Department of Economics

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BATH

STUDENT & UNIT DETAILS – TO BE COMPLETED BY THE STUDENT

Group Name	30
Unit Name and Code	Core skills for economists: Economic Data Analysis ES10004

DECLARATION – PLEASE READ CAREFULLY

cheating and is a very serious academic offence that may lead to disciplinary action.

6. No part of this assessment has been produced by, or communicated to you by, anyone other than members of your group.

An investigation into the relationship between unemployment and inflation rate in the United States from 1975 to 2019.

ES10004

Economic Data Analysis

Group Project

Group Number 30

By

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1.Background

In this report we are investigating the relationship between inflation and unemployment using data from the USA. We chose the USA as the country to obtain data from as the USA has lots of readily available data that is reliable and goes back far enough for our use. Furthermore, it is the biggest economy in the world and is therefore a good basis for economic analysis.

In 1958, AW Phillips proposed a negative relationship between unemployment and wage inflation and gathered data demonstrating the UK relationship between 1861-1913 (Phillips, 1958). When demand for a product or service rises relative to the supply, the price will likely increase. It is intuitive to assume that the labour market functions similarly to a commodities market. If unemployment is low, workers have more leverage. Therefore, employers may react by offering higher wages to attract and retain employees. Another cause of the relationship may be that if production in an economy increases, labour demand increases while unemployment decreases, causing employers to offer higher wages. The Phillips curve demonstrates this relationship, as seen below in Figure 1.

Figure 1: Original "Phillips curve" for the UK.
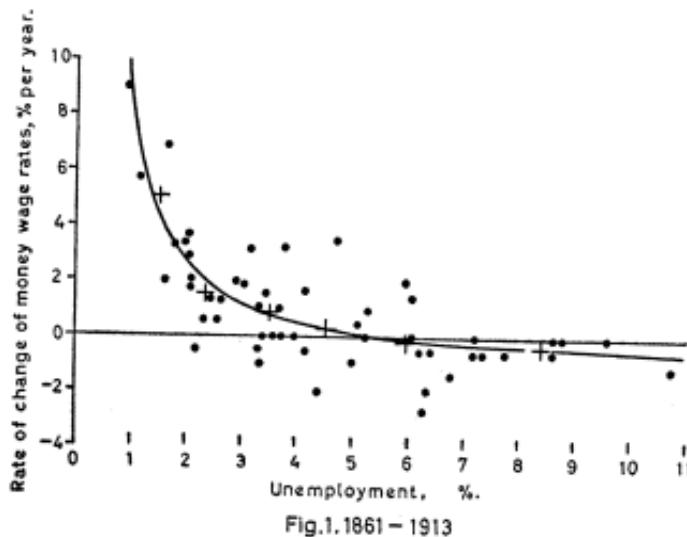
Source: (Phillips, 1958).

Samuelson and Solow then identified the same relationship in the USA between unemployment and price inflation (Samuelson and Solow, 1960) (Figure 2). Low unemployment could lead to high inflation in two ways. The first factor is that when unemployment is low, there is high demand in the economy because more consumers have income to spend, this causes prices to rise. The second factor could be that wage increases raise the production cost, possibly influencing firms to charge higher prices. However, if output in an economy rises with inflation, the inflation is likely caused by increased aggregate demand, although economists should not reject either hypothesis.

Figure 2: Modified Phillips curve for the US.

FIGURE 2

MODIFIED PHILLIPS CURVE FOR U.S.
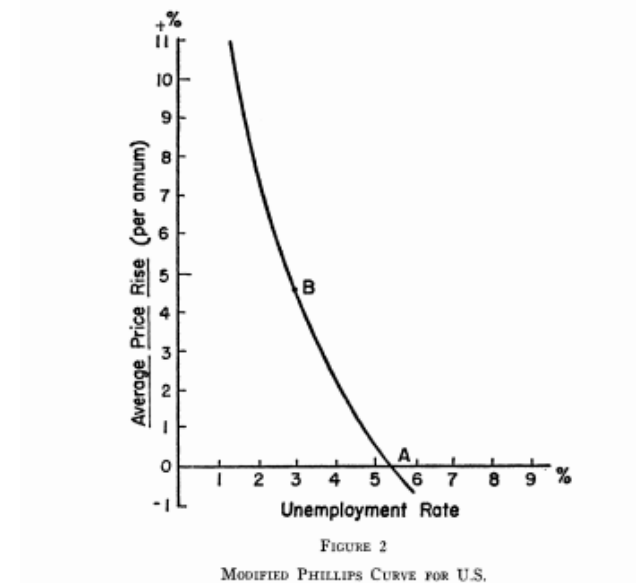
Source: (Samuelson and Solow, 1960).

Stagflation is the simultaneous rise in inflation and fall in output, leading to greater unemployment. One cause of stagflation is adverse supply shocks, which reduces the productivity in an economy (Abel, Bernanke and Dean Darrell Croushore, 2021, pp.491–492). The stagflation of the 1970's could be caused by the increase in the price of oil. This trend of stagflation seemed to disprove the notion that the Phillips curve was stable and could be used as a policy tool.

Friedman (Friedman, 1968) and Phelps (Phelps, 1967; Phelps, 1968) proposed that, in the long run, unemployment remains at its natural rate, determined by market factors. If monetary policy increases demand in an economy, there will be higher employment and increased price levels. But eventually, if employers and employees expect inflation, pressure for higher real wages and price increases of goods and services will cause aggregate supply to decrease, further increasing unemployment. Therefore, the relationship can only exist if salaries are not adjusted upwards because of expected inflation. The theory is represented graphically by the Phillips curve shifting upwards. In the long term, unemployment will remain at the original equilibrium level, but inflation will be higher. If the relationship only exists in the short run, policymakers cannot achieve low unemployment targets indefinitely.

The relationship between inflation and unemployment is an important one to look at and analyse as it theoretically has policy implications, for if the Phillips curve holds true then governments will be able to achieve low unemployment through high inflation. When we study the data for the US the extent to which the theoretical relationship is followed will be examined and this will give an insight into if a relationship exists and if so, how strong is it, therefore discovering if there are potential policy implications from the two variables.

2.Data and descriptive statistics

All the data we have collected is from the OECD. The OECD defines the unemployed "as people of working age who are without work, are available for work, and have taken specific steps to find work" (OECD, 2021). The unemployment rate is the percentage of the total population that falls under that definition of unemployment. The data for the unemployment rate is obtained from labour force surveys (LFS). The OECD is a reliable data source, although it is essential to remember that LFS does not have a 100% participation rate and that the data will not be entirely reflective of reality, but they still have some of the best data about the labour market.

The OECD defines inflation as 'the change in the prices of a basket of goods and services that are typically purchased by specific groups of households' (OECD, 2021). Inflation figures are based on the consumer price index (CPI). The CPI is the most widely used measure of inflation, but it does have certain flaws, such as using a basket of goods that only carries some usual consumer goods, not considering that consumers substitute cheaper goods for more expensive ones and not capturing innovative products widely bought within the basket (Maverick, 2020). Despite these issues, CPI remains the most used measure and is still a reliable source of data.

Figure 3: USA inflation rate from 1975-2019.
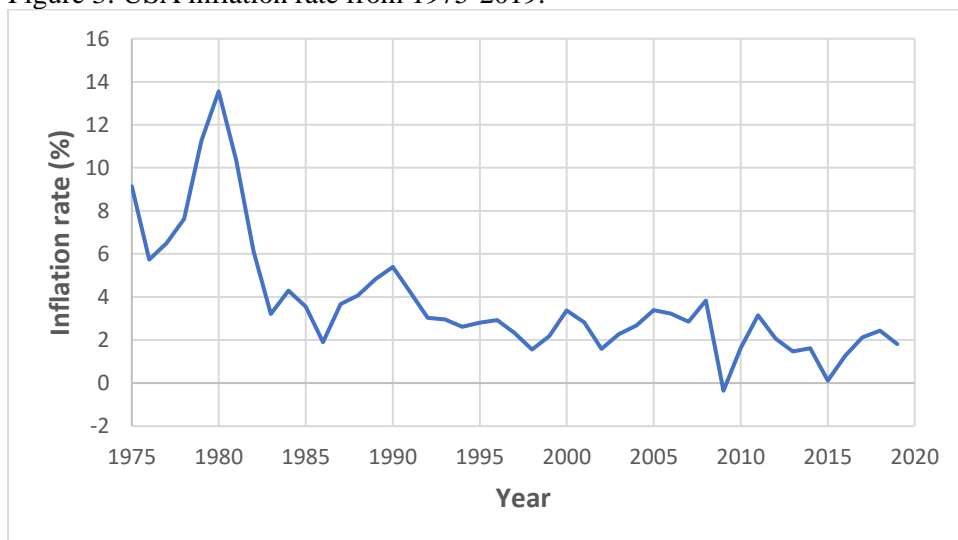
Source: (OECD, 2021).

Figure 3 shows the USA inflation rate over time. The overall trend is downwards sloping with a large anomaly in the 1980s. The spike in inflation was due to US neo-Keynesian monetary policies. The graph suggests that inflation has been falling in the USA over time since the high levels in the 70s/80s.

Figure 4: USA unemployment rate from 1975-2019.
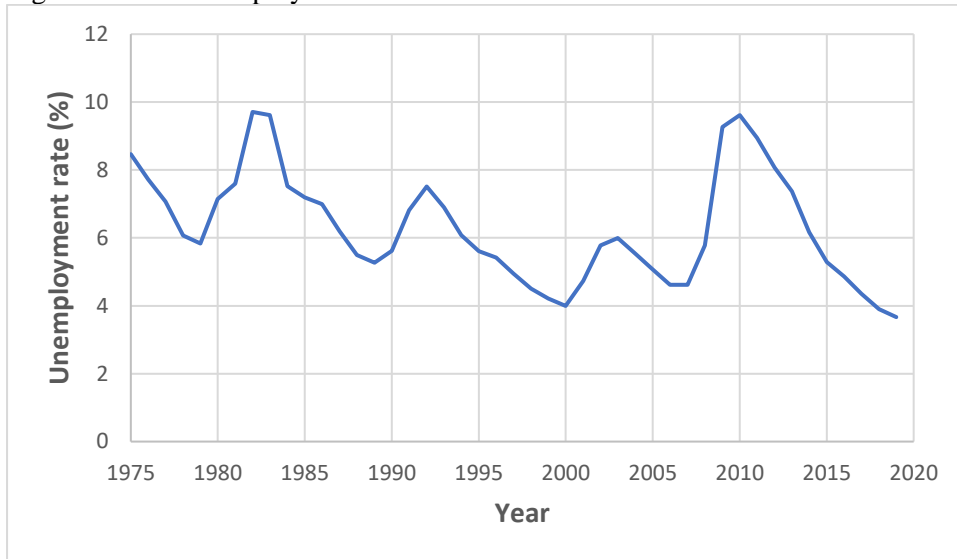
Source: (OECD, 2021).

Figure 4 shows the US unemployment rate over time. There is a slight downwards sloping trend, although unemployment fluctuates greatly during this period due to several factors such as the 80s recession and the 2007/8 financial crisis. The graph implies that unemployment within the USA is volatile and can change significantly from year to year. This already shows a disconnect from the theoretical relationship of inflation and unemployment as from 2010 unemployment falls whereas, in figure 1, we can see inflation fluctuating from 2010 onwards.

Figure 5: Unemployment rate vs inflation rate form 1975-2019.
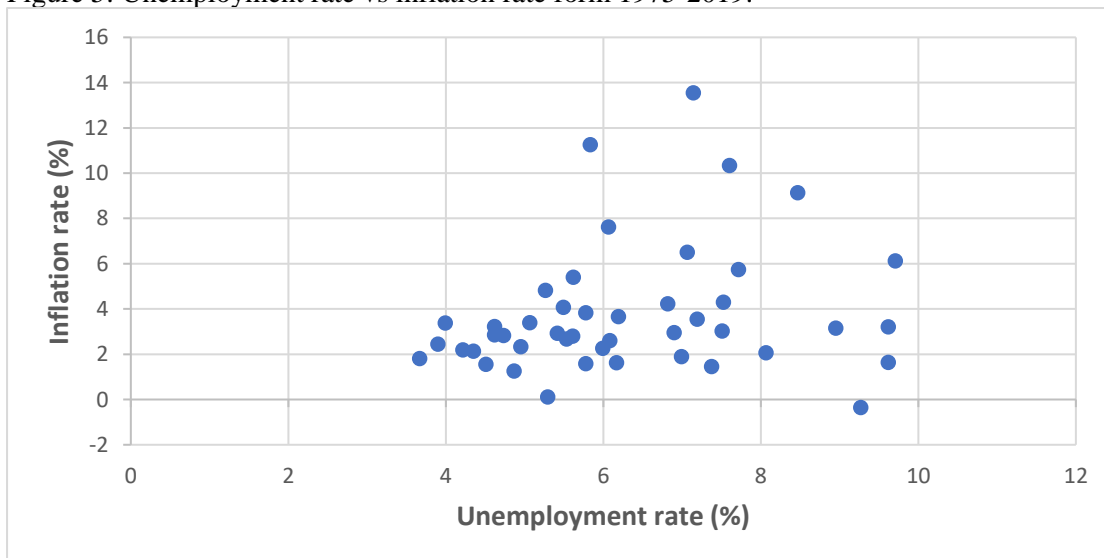
Source: (OECD, 2021).

Figure 5 shows the US unemployment rate against the US inflation rate. In the theoretical Phillips curve produced in 1958 there is an inverse relationship between inflation and unemployment, whereas, from the gathered data, there is a weak positive correlation. The breakdown of the Phillips curve seen here is the same breakdown seen during the 1970s stagflation. To look at the differences between the statistics and these theoretical relationships, we will analyse the data further below. Table 1 displays some summary information about the data we have collected.

Table 1: Summary statistics on the unemployment rate and inflation rate from 1975 to 2019.

	Unemployment rate	Inflation rate
Mean	6.2915	3.7614
Median	5.9917	2.9517
Standard deviation	1.6321	2.8227
Minimum	3.6667	-0.3555
Maximum	9.7083	13.5492
Range	6.0417	13.9047

3.Results

Table 2: Regression results between inflation rate and unemployment rate.

	Dependent Variable	
	(1) Inflation rate	**(2) Unemployment rate**
Coefficient	0.3579	0.1196
Intercept	1.5098	5.8415
Correlation coefficient	0.2069	0.2069
R Square	0.0428	0.0428
Standard error	2.7935	1.6152
P-value	0.1727	0.1727
Observations	45	45

From the regressions, there is a negligible positive correlation (0.2069) between unemployment and the inflation rate. This suggests that the Phillips curve cannot be applied to the data we collected from the United States. The R Square furthermore indicates that the data is not considered a good fit as only 4.28% of the values fit the regression analysis model. The standard error further reinforces the previous point as a higher value for this demonstrates a spread of data with little correlation. Also, the p-value (17%) implies that there is no statistical significance at a 5% level between unemployment and inflation rates in the US.

The model furthermore suggests that a one-unit increase in inflation leads to an 11.96% increase in the unemployment rate. This again negates the theory that as inflation increase unemployment falls.

Regression Equation:

$$Inflation\ Rate = 1.5098 + 0.3579(Unemployment\ Rate)$$

The value of the independent variable in the first regression is 0.3579 for the unemployment rate in relation to the inflation rate, shown in the regression equation. Our data presents an opposing idea to the theoretical relationship.

4.Causality and Robustness

Table 3: Regression results with inflation rate and unemployment rate time lags.

	Coefficient	P-value
Unemployment rate (t-1)	-0.0169	0.9735
Unemployment rate (t-2)	-0.3796	0.6240
Unemployment rate (t-3)	0.7126	0.1597
Correlation coefficient		0.5817
R Square		0.3384
Standard error		2.4394
Observations		42

The regression suggests that a 1 and 2-year time lag on unemployment display a negligible negative and low negative correlations respectively. This is closer to the Phillips curve model than with previous results. However, at a 3-year time lag on unemployment, the correlation coefficient shows a high positive correlation which doesn't support the conclusions from the previous 2 regressions. Furthermore, the p-values for the time lags are all above the 5% significance level meaning the regression is not statistically significant. The correlation coefficient suggests a moderate positive correlation. This disproves the traditional theory that there would be a negative relationship. Also, the R Square (34%) suggests that our values are not a good fit for the regression analysis model. Combining this with the high standard error value further promotes the previous point.

Table 4: Regression results with unemployment rate and inflation rate time lags.

	Coefficient	P-value
Inflation rate (t-1)	-0.1557	0.2791
Inflation rate (t-2)	0.2808	0.1595
Inflation rate (t-3)	0.1929	0.1547
Correlation coefficient		0.6006
R Square		0.3608
Standard error		1.3565
Observations		42

The regression suggests that a 1-year time lag on inflation produces a negligible negative correlation between the two variables. However, a 2 and 3-year time lag on inflation produces negligible positive correlations which go against the Phillips curve theory. Furthermore, the p-values suggest the data is not statistically significant at a 5% level. The correlation coefficient indicates a moderate positive relationship between the variables. This further shows how the data we analysed goes against the traditional economic theory. The R Square value (36%) implies our values are not a good fit for the regression model. The standard error value further supports this.

Combining these two pieces of evidence would suggest a stronger link to the theory with a slight time lag on unemployment (1-2 years). This would mean that there is the expected relationship between inflation and unemployment but with a time lag on unemployment. However, these values are not statistically significant.

GDP (Gross Domestic Product) per capita growth rate and long-term interest rates (OECD, 2021) were used as additional variables alongside the unemployment rate against inflation rate to determine any trends.

Table 5: Regression results with unemployment rate, GDP per capita growth rate and long-term interest rate.

	Coefficient	P-value
GDP per capita growth rate	0.4365	0.0019
Long-term interest rate	0.3416	0.0099
Unemployment rate	0.0805	0.6740
Correlation coefficient		0.7670
R Square		0.5884
Standard error		1.8761
Observations		45

This regression suggests that there is a low positive correlation between GDP per capita growth rate and inflation rate. This is statistically significant at the 0.2% significance level shown by the p-value. As well, there is a low positive correlation between long-term interest rate and inflation rate. This is statistically significant at the 1% significance level shown by the p-value. The unemployment rate coefficient suggests a negligible positive relationship between unemployment and inflation. Furthermore, the p-value implies this is not statistically significant at the 5% level.

The data we analysed suggests that GDP per capita growth rate and long-term interest rates have a greater effect on inflation than unemployment shown by the coefficients. This shows that the causality in this relationship may not be as expected according to the theory, as external factors have larger impacts than the variables involved.

5.Conclusion

The initial theory suggests that the relationship between inflation and unemployment should be negative year by year. Conversely, our data analysis showed a slight positive relationship between the variables, and potentially an inverse relationship after a time lag however these were statistically insignificant. We also found external factors that can influence inflation rate.

The Friedman-Phelps model could provide an explanation as to why there is not a direct relationship between inflation and unemployment in our data. The implication of the model could be that monetary policy should not be used to drastically reduce unemployment because expected inflation leads to the level of employment to be the same in the long run (Friedman, 1968). The model could be limited because it makes classical assumptions, such as continuous market clearing, whereas prices and wages may be rigid. (Gordan, 2018). Supply shocks could have also influenced the level of unemployment and inflation in our data, which could have caused the relationship to break down. Adverse supply shocks cause productivity and output to increase, leading to permanently higher levels of employment (Abel et al, 2021).

Furthermore, the economic policy of keeping inflationary expectations stable has broken down the Phillips curve further by attempting to keep inflation around the 2% level (Engemann, 2020). As seen in figure 3 the US government has succeeded in keeping inflation around the 2% target, this means that workers are less likely to ask for raises based on inflation as they trust prices to be stable.

Overall, from the data we have collected we have seen how the traditional Phillips curve from 1958 is not as useful to policymakers now compared to how it was seen back then. There are several potential reasons as to why the relationship is no longer a clear-cut inverse relationship. What is certain is that the US government cannot use the relationship as an easy way to control inflation or unemployment because, as this investigation has shown, the interactions between inflation and unemployment in the US are far more complicated than one curve can display.

Bibliography

Abel, A.B., Bernanke, B. and Dean Darrell Croushore (2021). *Macroeconomics*. 10th ed.
[online] Harlow, Essex: Pearson Education Limited, pp.491–492. Available at:
https://ebookcentral.proquest.com/lib/bath/detail.action?docID=6000974&pq-
origsite=primo [Accessed 22 Apr. 2021].

Blanchard, O. (2017). *Macroeconomics.* 7th ed. [online] Harlow: Pearson Education Limited,
pp.185–188. Available at:
https://ebookcentral.proquest.com/lib/bath/reader.action?docID=5186034 [Accessed
19 Apr. 2021].

Engemann, K. (2020). What Is the Phillips Curve (and Why Has It Flattened)? (Online).
Available at: https://www.stlouisfed.org/open-vault/2020/january/what-is-phillips-
curve-why-flattened (Accessed 21/4/2021)

Friedman, M. (1968). The Role of Monetary Policy. *The American Economic Review*,
[online] 58(1), pp.1–17. Available at:
https://www.jstor.org/stable/1831652?origin=JSTOR-
pdf&seq=1#metadata_info_tab_contents [Accessed 10 Mar. 2021].

Gordon, R.J. (2018). Friedman and Phelps on the Phillips curve viewed from a half century's
perspective. *Review of Keynesian Economics*, [online] 6(4), pp.425–436. Available at:
https://www.nber.org/system/files/working_papers/w24891/w24891.pdf [Accessed 21
Apr. 2021].

Maverick, J.B., 2020. What are some limitations of the consumer price index (CPI)?
(Online). Available from: https://www.investopedia.com/ask/answers/012915/what-
are-some-limitations-consumer-price-index-cpi.asp [Accessed 6/3/2021]

OECD. 2021. Gross Domestic Product (indicator) [Online]. OECD. Available from:
https://data.oecd.org/gdp/gross-domestic-product-gdp.htm [Accessed 17 April 2021]

OECD. 2021. Inflation (CPI) (indicator) [Online]. OECD. Available from:
https://data.oecd.org/price/inflation-cpi.htm [Accessed 12 February 2021]

OECD. 2021. Long-term interest rates (indicator) [Online]. OECD. Available from:
https://data.oecd.org/interest/long-term-interest-rates.htm#indicator-chart [Accessed
17 April 2021]

OECD. 2021. Unemployment rate (indicator) [Online]. OECD. Available from:
https://data.oecd.org/unemp/unemployment-rate.htm#indicator-chart [Accessed 12
February 2021]

Phelps, E.S. (1967). Phillips Curves, Expectations of Inflation and Optimal Unemployment
over Time. Economica, 34(135), pp.254-281.

Phelps, E.S. (1968). Money-Wage Dynamics and Labor-Market Equilibrium. Journal of
Political Economy, 76(4, Part 2), pp.678–711.

Phillips, A.W. (1958). The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957. Economica, 25(100), pp.283–299.

Samuelson, P.A. and Solow, R.M. (1960). Analytical Aspects of Anti-Inflation Policy. The American Economic Review, [online] 50(2), pp.177–194. Available at: https://www.jstor.org/stable/pdf/1815021.pdf [Accessed 7 Mar. 2021].

Sasongko, G. and Huruta, A. D. (2019) "The causality between inflation and unemployment: the Indonesian evidence", Business: Theory and Practice, 20, pp. 1-10. doi:10.3846/btp.2019.01. [Accessed 17 April. 2021]

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Group Project Evaluation Form

Student I.D.	Attendance/ participation	Intellectual Contribution	Effort	Overall Contribution (sum of cols 2-4)
199199026	4	4	4	12
209121274	4	4	4	12
209435492	4	4	4	12
209101128	4	4	4	12
209336616	0	0	0	0