



MACROECONOMICS PROJECT

Topic:

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

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OBJECTIVE

Verification of the Phillips
curve through actual
application on real data

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

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.

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.

Source-

<https://databank.worldbank.org/World-unemployment-rates/id/c5765b65>

<https://www.imf.org/en/Countries/USA>

<https://www.imf.org/external/datamapper/profile/IND>

<https://www.imf.org/external/datamapper/profile/CHN>

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.

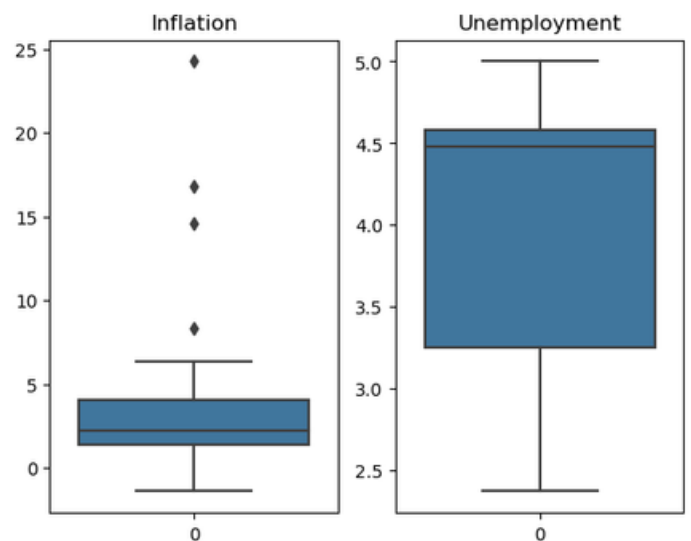
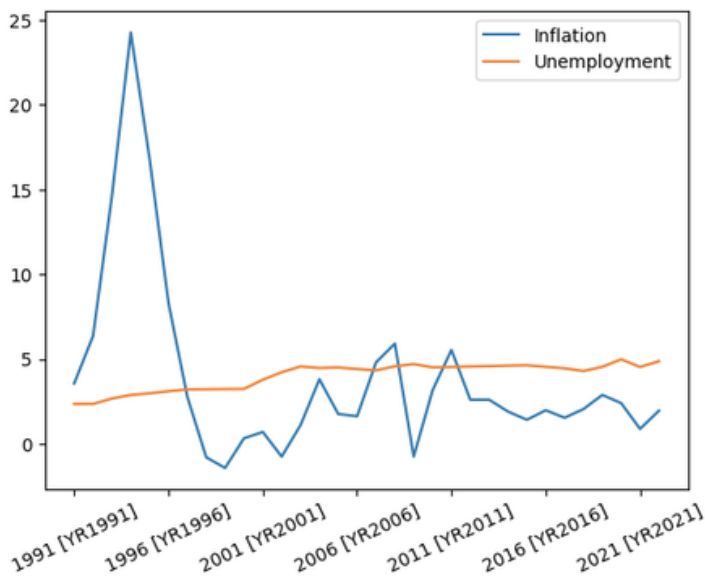
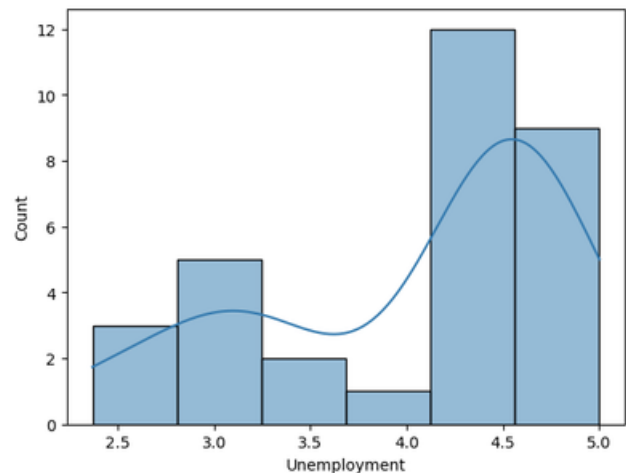
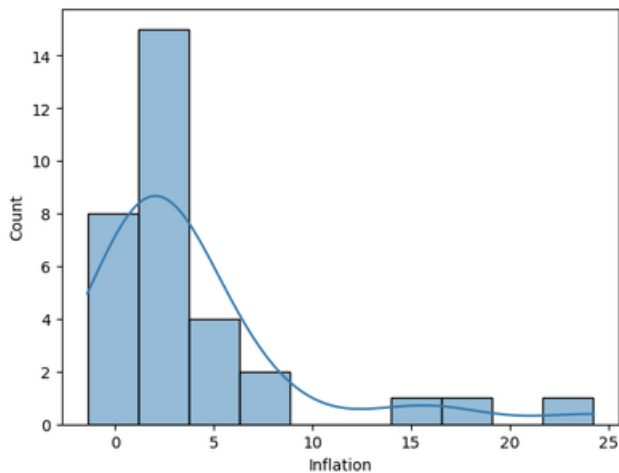
As we can see that the $\text{mean} > \text{median}$ for inflation, it means that the inflation rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

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

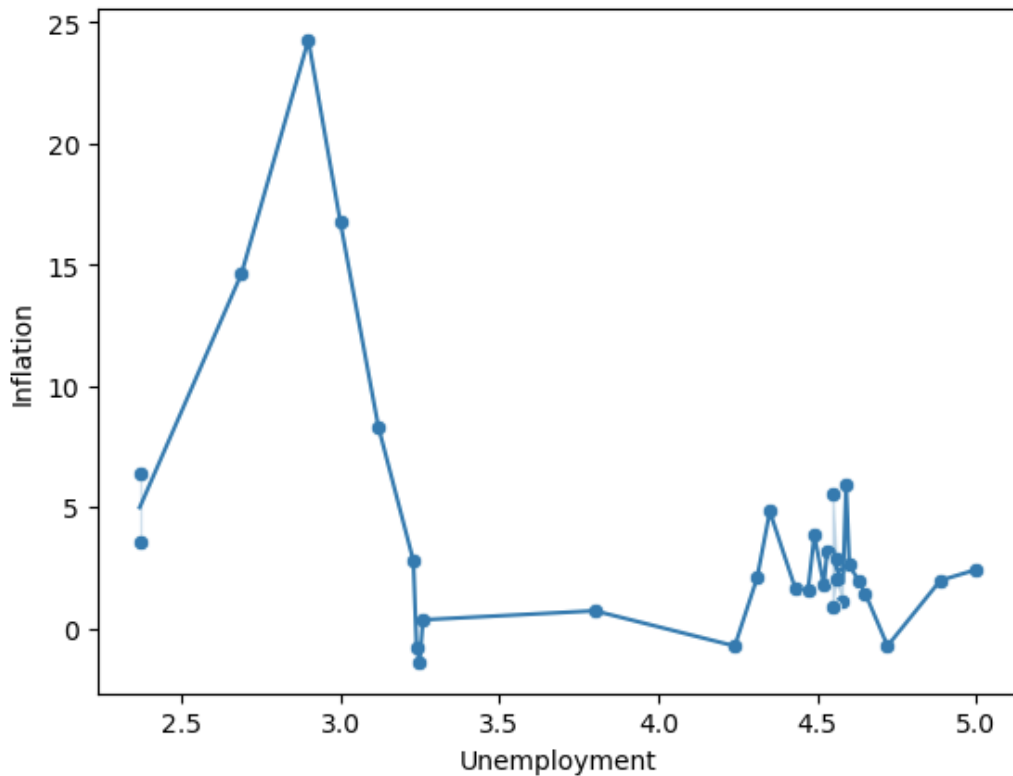


It can be seen from the given graphs that the inflation rate is positively skewed while the unemployment rate is negatively skewed. Thus fitting our expectations based on the given data.

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.

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.

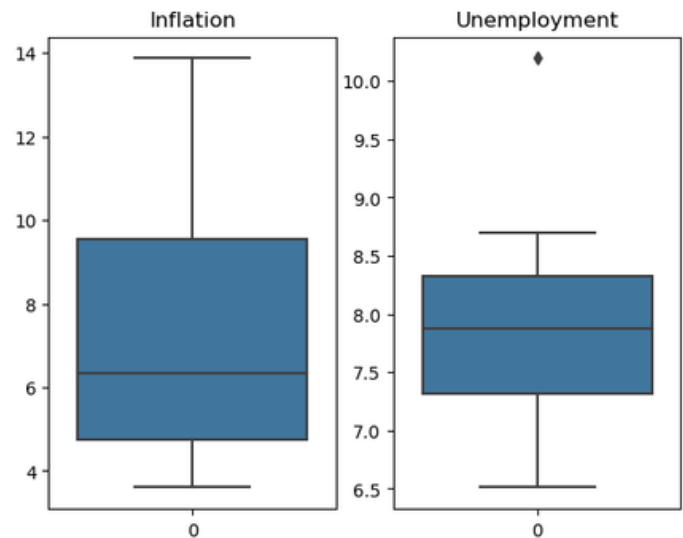
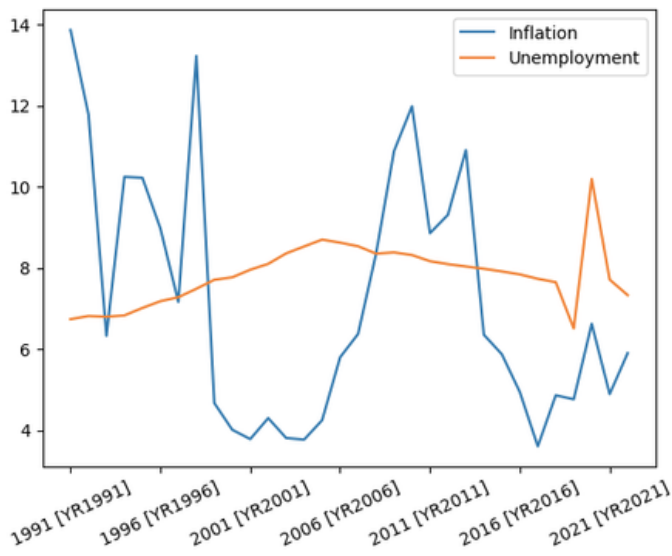
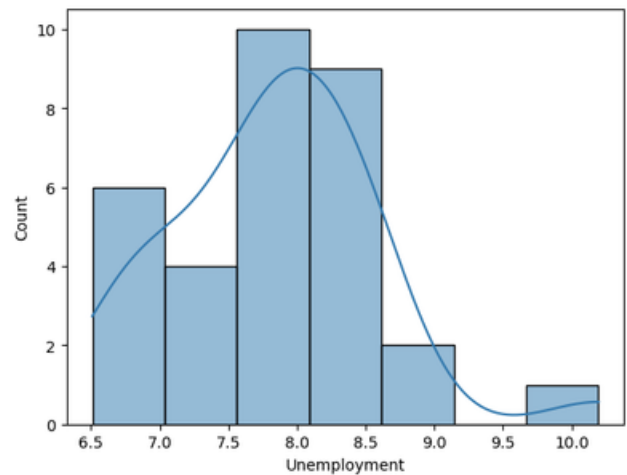
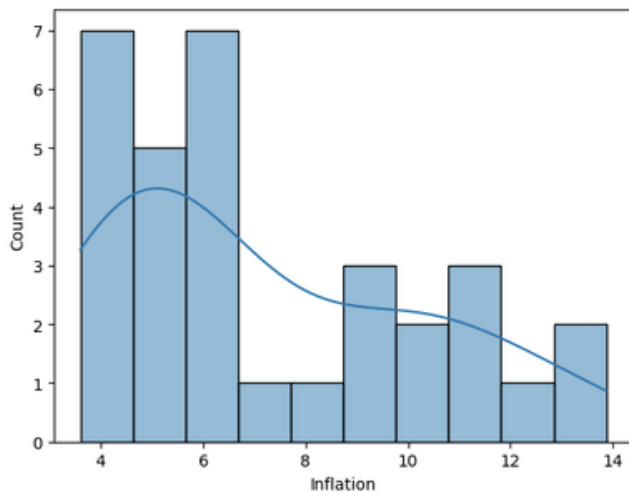
As we can see that the $\text{mean} > \text{median}$ for inflation, it means that the inflation rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

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

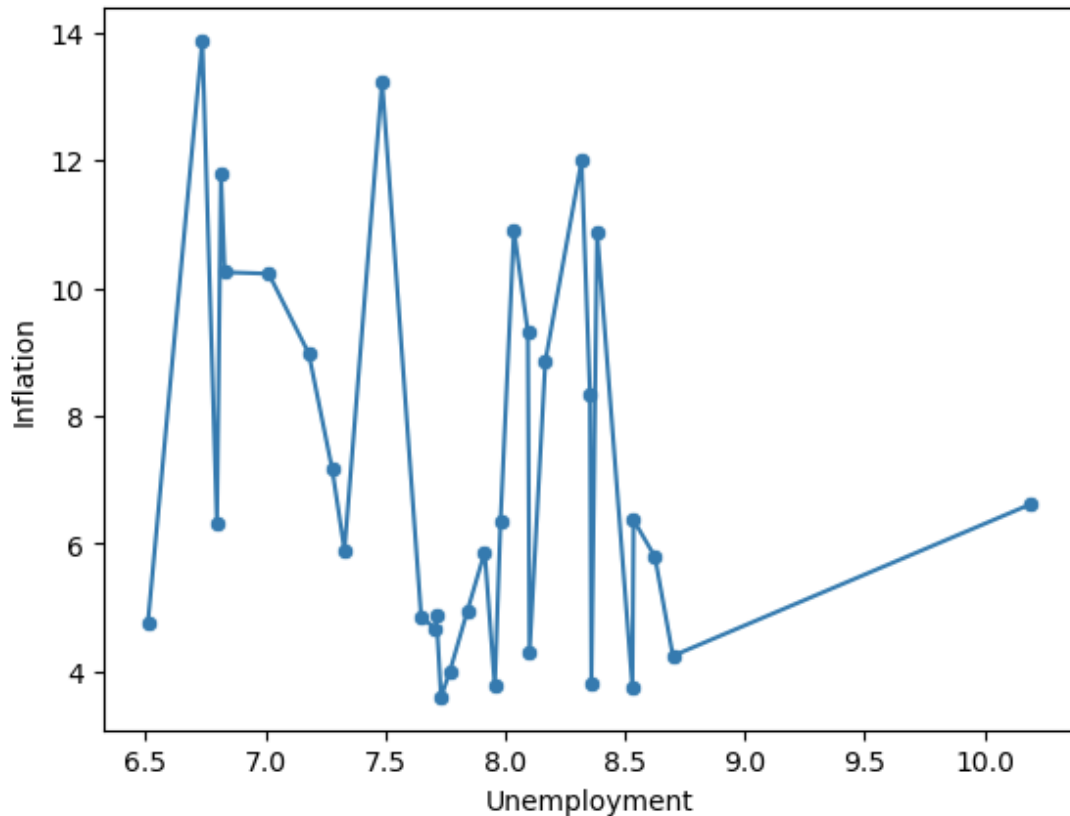


It can be seen from the given graphs that the inflation rate is positively skewed while the unemployment rate is slightly positively skewed.

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.

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.

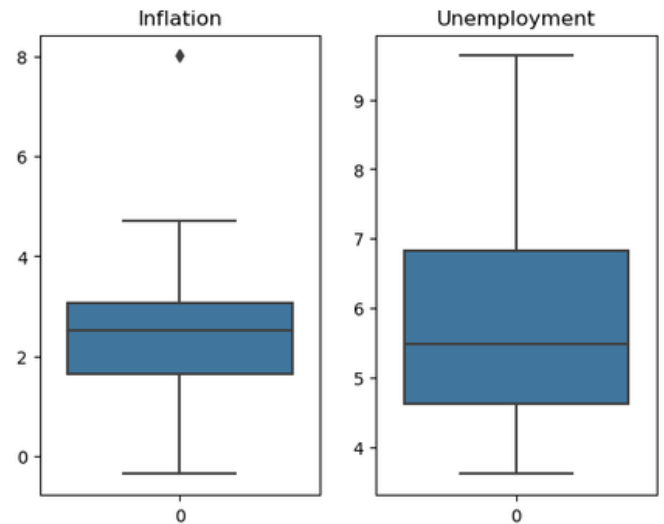
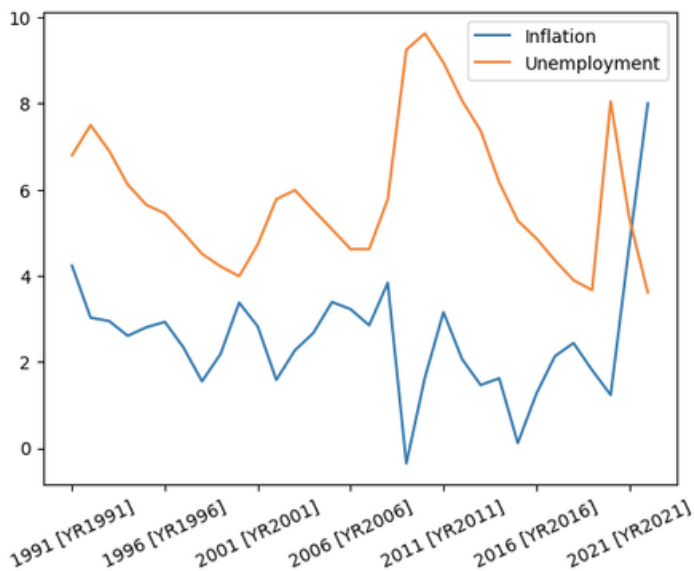
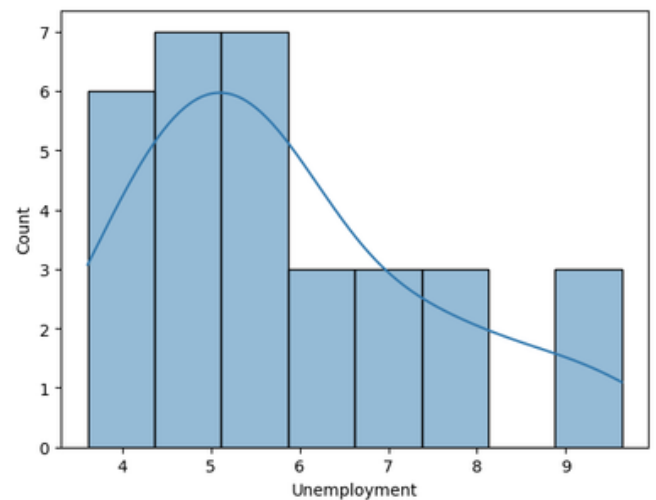
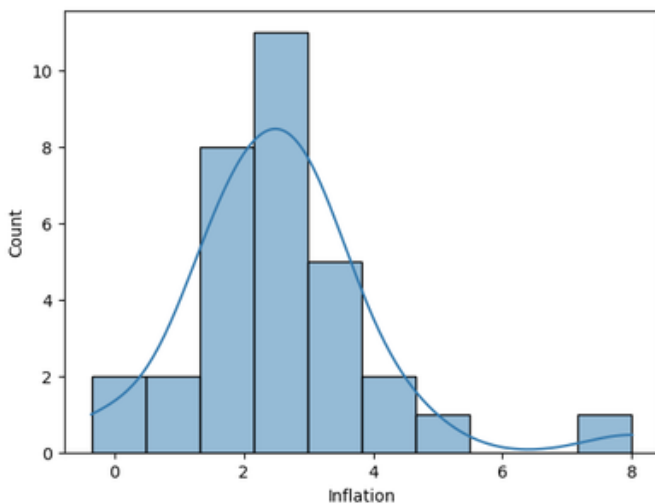
As we can see that the mean > median for inflation, it means that the inflation rate is positively skewed. It means that the data might have outliers towards the higher side, or just some high values in general.

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

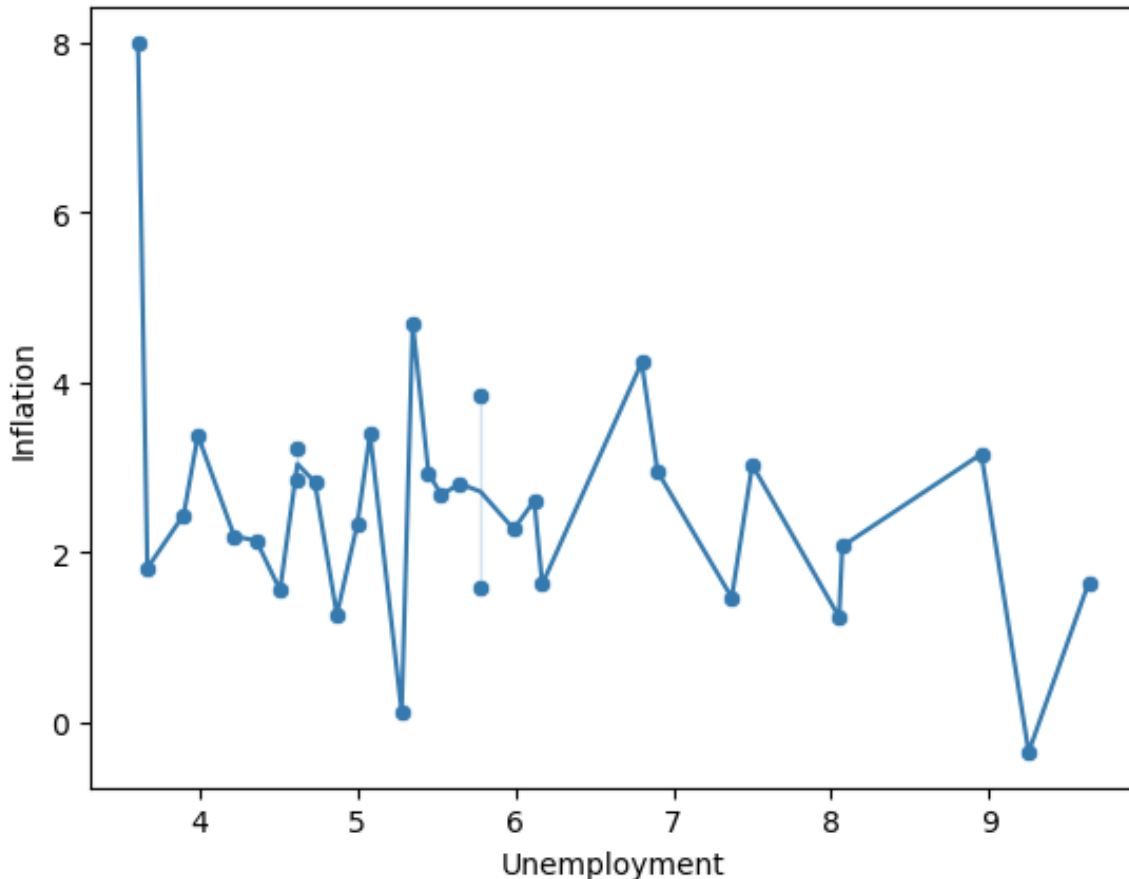


It can be seen from the given graphs that the inflation rate is nearly normal while the unemployment rate is positively skewed.

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.

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

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.

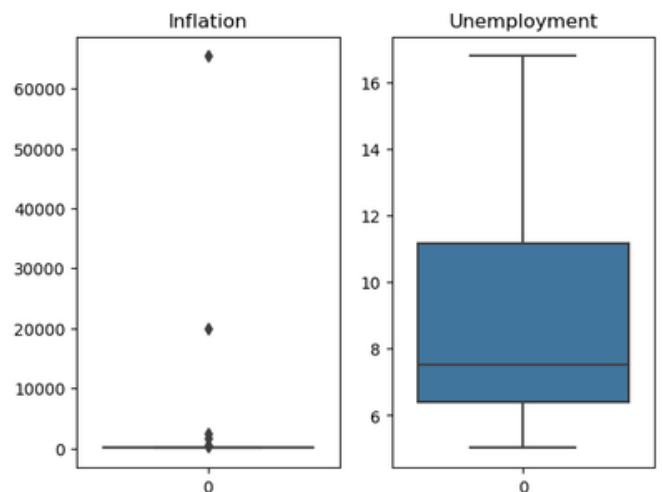
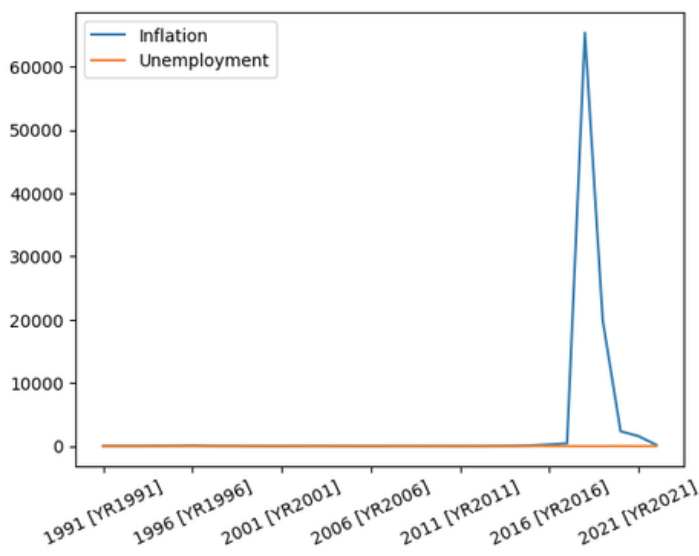
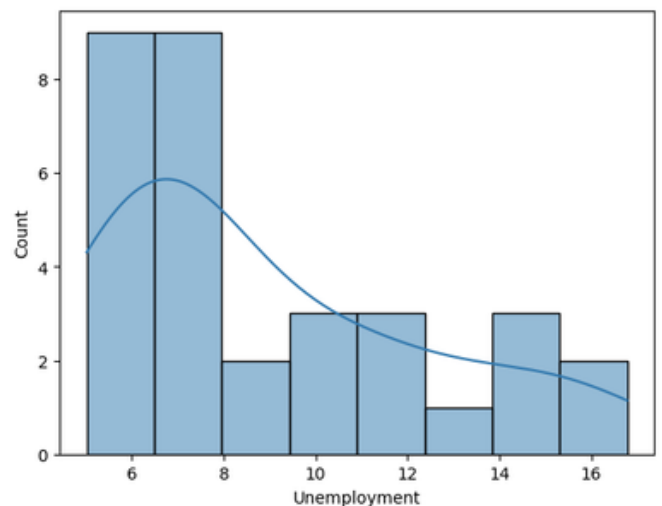
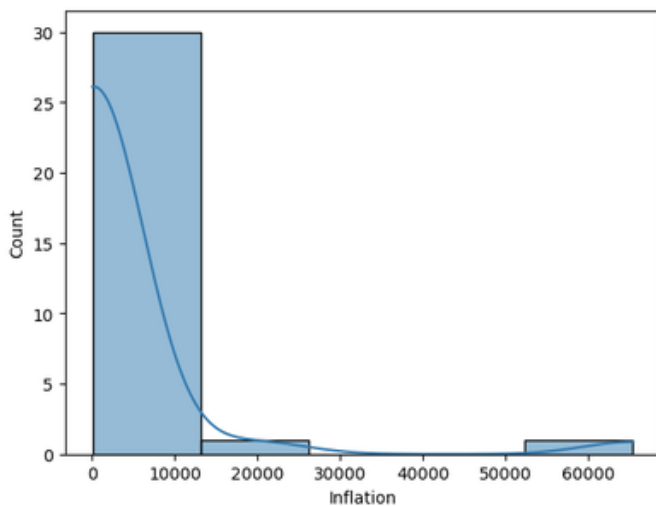
Similar to the inflation rate, the unemployment rate is also positively skewed due to the fact that $\text{mean} > \text{median}$.

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

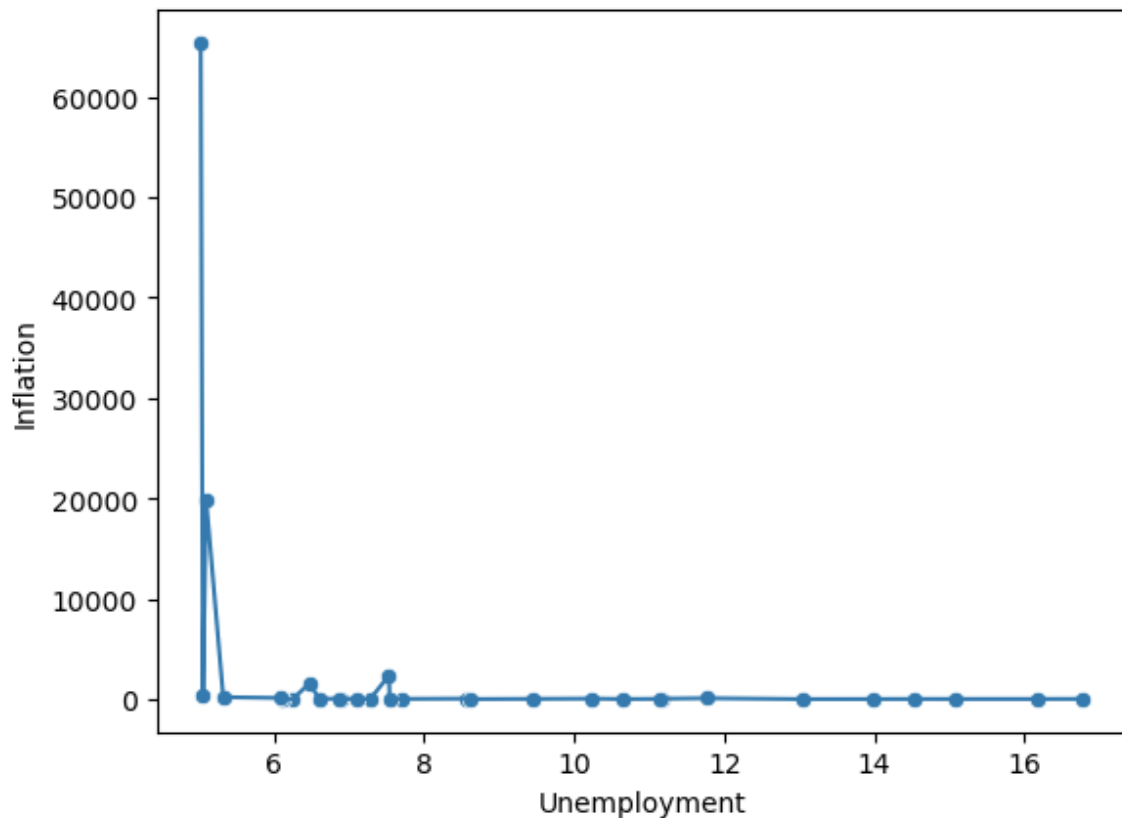


It can be seen from the given graphs that the inflation rate and the unemployment rate are both positively skewed.

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.

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 China 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 -0.4791.

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

We get the t value as -2.9893

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): -0.4791  
P-value: 0.0055  
T-statistic: -2.9893  
Degrees of Freedom: 30  
Critical t-value at alpha = 0.05: 2.0423  
Reject the null hypothesis: There is a significant correlation.
```

The above data has been generated using python

Since the t value is greater than the critical value, the relationship is statistically significant ($p < \alpha$). The data allows us to reject the null hypothesis and provides support for the alternative hypothesis.

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

Since we used the data obtained for China, thus we can say that for a relatively stable economy and a developing country the inverse relation between the inflation rate and the unemployment rate remains as expected.

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.

As per studies it is believed that an inflation rate of 2-4% is good for a healthy economy since the rising price level isn't that much and unemployment can also be kept under control.

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.

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%). Thus other than the deflationary policies, a number of job creating policies will also be required since we need to lower the unemployment level as well. Thus a combination of policies will be required so that both the inflation rate and unemployment rate can fall simultaneously.

In case of Venezuela, the inflation is very high while the unemployment is at an acceptable level, thus it is 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 that we have taken up. That is that the variable are negatively related to each other, or in other words when one of them increases the other one decreases.

CONCLUSION

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. 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.

DATA PREPARATION

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>

**THANK
YOU!**