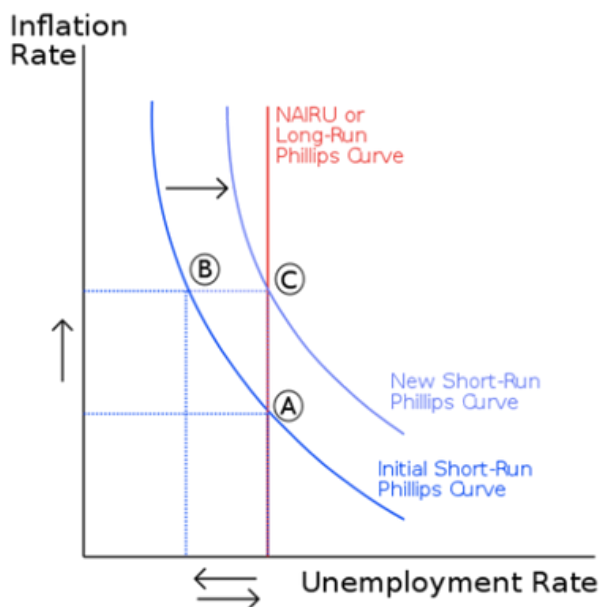
Apart from these three events, we find that the data at all times varies as expected and has a negative correlation in all four of the cases over the period of 30 years. But the strength of this relation wasn't significant enough to make it so that we can conclude its appliance for the population.

CONCLUSION

As economies recover from major economic problems, the interplay of various factors can disrupt the simple Phillips curve relationship. Thus at those times we see that the economy shows increasingly unexpected behaviour even in the short run since at the time economic development is prioritized even at the cost of stagflation.

The Phillips curve assumes that there is a stable relationship between unemployment and inflation, but it doesn't account for supply shocks, demand shocks, or changes in inflation expectations. When these factors change, the relationship between inflation and unemployment can become less predictable.

In summary, the accuracy of the Phillips curve varies depending on the economic conditions, time frame (short-run vs. long-run), and the presence of external factors and policy actions. We saw in the detailed research for the US and Venezuela that in the short run the Phillips curve is followed, in the long run we always get the negative correlation in unemployment and inflation but not necessarily the tradeoff that was expected.



CONCLUSION

The long run Phillips curve is vertical, because the tradeoff that exists between unemployment and inflation in the short run doesn't exist in the long run. After a short run deviation, prices adjust, and the curve moves back towards its long-run equilibrium as employers and employees adjust to a new price level and unemployment returns to its 'natural' level.

The Diagram shown above starts to make sense when we take a deeper look into the unemployment and inflation trends. We noticed in the case of all four of the countries that the unemployment rate either remained nearly constant or had very little variation, on the other hand the inflation rate was very volatile and had huge variations in each case. Thus even though we get the negative correlation that we expected, we also see that it was very minute changes in unemployment that caused high changes in inflation. Its because the Phillips curve fails to account for inflation expectations. It assumes rational inflation expectations, which are not always the case. The expectation that inflation will continue causes employees and employers, in the expectation that prices will be higher, demand higher wages and charge higher prices. This causes stagflation. This means that even at near constant rate of unemployment, the inflation rate changes simply because of other factors.

While the Phillips curve provides a useful framework for understanding the relationship between inflation and unemployment, its applicability to different economies and situations is not universal, and it should be interpreted with caution, especially in more volatile or complex economic environments. Thus we conclude that the Phillips curve is only applicable in short run and not long run.

DATA PREPARATION AND SOURCES

Python file (Data Cleaning, data processing, data analysis, data visualization, hypothesis testing and prediction model):

<https://github.com/HarshitShree/Data-Analysis-Projects/tree/main/Phillips%20Curve%20Analysis>

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