Phillips Curve in Pakistan: A Graphical and Empirical Analysis

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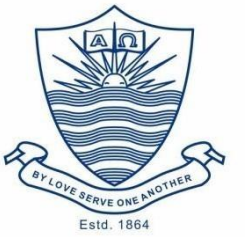
This Dissertation is submitted to the Department of Economics, Forman Christian College (A Chartered University), Lahore, in partial fulfillment for the award of the degree of Bachelors of Sciences in Economics. The submitted research work is the sole responsibility of the candidate.



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DECLARATION BY THE RESEARCHER

I declare that the main contents of this dissertation accounts for my own research and has not previously been submitted for a degree at any educational institution. Further it is stated that the material taken from the other sources has been properly acknowledged.

Irtiza Imran Waheed
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Monday, January 12, 2020

Certificate

We accept the research work contained in this dissertation titled: **"Phillips Curve in Pakistan: A Graphical and Empirical Analysis"** as confirming to the required standard for partial fulfillment of the degree of Bachelors of Sciences in Economics.

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Abstract

This study estimates the Phillips curve for Pakistan using time series data for unemployment and CPI for the years 1972 to 2018. In addition to empirical analysis extensive graphical analysis is conducted to get a better insight of the behavior of the Phillips curve. By dividing the sample size into periods of four decades and 2 equal halves the trend line is plotted for different periods which experience a shift as well as change in slope over time. The unit root tests proved the data to be stationary at level so OLS is used to run 3 different regressions. Since the data for unemployment contains a lot of repeated values which is problematic for post-regression analysis so output gap is also used as a proxy for unemployment. The empirical analysis is in accordance to the graphical analysis which shows a negative relationship between unemployment and inflation.

SYMBOLS, NOTATIONS AND ABBREVIATIONS

Notation	Description
AD	Aggregate Demand
AS	Aggregate Supply
CPI	Consumer Price Index
GDP	Gross Domestic Product
OLS	Ordinary Least Squares

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1. Introduction

The great depression of 1929 did not just bring misery but it let to the inception of macroeconomics as a distinct field of study (Bernanke, 1995) dominated by propagation of government intervention to achieve economic targets which was championed by the Keynes school of thought. The inability of Keynesian economics to provide appropriate policy responses to the high inflation and unemployment gave rise to monetarism, credited to Milton Friedman, which placed more importance to monetary policy rather than fiscal policy. Although the two popular schools of thought have distinct ideologies, a common theme of active role of policymakers to obtain the most popular macroeconomic goals of low unemployment, stable price level and economic growth (Froyen, 2013) is evident.

However, these desirable macroeconomic goals have an undesirable consequence of conflicting with each other where trade-offs have to be made in order to achieve a macroeconomic goal so policy makers have to make sacrifices in order to achieve their goals. One such common trade-off occurs between low inflation and low unemployment with low level of inflation associated with high level of unemployment and vice versa.

This relationship is displayed in the Phillips curve which is named after an economist hailing from New Zealand, Alban William Phillips. In his paper "*The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957"* published in 1958 Phillips studied the relationship between unemployment and wage rates in United Kingdom between 1861 and 1957 and his findings suggested that an inverse and a stable association between the wages and unemployment level exist where period of low change in wage rates were associated with high unemployment and vice versa which opposed the prevailing beliefs at that time that inflation and unemployment did not coexist and any economy at a particular time either faced inflation or unemployment. This curve was coined as the "Phillips Curve" by other economist R. G. Lipsey (1960), Paul Samuelson and Robert Solow (1960) who plotted price inflation against unemployment for US data and found that trade-off existed between the two variables. Although, Phillips did not intend for his findings to be used as a policy guide, Samuelson and Solow were of the view that the Phillips curve could serve as "menu of choice[s] between different degrees of unemployment and price stability" which led policymakers to believe that the Phillips curve provided a set of socially optimal points which could be chosen to achieve their macroeconomic goals in the short run (Dorn, 2020, p. 134).

Over the past three decades Pakistan has witnessed periods of high price level which in addition to reducing the purchasing power of the population, opposite to the desired political goal, conflicts with the central bank's aim of price stability. This research focuses on Pakistan in a bid to figure out if there exists any association between unemployment level and price level to determine if the goal of low-price level backed by the political policy makers and the central bank would induce high unemployment in the country, or vice versa, substituting one "evil" with another and whether this relationship is stable and homogenous over time.

In this study, the Phillips curve has been estimated using time series data for price level and unemployment rate for Pakistan from 1972 to 2018 after applying stationarity checks. The aim of this paper is twofold. The first aim is to find out if the Phillips curve exists for Pakistan by graphically analyzing the scatter plots for unemployment and inflation and if it exists then whether it is stable over time or varies in terms of shifts in the curve or changes in the slope. The second aim is to estimate the Phillips curve empirically to determine the elasticity of change in inflation due to change in unemployment.

The remainder of the thesis is structured as follows: Chapter 2 includes the literature review, in Chapter 3 data and methodology is discussed and stylized facts are discussed in chapter 4. Chapter 5 reports the empirical analyses which are followed by the discussion and conclusion in Chapter 6 and 7 respectively.

2. Literature Review

In history the Phillips curve has evolved five times as analysts aimed to make theoretical foundations of the Philips curve more concrete and increase its explanatory power, its ability to achieve policy targets and its ability to explain economic phenomenon. The earliest example of a Phillips curve type analysis can be credited to an eighteenth-century economist David Hume (Humphrey, 1985). His version of the Phillips curve presented in 1752, related deviations of unemployment from its natural rate with changes in price level with respect to time and he claimed that by increasing prices, low levels of unemployment can be achieved. His analysis was followed by Henry Thornton (1802) who made similar analysis between level of unemployment and level of inflation and stated that the two variables were inversely related,

> ". . . additional industry will be one effect of an extraordinary emission of paper, a rise in the cost [i.e., price] of articles will be another." (p. 237)

Implying that an increase in income would not only increase the output and employment but also increase the price levels. However, Thornton did not agree with using his version of the Phillips curve for conducting policy since he thought that policies related to Phillips curve will involve inflation and such inflationary policies are "attended with a proportionate hardship and injustice." The gains from a high level of output and employment in his opinion would not outweigh the costs of high inflation. These analyses were followed by the debates between Thomas Attwood (1816) and John Stuart Mill (1833) who presented their own versions of the Phillips curve. While Attwood claimed there existed a long-run tradeoff relation between unemployment rate and prices where both variables are taken relative to their base period, Mill argued that by relating deviations of price level from the expected price level to deviations of unemployment from its steady-state level would result in temporary trade-offs. Later in 1926, the first person to statistically estimate and analyze the Phillips curve was Irving Fisher. In his paper termed "A Statistical Relationship Between Unemployment and Price Changes" he used monthly data for US from 1915- 1925 for unemployment and lagged price changes and his estimations showed a strong correlation between the two variables. He further claimed of a unidirectional causality which runs from price changes to unemployment. In 1936 Jan Tinbergen was the first to estimate the association between changes in wages and unemployment where changes in unemployment caused changes in wage inflation. He also included a lagged variable for price changes and estimated this relationship using data of Netherlands for the period 1923 – 1933. Later, in 1955 Lawrence Klein and Arthur Goldberger estimated their own version of the Phillips curve. It related changes in wage rates to unemployment level and lagged price level and their equation also included a time trend. Unlike Tinbergen, Klein's and Goldberger's equation included the unemployment variable linearly. They too claimed that low levels of unemployment would put upward pressure on wage rates and thus stated that the two variables were negatively correlated. It is J. Brown and Paul Sultan who are credited with supplementing the research of identifying the relationship between unemployment and wage and/or price changes with scatter plots and graphical presentations. In 1955 in his paper "The Great Inflation 1939-1951" J. Brown presented scatter plots that plotted unemployment rates against annual wage changes for UK data for the periods 1880 – 1914 and 1920 – 1951 and for the US for the period 1921 – 1948. His conclusions were that the association between unemployment

rates and annual wage changes is non-linear and also that they were negatively related. The difference between his contribution to the topic and A. W. Phillips' work is that J. Brown did not fit a curve to a scatter plot. It was really Paul Sultan who in his 1957 book "Labor Economics" presented the graphical representation of price-change Phillips curve which depicted a trade-off relationship between level of unemployment and price inflation. But it was not until 1958 when A.W. Phillips published his paper "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957" the inverse relationship between unemployment and wage/price change was coined as the "Phillips curve equation". A.W. Phillips estimated a statistical equation fitted to annual data of percentage changes in the unemployment rate and changes in wages of the data for United Kingdom for 1861 – 1957. The findings were that the curve was a convex downward sloping curve which cut the horizontal axis at some positive level of unemployment. This means that wage inflation and unemployment are negatively related which means a direct association between real GDP and inflation (given that jobless growth is not present) (Motoyovszki, 2013). In his analysis Phillips did not provide any policy implications and there is no mention of any circumstances that would shift the curve up or down in the long run as it was devoid of any theoretical foundations and was completely empirical in nature. It was the work of Samuelson and Solow (1960) which gave the relationship between unemployment and price/wage inflation the name "Phillips Curve" and the popularity of their paper caused this term to enter the language of macroeconomics and consequently became central to large-scale macroeconomic models (Gordon, 2008)

Low inflation and unemployment rates are both one of the most vital goals of economic policy and have elicited a huge amount of interest from policy makers because one often comes at the expense of the other. Whether both can be achieved simultaneously or some sort of sacrifice has to be made in order to achieve the right combinations of unemployment rates and inflation rates is a highly debated topic, hence it is essential to examine their relationship thoroughly. The short run trade-off between rate of inflation and rate of unemployment can be demonstrated by the help of the Phillips curve which shows the inverse relationship between inflation rates, measured on the vertical axis and unemployment rates, measured on the horizontal axis. Lower levels of inflation (downwards movement on the vertical axis) are associated with higher rates of unemployment (rightwards movement on the horizontal axis).

The AD-AS models help us to determine the short and the long run association between inflation and unemployment. Suppose there is an upward or a rightward shift in the AD curve, due an injection of fiscal stimulus, the effect would be a rise in prices and output in the short run. If all the resources in the economy are employed, meaning the economy is operating at its natural level of employment, the increased output would decrease the level of unemployment below the natural rate of employment. Abel et al. (2017) define natural rate of unemployment as the rate of unemployment when output and unemployment are at full employment. The increased production would require employing the unemployed resources and the excess spending would put pressure on the inflation rate. On the Phillips curve this would mean upward movements on the vertical axis met by leftward movements on the horizontal axis. The greater the increase in the AD the greater would be the increase in inflation rate and the decrease in unemployment rate. Conversely, a reduction in AD, due to a contractionary fiscal policy, would reduce output; laying-off of employed resources with natural rate of unemployment falling below the rate of unemployment and weak demand pressure would weigh down the inflation rate. The change in AD would determine the trade-off between the unemployment rate and inflation rate. To sum up, low levels of unemployment are associated with higher levels of inflation and vice versa, given that the short run aggregate supply curve is constant.

However, this analysis changes in the long run as the trade-off between inflation rate and unemployment rate is non-existent. The explanation is centered on the concept of the difference between expected and actual inflation. Suppose at some particular equilibrium point on the AD-AS curves workers are locked into contracts with their employers with the assumption that a 3% inflation rate would persist. But suppose on the contrary increased AD pushes up the inflation rate much higher, say up to 6%. The firms would respond with increased employment and output. Thus in the short run the economy has moved to a level where there is low level of unemployment at the expense of high price level which could only be made possible when the expected inflation rate is lower than actual inflation rate but eventually workers realize that inflation rate has outpaced the increase in their nominal wages and their attempts to regain the lost purchasing power cause firms to lose the excess profit gains which motivated them to increase employment in the first place and in return would lay off workers. This would lead to economy returning to its natural rate of unemployment but with higher level of prices. If the increase in AD persists this cycle would continue where in the short run natural rate of unemployment could be higher than actual

unemployment at the expense of higher price level but when expected inflation rate would equal the actual rate the consequence of increased AD would only be increased levels of inflation at the natural level of unemployment and the trade-off between inflation and unemployment rate would be absent. In the long run, the Phillips curve would be a vertical line.

During some years the data for rates of inflation and rates of unemployment would not suggest an inverse relationship rather higher rates of unemployment are associated with higher rates of inflation. Such a period is known as stagflation. The analysis for the long run and short run Phillips curve was made with the assumption that the supply curve was constant and not shifting. Baumol and Blinder (2011) write in their book that if fluctuations in economic activity originate from supply side shock, e.g., a rise in oil prices like in the 1970s, then high rates of unemployment will be accompanied by high rates of inflation and vice versa.

Below is a summary of some of the causes of supply shocks

Table: 2.1 Summary of causes of supply shocks

Factor	Effect on Supply Curve	Source
Increase in Oil/Energy prices	Adverse supply shock	Abel et al., Baumol, Blanchard, Froyen, McConnell et al.Mitchell et al, Sexton.
Resource short-fall/bountiful harvests	Adverse/favorable supply shock	Baumol, McConnell et al, Sexton
Depreciating/appreciating currency	Adverse/favorable supply shock	Baumol, McConnell et al
Wage hikes	Adverse supply shock	McConnell et al
Declining productivity	Adverse supply shock	Blanchard, McConnell et al,
Technological improvements	Favorable shock	Baumol, McConnell et al, Sexton,

Source: Author's compilation

In the AD-AS analysis the supply shock has the effect of increasing the price level and reducing the output. At lower level of output unemployment will increase and it will be associated with high rates of inflation, distorting the conventional Phillips curve. This idea is also shared by Robert L. Sexton (2015) who writes in his book that supply side shocks lead to a direct association between unemployment rates and inflation level.

Productivity and technological improvements can directly affect both unemployment and inflation. Increased productivity can be achieved by employing more machines and technologically oriented production methods. Although it can result in unemployment which is known as Technological Unemployment, technological unemployment may not affect overall unemployment but could change the level of unemployment in different industries (Kapeliushnikov, 2019). People working on farms laid off due to tractors could be employed in industries manufacturing tractors. This depends on flexibility in the labor market. Geographical and occupational immobility can restrict a farmer from working in the technology industry. However, if the labor force does get laid off due to technology, reforming the labor market to remove geographical and occupational immobility can help workers to find jobs that assist in the production and service of the new technology.

Increased productivity in one industry can lead to decreasing level of prices of goods and services, since productivity allows goods and services to be produced at a lower cost, and in the portion of income that is being spent by consumers allowing them to spend more on other goods and services. In the AD/AS analysis this would mean a rightward shift in the AD curve which means higher output and price level. The increased demand will lead to employing more workers, (given that the firms do not match increased demand by increased productivity). If other industries respond to the increased demand for goods and services initiated by increased productivity, by increasing their own productivity, through innovation etc., then there still will be increased employment as the gains in profit margins by firms will be further invested for expansion and it will create jobs. Nonetheless, this increase in employment of resources would mean increased output and the AS will shift rightwards which will remove the pressure on the prices which was exerted by increased AD so the net effect is increased output without a significant effect on price level. (Pettinger, 2017)

The effect of productivity on inflation can be observed through the following chain of events. The effect of a decrease in productivity would be twofold. First, firms will face rising unit

labor cost and to prevent profit margins from being squeezed they would resort to price increases. Over time, workers will have to accept lower growth of wages corresponding to their lower growth of productivity and per unit cost will decrease to their previous levels. During the time firms raise their prices to maintain their profit margins there would have been inflation. Secondly, lower rates of productivity can depress aggregate demand and in turn, inflation. Lower rates of firms' profit margin will reduce stock market gains as well as consumer wealth and ultimately their spending, so foresighted consumers would reduce their spending believing that the probability/chances of an increase in real wage (equal to productivity) in future look slim. If it is expected that productivity growth will be low it would restrict investment due to the lower expected return on capital. The same argument could be made for the relation of lower levels of inflation and increased level of productivity. (Yellen, 2005)

On the other hand some people believe that the relationship between productivity and inflation is fictional. Like Milton Friedman put it "Inflation is always and everywhere is a monetary phenomenon" they argue that productivity is not a monetary phenomenon rather a real phenomenon and changes in real goods or services do not affect inflation.

In addition to changing the traditional relationship between inflation and unemployment, supply shocks are also responsible in shifting the Phillips curve. Abel et al. (2017) discuss the Friedman-Phelps Phillips curve in their book which relates the natural level of employment with the expected rate of inflation. It is argued that the consequence of any change in either factor would be the shifting of the Phillips curve either to the right or to the left. It says that supply shocks would make the Phillips curve unstable. Further, there is discussion of how unfavorable supply shocks would jack up natural rate of unemployment and expected inflation and lead to rightwards movement of the Phillips curve. Beneficial supply shocks on the other hand would similarly lead to leftwards shifts of the Phillips curve. According to this analysis there would be a stable Phillips curve relationship only if natural employment rate and expected inflation rate are constant and even if they are changing a systematic relationship between cyclical unemployment and unanticipated inflation can be observed.

Oliver Blanchard (2017) discusses the reasons that could cause the natural level of unemployment to change. Globalization reduces union's bargaining power since there is always the threat of firms moving their business abroad to take advantage of low-cost labor. Secondly, a change in demographics of the population in the sense that having a higher proportion of young

workers would jack up the natural level of unemployment because young workers with low experience tend to change their jobs more frequently and unemployment rate is high in this group. Furthermore, an increase in prison population, a relaxation in the criteria for people receiving disability benefits and an increase in agencies that provide temporary employment would decrease the natural unemployment rate. Oliver Blanchard mentions Hysteresis and Eurosclerosis the other two reasons for a change in unemployment rate over time. The hysteresis argument is that chronic unemployment makes workers unemployed for so long that they lose the skills and morale to be employed and become unemployable. It also includes arguments that there has been a change in the attitudes of workers such that they prefer to remain unemployed rather than work for low wages. Generous unemployment benefits by some governments have aggravated this attitude as people can survive on unemployment benefits rather than seek jobs. The result is a higher natural rate of unemployment. However, Blanchard does claim that there is little empirical evidence to show that labor market institutions, responsible for handing out unemployment benefits, have changed significantly in the past four decades so their effect on natural rate of unemployment might not be very strong. The Eurosclerosis argument states that technological advancements have led to a reduced demand of low-skilled workers but high-skilled workers have witnessed an increased demand for their skills. The suppressed demand for low-skilled workers would consequently make low-skilled workers to receive lower real wages and firms would find it profitable to employ them at lower rates however at places with a high minimum wage rate these low skilled workers would still remain unemployed which will increase the natural rate of unemployment. Dolado et al. (2011) mention labor market reforms as a cause of falling natural unemployment level.

In addition to being shifted, time varying slopes of the Phillips curve can also be observed. Stock and Watson (2019) estimated the Phillips curve of US for three consecutive periods from 1960 – 2018 by using data for unemployment gap and core PCE inflation. A decline in the slope of the Phillips cure in absolute terms which means a more flat Phillips Curve were a part of their findings. Variations in slopes of the Phillips curve have policymaking implications as it means that more output has to be sacrificed, which in turn means more workers need to be unemployed, in order for the economy to experience diminishing levels of inflation (Carlstorm & Fuuerst, 2008). The change in inflation becomes inelastic with respect to the change in unemployment rate. However, Fujita (2019) warns that Phillips curve may become flatter because of inaccuracy in the

data. It is possible that the unemployment gap which is usually used to estimate Phillips curve might not fully capture the size of labor market slack. Many different causes of flattening of the Phillips curve in literature can be found.

Information from various papers combined: Causes of flattening of the Phillips curve

Table: 2.2. Causes of flattening of the Phillips curve

Causes	Author
Globalization reduces monopoly and prices	Dora Iakova, Kabundi et al.
Globalization leads to price stability	Bean Charlie, Dora Iakova,
Labour mobility reduces bargaining power	Dora Iakova,
Cheap imports act like a positive supply shock	Bean Charlie
Anchored inflation expectations keep prices low	Bean Charlie, Dolado & Jimeno
Productivity	Dolado & Jimeno,
Immigration	Dolado & Jimeno
Reduction in information and transaction costs	John A James
Gold standard providing price stability	John A James

Source: Author's compilation

Many studies have been conducted to estimate the Phillips curve of Pakistan. Hasan (1988) was the first person to estimate the Phillips curve for Pakistan using the rational expectations model with quaterly data from 1972 – 1981 and found that the short-run Phillips curve exists for Pakistan in that time period.

Katira et. al. (2012) calculated the Phillips curve for SAARC countries using unbalanced annual panel data, obtained from World Bank, for the years 1980-2010 using multistage regression with 420 observations. Inflation was regressed on unemployment, interest rates, debt servicing and exchange rate however no explanation was given for the selection of aforementioned regressors. They found that the trade-off between inflation and unemployment does exist for SAARC countries including Pakistan.

Subhani et al. (2011) estimated the Phillips curve for Pakistan, India, Bangladesh and Sri-Lanka using data from 1981 – 2010. Data for unemployment for Pakistan was obtained from Indexmundi website. They regressed the rate of inflation on rate of unemployment using simple

linear regression via data split technique. The findings were that a direct association between inflation and unemployment exist and the coefficient for unemployment was 0.559. The explanation given for a positive association between inflation and unemployment is that Pakistan has faced stagflation and slow economic growth since its birth which has resulted in shifting of the Phillips curve.

Zulfiqar (2014) estimated Phillips curve for Pakistan using time series data from 1983 – 2018. The data for inflation is obtained from World Bank database and unemployment data is obtained from various issues of economic surveys of Pakistan. It is claimed that these sources of data were chosen since most researchers, who were not mentioned, deem these sources reliable. The data is found to be integrated of order 1. Vector Error Correction Model was used to estimate the Phillips curve and only a long run positive relationship between inflation and unemployment was found. The study was silent about the possible reasons behind such a relation.

Haq et al. (2012) estimated the Phillips curve for Pakistan using time series data of unemployment and inflation from 1974 – 2010. The data was collected from World Bank database and various issues of economic survey of Pakistan. The reason given for choosing these sources were that many researchers use these resources consistently so these sources are reliable. The data was found to be integrated of order 1. By using VECM they found a long run positive relationship between unemployment and inflation. The authors claim whether the relationship between inflation and unemployment is positive or negative, it depends on the economic situation of the country.

Afzal and Awais (2010) estimated Phillips curve for Pakistan using data of inflation, as measured by CPI, and unemployment from 1973 – 2010. The data was collected from various issues of economic survey of Pakistan. They regressed deviation of actual inflation rate from expected inflation rate, taking lagged term as expected inflation, to deviation of unemployment rate from the natural unemployment rate. Natural unemployment rate is taken at 5.30% which is questionable since Staiger et al. (1997) calculated natural rate of unemployment for a developed country like USA and found it to be around 6.2% so it must surely be higher for a developing country like Pakistan. They also used a second equation where deviations in inflation from expected rate was regressed on deviations of unemployment from the natural rate and also on change in unemployment using non-linear least squares. Their findings were that Phillips curve holds in Pakistan.

Zaman et al. (2011) estimated the Phillips curve for Pakistan using annual data of 35 years from 1975 – 2009 for unemployment and inflation. The data is obtained from various economic surveys of Pakistan, World Bank database and International Financial Statistics (2007-2008). They found variables to be integrated of order 1. VECM was used to estimate the Phillips curve and they found that Phillips curve exists in Pakistan both in the short run and in the long run.

Ahmad et al. (2013) estimated the Phillips curve for Pakistan using time series data from 1984 -2012. The data was collected from World Bank database and various issues of economic survey of Pakistan. Inflation was regressed on trade as a percentage of GDP, exchange rate and unemployment level. They found the variables to be stationary at level so they used the method of Ordinary Least Squares. They found a negative and statistically significant relationship between inflation and unemployment. The coefficient of unemployment was -1.1383.

Below is a summary of all the studies related to Phillips curve in Pakistan.

Table 2.3. Summary of all studies related to Phillips curve in Pakistan

Author	Date	Findings
Afzal and Awais	2010	Trade-off exists
Subhani	2011	Positive relationship between unemployment and inflation
Zaman et. al.	2011	Long-run and short-run trade-off exists
Kitara et. al.	2012	Trade-off doesn't exist
Haq et. al.	2012	Long-run positive relationship between unemployment and inflation
Ahmad et. al	2013	Negative relationship between unemployment and inflation
Zulfiqar	undated	Long-run positive relationship between unemployment and inflation

In this study extensive graphical analysis will be done in addition to empirical analysis to test the Phillips curve and its behavior in different time periods by dividing the sample size into periods of 4 decades and 2 equal halves.

3. Data and Methodology

Annual time series data for unemployment, inflation and real GDP from 1972 to 2018 has been used to estimate relationship between level of inflation and unemployment. The data for annual inflation rate has been obtained from World Bank database which defines inflation as

> " measured by the consumer price index which reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used."

World Bank lists IMF and IFS as its sources of data for annual inflation rates.

Data of GDP at constant factor cost with base year 2005-2006 has been used for real GDP and has been obtained from Handbook of Statistics on Pakistan Economy 2015. For the years 2016-2018 the source of data for real GDP is the World Bank database.

The unemployment data has been obtained from various issues of Economic Surveys of Pakistan. The economic survey of Pakistan reports unemployment rates as reported in labor force surveys.

The table below mentions the years which has same unemployment as the subsequent years.

Table 3.1. Years with same level of unemployment recorded

Level of employment recorded	Same as in the year
1989, 1990	1988
1996	1995
1999	1998
2001	2000
2003	2002
2005	2004
2009	2008
2012	2011
2016, 2017	2015

According to the economic survey of 1988-1989 (p. 117) the labor force survey was not conducted for the years 1972-73, 1973-74, 1975-76, 1976-77, 1977-78, 1979-80, 1980-81, 1981-82, 1983-84 and the numbers published were based on interpolation. The data for unemployment in consequent issues record values which are the same as to previous year and no mention is made as to why they are same. According to economic survey, labor force survey had not been conducted for 2015-16 and 2016-17 due to population census.

The economic survey of 1992-1993 states that there had been a change in definition of unemployment which is given as follows:

Unemployment (Pre-1992-1993)

- "Include all persons who, during the reference week were either looking for work, or not looking for work because of illness, or not looking for work believing job not available or temporarily or indefinitely laid off, or waiting to report to a new job or willing to work if job is provided, or apprentice with no guaranteed job or had some usual occupation but were doing nothing during reference period."

Unemployment: (Since 1992-1993)

- "The "unemployed" comprises of all persons of 10 years age and above who during the reference week were either; i) "available for work" i.e., were available for paid employment or self-employment; or ii) "Seeking work" had taken specific steps in a specified recent period to seek paid employment or self-employment."

"It also includes persons who were not available for work during the reference week due to certain reasons such as illness, will take a job within a month, temporarily laid off and apprentice and not willing to work."

Although originally Phillips regressed changes in wage rates with unemployment data but since wage inflation and price inflation are closely related (Mankiw, 2010) regressing changes in inflation rate to unemployment would have the same meaning. As mentioned by Mitchell et al. (2019) the linear price Phillips curve can be expressed as:

$$\pi = \alpha + \beta U + \epsilon \ldots\ldots\ldots\ldots\ldots (1)$$

Where π = Annual inflation rate

α = constant of regression

U = Annual unemployment rate

Since the data for unemployment contains values for a lot of years which are repeated it is highly suspected that the above regression would not be free of the problem of autocorrelation. Hence a second regression will have to be run using data points only for the years which have the original and unique value of unemployment.

The second equation would capture the effect of cyclical unemployment on inflation. Cyclical unemployment can be expressed as deviation of unemployment rate from the natural rate of unemployment (Mankiw, 2010). Natural rate of unemployment can be defined as the rate of unemployment when output and unemployment are at full employment (Abel et al., 2017).

$$\pi = \alpha + \beta(U - U^n) + \epsilon \ldots\ldots\ldots\ldots (2)$$

Where π = Annual inflation rate

α = constant of regression

U = Annual unemployment rate

U^n = Natural rate of unemployment

HP filter is used to generate the series of natural rate of unemployment. The Hodrick – Prescott Filter is a smoothing method which is used to smooth the long-term trend component of a series. The smoothed series is decomposed into growth and cyclical components and the method assumes that the smoothed series does not contain any seasonality but also does not separate out irregular movements from the series. It computes the smoothed series μ of U^n by minimizing variance of U^n around μ, subject to a penalty that constraints the second difference of μ. The filter is given by:

$$\text{Min} = \sum_{t=1}^{T}({U^n}_t - \mu_t)^2 + \lambda \sum_{t=2}^{T-1}((\mu_{t+1} - \mu_t) - (\mu_t - \mu_{t-1}))^2$$

Where λ is the penalty parameter and controls the smoothness of the series. The larger the value of λ the smoother will be the smoothed series and when λ = ∞, the smoothed series approaches a linear trend. As suggested by Hodrick and Prescott (1997) λ is usually set to 1600 for quarterly data. And according to Ravn and Uhlig (2002) this implies that penalty parameter should then be set to 6.25 when we have annual data and 129,600 for monthly data.

Since the veracity of data of unemployment is questionable a third equation is also estimated where changes in inflation rate is regressed on the output gap. Brouwer (1998) describes output gap as the difference between actual and potential output that represents deviation from potential output. The output gap contains vital information regarding movements in price and wage inflation and is closely related to unemployment gap (Jahan & Mehmood, 2013). Using a version of Okun's law the output gap is inversely related to unemployment gap (Mankiw, 2010). Once again, the HP filter is used to find the deviation from potential output. So the third equation to be estimated is:

$$\pi = \alpha + \delta\pi_{t-1} + \beta(Y - Y^n) + \epsilon \ldots\ldots\ldots\ldots (3)$$

Where π = Annual inflation rate

α = constant of regression

π_{t-1} = Lagged inflation rate

$Y - Y^n$= Output gap as measured by $\frac{Y-Y^n}{Y^n} * 100$

Before running regression, variables will have to be tested for stationarity to avoid spurious regression. A stationary series is one where roots of characteristics equation lie inside the unit root circle or the roots of lag polynomial lie outside the unite circle (Ahmad et al., 2017). There are various tests present in literature that can be used to test for stationary which include Phillips Perron test (Phillips & Perron, 1988) Dicky Fuller test (Dickey & Fuller, 1979) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowski et al., 1992).

Dicky Fuller and Augmented Dicky Fuller Test

The DF tests for unit root with AR(1) component and assumes that errors are white noise with the following regression equation:

$$Y_t = \alpha + \delta Y_{t-1} + \varepsilon_t$$
$$H_0 = \ \delta = 1, \ \ H_1 = \ \delta < 1$$

The δ is the characteristic root of the equation or reciprocal of the root of lag polynomial and if it is less than 1 then Y_t is said to be stationary. The null hypothesis implies that the series follows a random walk and the error term will not have standard *t*- distribution and instead Dicky-Fuller distribution is used which depends on the deterministic parts of the above model. If the error term is not white noise then other tests like the Augmented Dicky-Fuller test have to be used. The Augmented Dicky Fuller Test (Dicky & Fuller, 1981) makes the disturbances white noise by assuming that the series to be tested for unit root follows an AR(*p*) scheme and hence can be useful to test unit root in higher order auto regressive scheme:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \rho_1 \Delta Y_{t-1} + \rho_2 \Delta Y_{t-2} + \ldots\ldots + \rho_p \Delta Y_{t-p} + \varepsilon_t$$
$$H_0 = \ \delta = 0, \ \ H_1 = \ \delta < 0$$

By using nonparametric statistical methods Phillips-Perron test can deal with the serial correlation in the disturbance term without adding lagged difference terms. The ADF test statistic and PP test have a common asymptotic distribution hence they give the same results (Gujrati, 2004).

The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test

Unlike other tests for unit root the KPSS assumes the series to be tested to be trend stationary under the null hypothesis. The statistic is based on the error term obtained by OLS regression of Y_t on the exogenous variable in the system:

$$Y_t = \ \delta X_t + \epsilon_t$$

And the LM statistic is defined as:

$$LM = \sum_t \frac{S(t)^2}{T^2 f_0}$$

f_0 is an estimator of the residual spectrum at frequency zero and *S(t)* is a cumulative residual function:

$$S(t) = \sum_{r=1}^{t} \epsilon_r$$

based on the error terms:

$$\epsilon_t = Y - \delta X_t(0)$$

3.1. Results of unit root test

Table 4.1 Result of ADF test

Augmented Dicky-Fuller Test						
Variable	Level			1st difference		
	C	C + T	None	C	C + T	None
Inflation	Non-stationary	Non-stationary	Non-stationary	Stationary	Stationary	Stationary
Unemployment	Non-stationary	Non-stationary	Non-stationary	Stationary	Stationary	Stationary

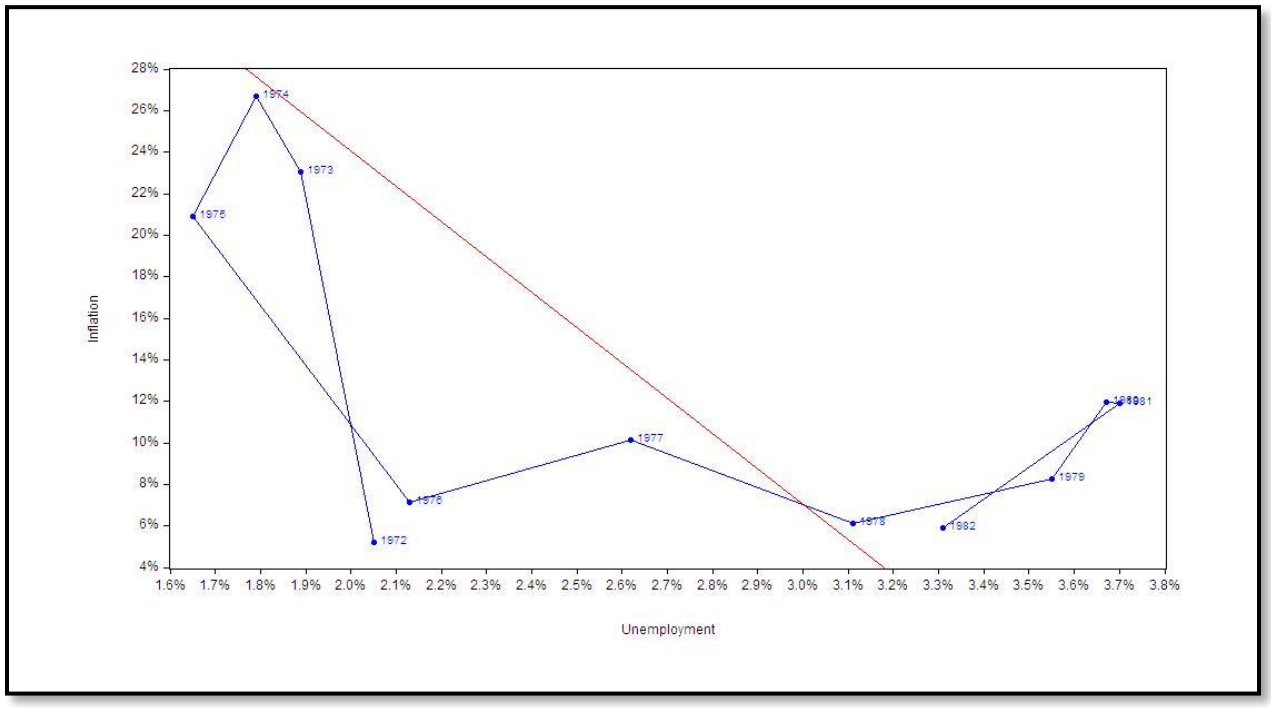
Table 4.2 Result of KPSS test

Kwiatkowski-Phillips-Schmidt-Shin Test			
Variable	Level		
	C	C + T	None
Inflation	Stationary	Stationary	Stationary
unemployment	Stationary at 5%	Stationary	Stationary

Since KPSS test is a newer technique than ADF test and since newer techniques are more robust the results of KPSS test are selected over results of ADF test so the variables are stationary at level.

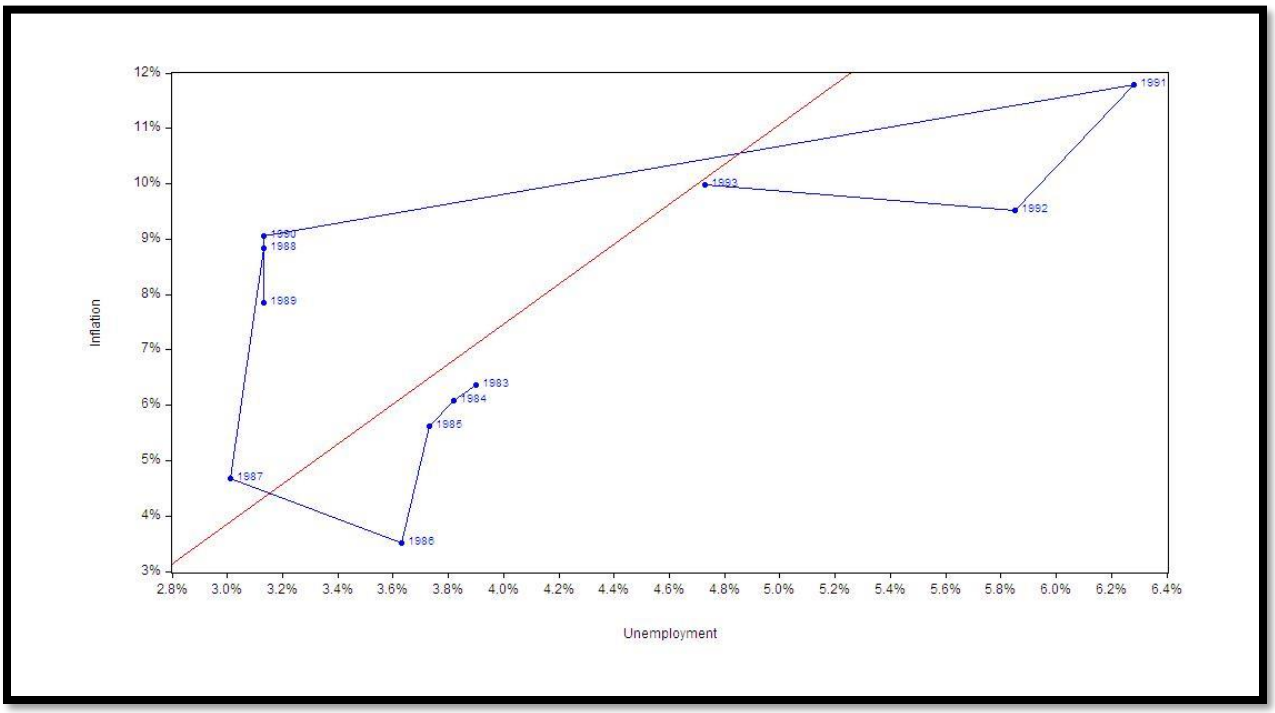
4. Stylized Facts

Figure 4.1. Relationship between unemployment and inflation (1972-1982)



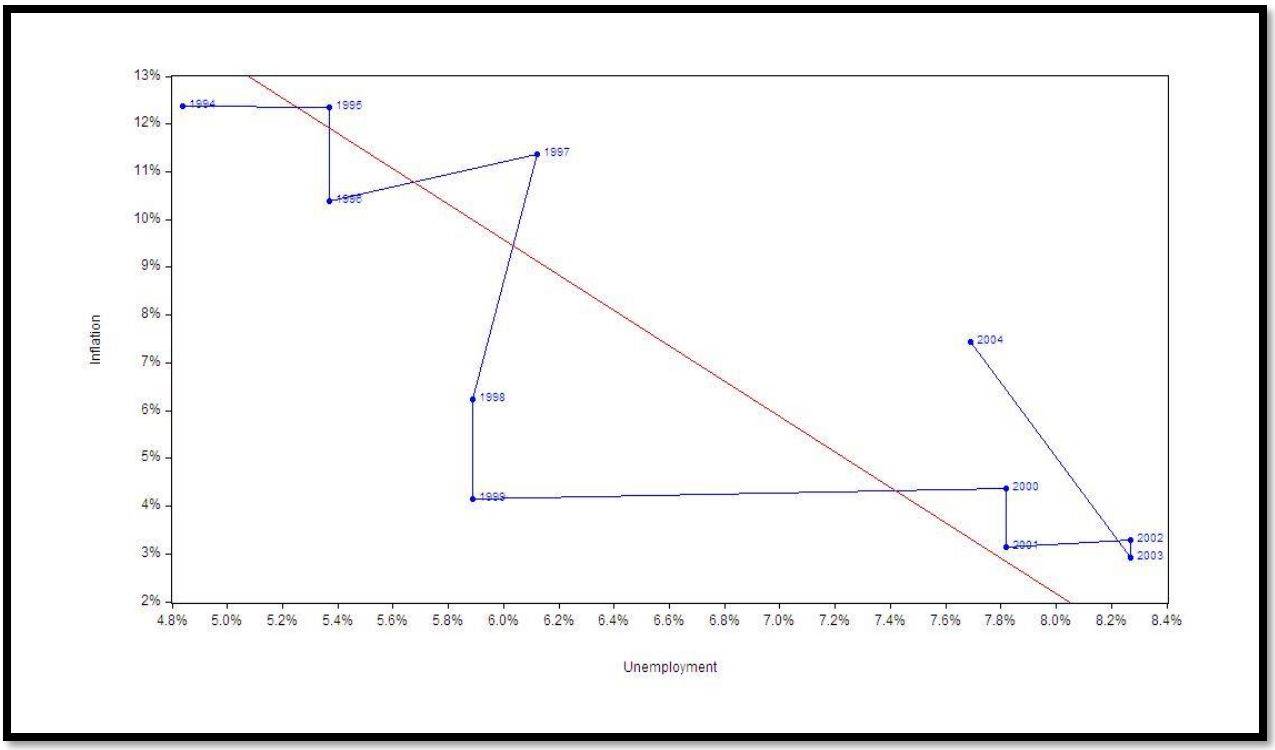
From 1972 to 1982 an inverse association between inflation and unemployment can be found. The fall in unemployment is accompanied by a rise in inflation as described by the Philips curve. From 1975 to 1976 rising unemployment caused by the global recession from 1974-1977 tamed inflation rate which peaked to 27% in 1974 due to oil price shocks in early 1970s. The traditional relationship between inflation and unemployment cannot be observed after 1976 to 1982 since episodes of rising unemployment with rising inflation and falling unemployment with falling inflation can be observed. The fitted regression line shows a fairly inelastic relationship between unemployment and inflation.

Figure 4.2. Relationship between unemployment and inflation (1983-1993)



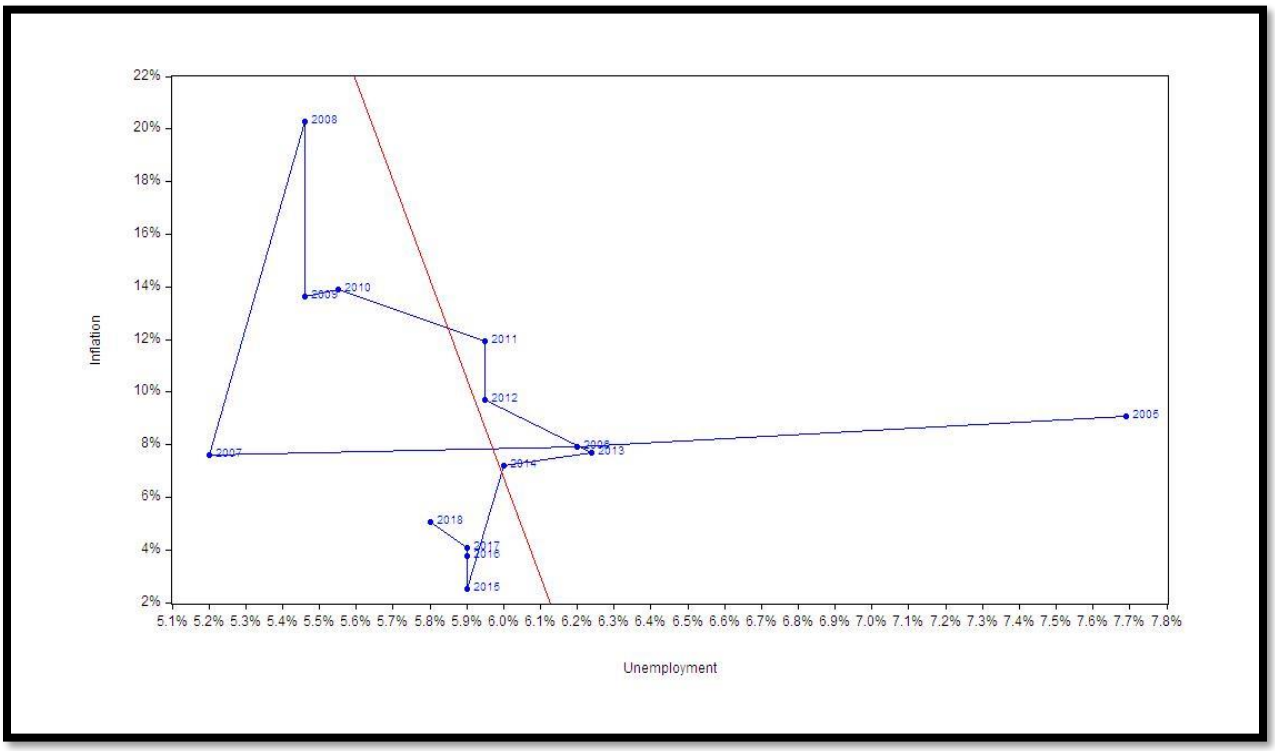
In the decade from 1983 – 1993 the traditional relationship between unemployment and inflation breaks down. Even though unemployment has been falling, owing to privatization policies adopted by the government which led to high growth rates (Fasih-Uddin, 2008), inflation has been falling as well and rise in unemployment from 1987 to 1991 has not been able to lower the inflation level. The fitted regression line shows a direct association between inflation and unemployment.

Figure 4.3. Relationship between unemployment and inflation (1994-2004)



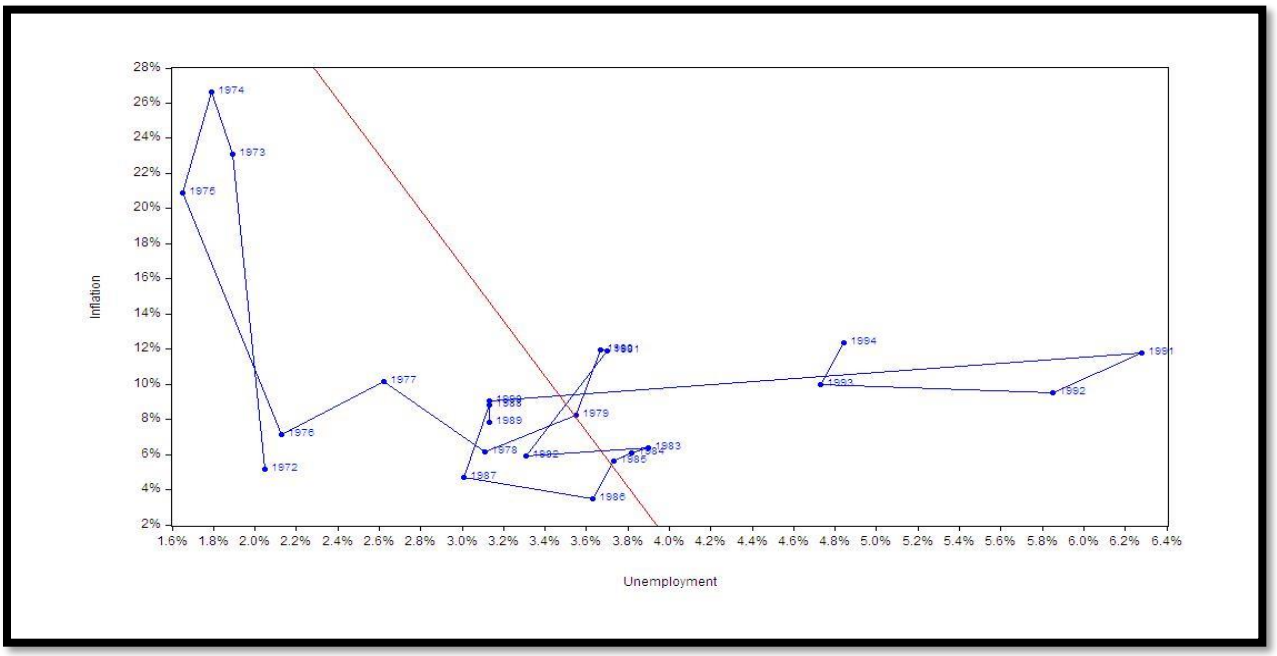
In 1990s Pakistan faced high inflation rate and declining GDP growth rates (Hasan, 1997). The declining growth in GDP and subsequent rise in unemployment rate from 4.8% in 1994 to 8.3% in 2003 pulled down inflation from 12.5% in 1994 to around 3.5% in 2003. The fitted regression line shares a similar slope for the scatter plot from 1972 to 1974 however it has shifted further to the right.

Figure 4.4. Relationship between unemployment and inflation (2005-2018)



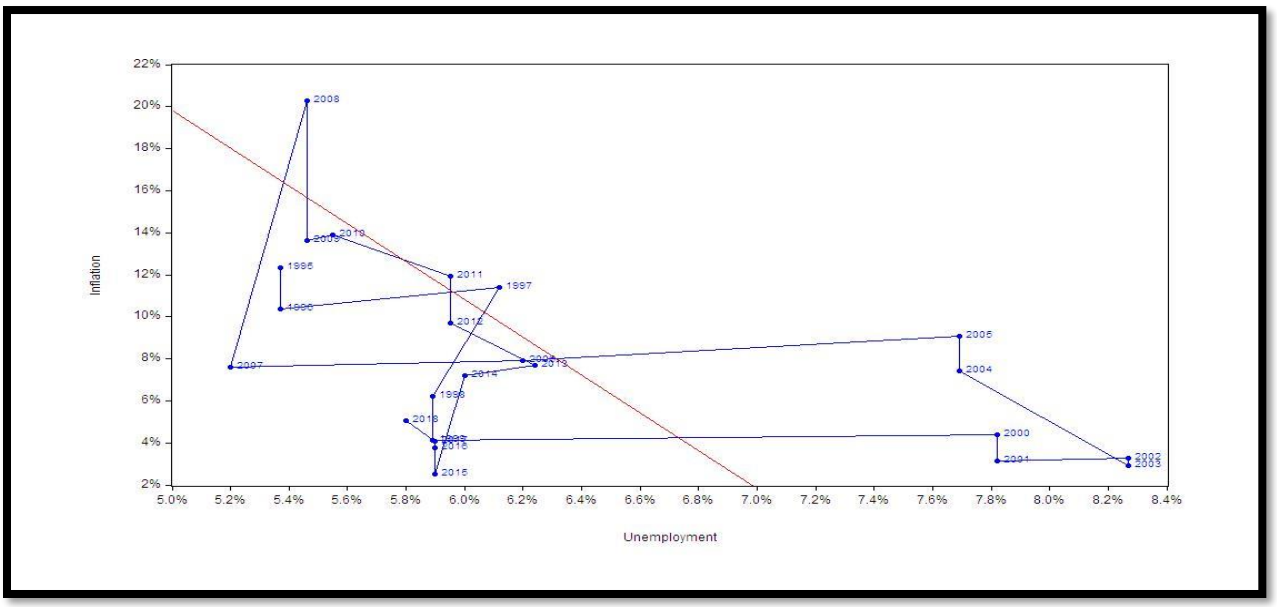
From 2005 to 2007 the unemployment rate has fallen from 7.7% to 5.2% but inflation on the other hand has fallen slightly. After 1976 the inflation rate once again reached above 20% in 2008. This was also the year where the global economy was facing financial crises and global growth rates were declining (Irfan-ul-Haque, 2010). During 2008 to 2013 the rise in unemployment has been met by a fall in inflation rate. However, after 2013 fall in unemployment rate has been matched by a fall in inflation level as well breaking down the traditional relationship. The fitted regression line has become steeper reflecting a rather elastic association among inflation level and unemployment level.

Figure 4.5. Relationship between unemployment and inflation (1972-1994)



For the period 1972 to 1994 the association between inflation and unemployment has been inverse and the slope also suggests that the relationship is elastic.

Figure 4.6. Relationship between unemployment and inflation (1995-2018)



For the period 1995 to 2018 the slope of the fitted regression line has become steeper suggesting a more inelastic relationship which means any fall or rise in unemployment results in a rather static change in inflation rate.

Figure 4.7. Relationship between unemployment and inflation (1972-2018) with outliers

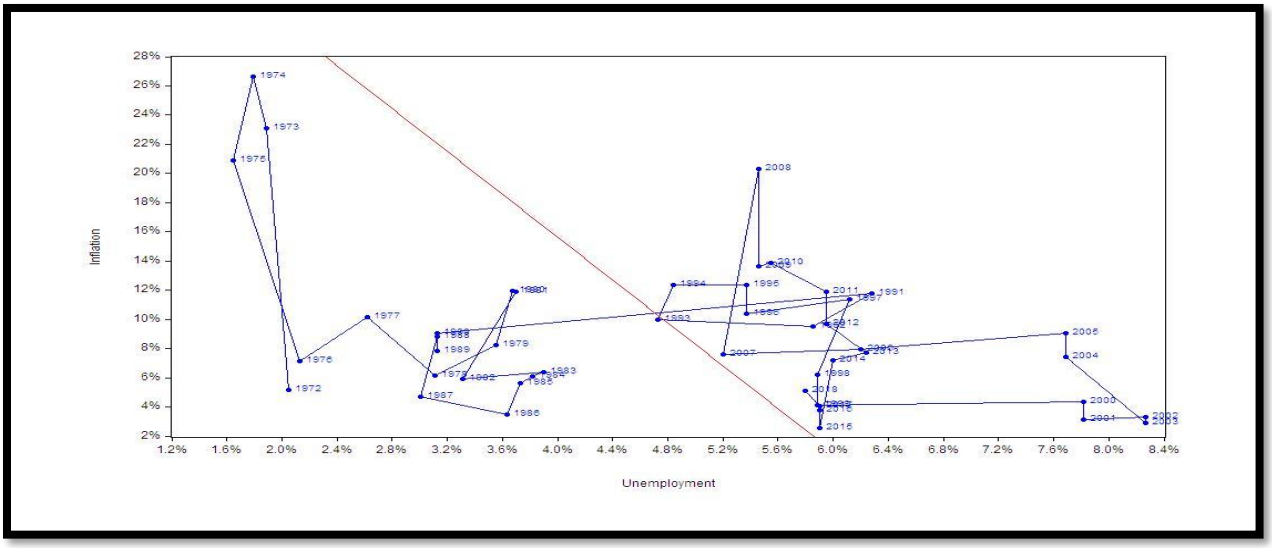
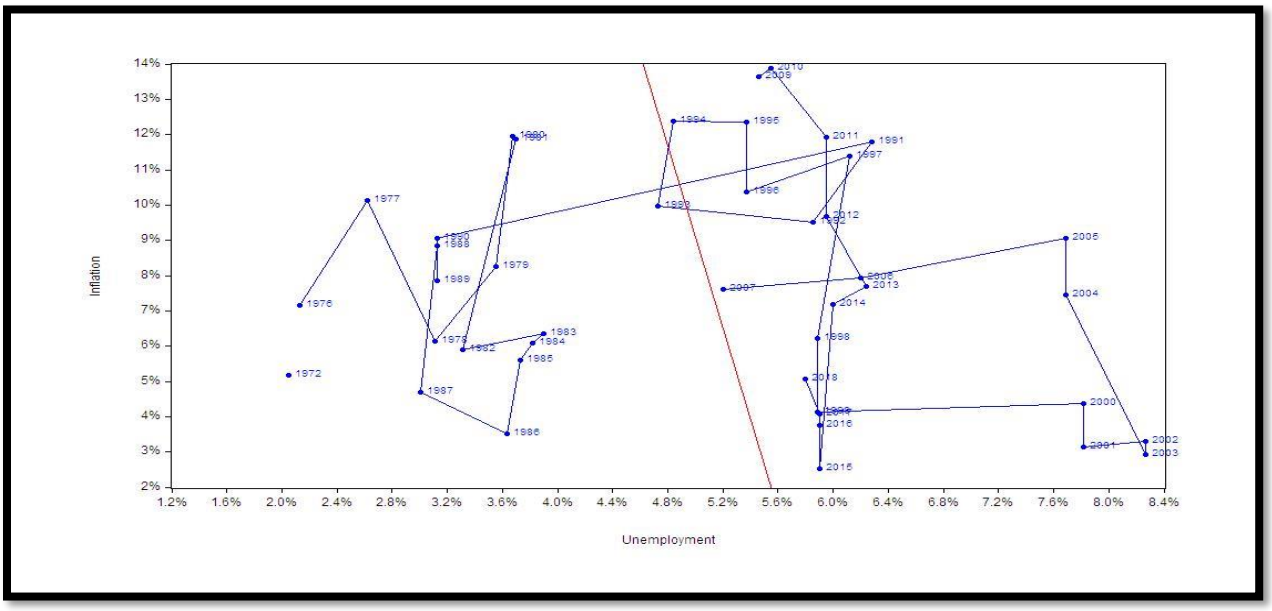
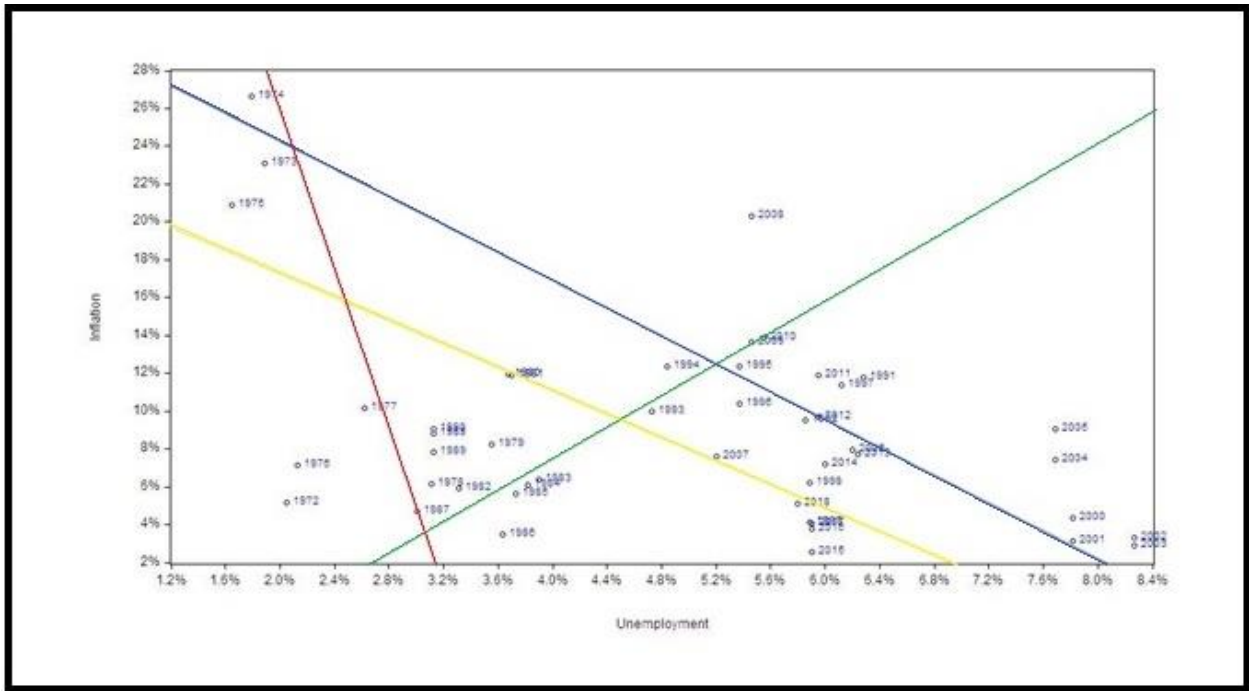


Figure 4.8. Relationship between unemployment and inflation (1972-2018) without outliers



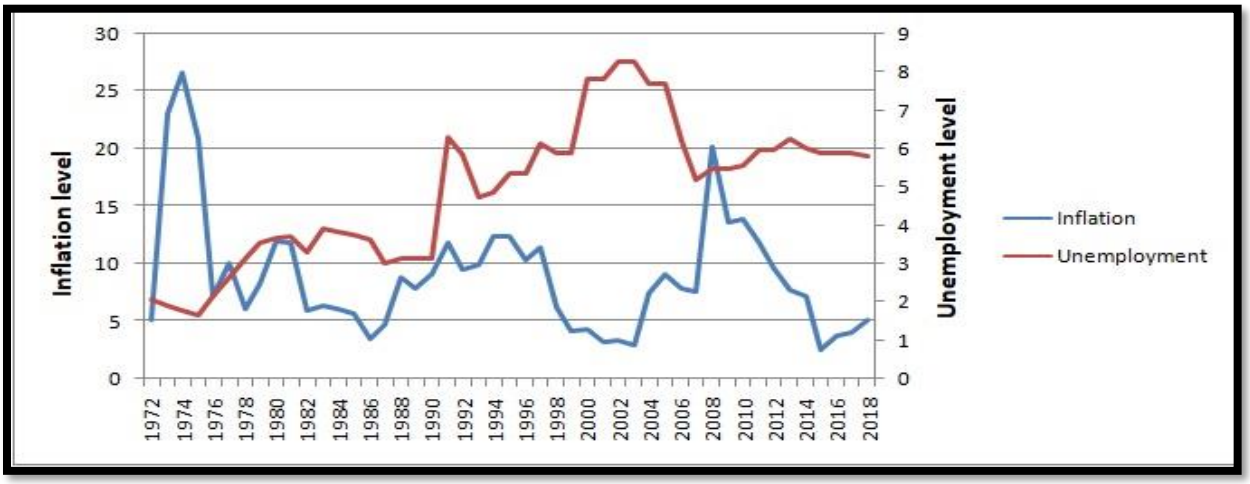
Removing the outliers make the regression line steeper which shows a more inelastic relationship between the two variables which resembles a vertical long-run Phillips curve as mentioned in the analysis earlier however the slope suggest that there still exist a little trade-off between unemployment and inflation even in the long run.

Figure 4.9. Relationship between unemployment and inflation (Trend lines for all decades combined)



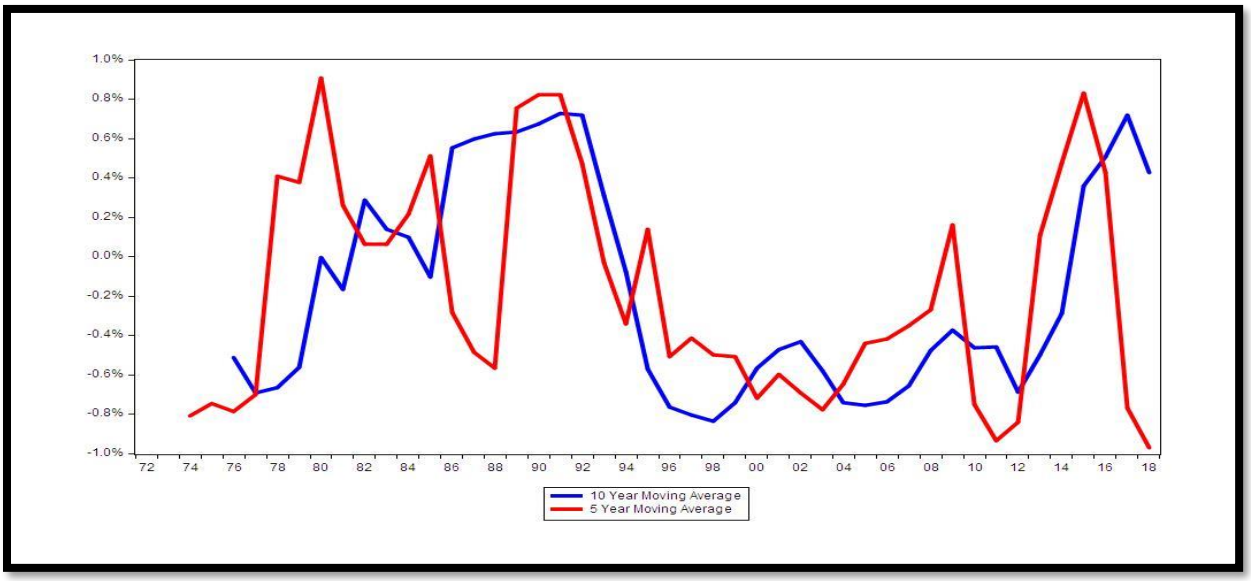
Red line: 1972 – 1982, Green line: 1983 – 1993, Blue line: 1994 – 2004, Yellow line: 2005- 2018

Figure 4.10. Line graphs for unemployment and inflation (1972-1982)



The inflation rate has been relatively high in 1970s and in late 2000s, rising in excess of 15% in both the decades. Unemployment has been relatively stable varying between 2.5% to 9% and has never gone into double digits despite Pakistan having to face floods in many years, external shocks, international sanctions and energy crises.

Figure 4.11. 5- and 10-year moving correlations for unemployment and inflation (1972-2018)



The 5 year and 10 year moving correlations show that the relationship between unemployment and inflation has been quite erratic over the period from 1972 to 2018. The intensity of their relationship has been changing over the time and has also been strongly positively correlated in early sample period, evidence of the demise of the Phillips curve, followed by periods where the two variables are strongly inversely correlated.

5. Results

The following are the results of the regressions.

$$\pi = \alpha + \beta U + \epsilon \ldots\ldots\ldots(1)$$

Table 5.1. Inflation as dependant variable

Parameter	***α***		***β***
Estimate	14.49767		-1.086264
t – statistic	6.945414		-2.701023
Probability	0.0000		0.0098
R – Squared	F- Statistic	7.295525	Durbin – Watson Stat
0.145053	Probability	0.009850	0.998859

The reported lower and upper values for DW test for 45 observations and 1 regressor excluding constant are:

0.05 %	1.475	1.566
0.01%	1.288	1.376

Using only unique values of unemployment

Table 5.2. Inflation as dependant variable

Parameter	α		β
Estimate	14.62827		-1.094392
t – statistic	5.878743		-2.168598
Probability	0.0000		0.00372
R – Squared	F- Statistic	4.702817	Durbin – Watson Stat
0.121511	Probability	0.037201	1.228745

The reported lower and upper values for DW test for 36 observations and 1 regressor excluding constant are:

0.05%	1.411	1.525
0.01%	1.206	1.315

$$\pi = \alpha + \beta(U - U^n) + \epsilon \ldots\ldots(2)$$

Table 5.3. Inflation as dependant variable

Parameter	***α***		***β***
Estimate	8.996425		-2.079801
t – statistic	11.96783		-1.788057
Probability	0.0000		0.0805
R – Squared	F- Statistic	3.197149	Durbin – Watson Stat
0.066335	Probability	0.080501	0.928184

$$\pi = \alpha + \delta\pi_{t-1} + \beta(Y - Y^n) + \epsilon \ldots\ldots(3)$$

Table 5.4. Inflation as dependant variable

Parameter	***α***	***δ***	***β***
Estimate	4.653751	0.490695	0.967472
t – statistic	4.013516	4.394069	3.530112
Probability	0.0002	0.0001	0.0010

R – Squared	F- Statistic	22.79532	Durbin – Watson Stat
0.511493	Probability	0.000000	1.510691

Since the above regression contains lagged value of inflation as an explanatory variable the Durbin-Watson stat is not useful for detecting auto-correlation so Breusch – Godfrey Serial LM test is used to detect auto-correlation. The lagged values of the error term of the above regression are selected on the basis of minimum of SIC and AIC criteria.

$$\epsilon = \alpha + \delta\pi_{t-1} + \beta(Y - Y^n)_{t-1} + \rho\epsilon_{t-1} + \mu$$

Table 5.5. Results of Breusch – Godfrey Serial LM test

Parameter	α	δ	β	ρ
Estimate	0.945450	-0.105966	3.684752	0.212950
t – statistic	0.626636	-0.682673	0.132607	0.987050
Probability	0.5343	0.4986	0.8951	0.3293

F- Statistic	0.974267	Observation*R^2	1.042864
Probability F(1,42)	0.3293	Prob. χ^2	0.3072

6. Discussion

The scatter plots suggest that there exist an almost vertical Phillips curve in Pakistan in the long run meaning that the effect of change in unemployment on inflation is minimal. Decade wise analysis suggest that in the sub-sample period the Phillips curve has changed slopes, shifted and has even been inverted, implying a positive relationship between unemployment and inflation, for the period 1983 – 1993. This change in Phillips curve for the sub-sample period suggest that since `Pakistan is more heavily affected by external shocks the Phillips curve is not a good policy guide.

Empirically, there does exist a negative relation between unemployment and inflation with the slope coefficient of the Phillips curve being around -1.1. Estimation of Phillips curve by unemployment gap suggests a more close relation between unemployment and inflation with a slope coefficient of -2 meaning the change in inflation is double as compared to a single percent change is unemployment. However, the veracity of data undermines the estimated coefficients and the estimate from output gap is more robust since they pass post-regression tests. The equation with output gap proxy suggests that inflation is positively related to its value in the past year and negatively related to unemployment gap since output gap and unemployment gap are inversely related. The estimation of Phillips curve equation by the output gap method suggests that a unit increase in unemployment rate reduces inflation rate by 0.96 units.

7. Conclusion

This study aimed to estimate the conventional Phillips curve for Pakistan using annual data from 1972 – 2018 in a bid to find out whether the relationship between unemployment and inflation, as portrayed by the Phillips curve, remains constant or is time varying. The Phillips curve was estimated by regressing inflation rate to unemployment rate however, due to irregularities in the data for unemployment the specific regression did not pass the diagnostic tests. Therefore, the concept of output gap and its relationship with unemployment level was used to estimate the Phillips curve which also included lagged values of the inflation rate as explanatory variables. The empirical analysis suggests a negative relationship exists between unemployment and inflation however the elasticity increases when using output gap as a proxy for unemployment. Even though, the empirical analysis suggests an inverse association between inflation and unemployment, previous studies conducted in Pakistan have found a positive relationship between inflation and economic growth which implies a positive relationship with inflation and unemployment (Arby & Ali, 2017).

In addition to empirical analysis, graphical analysis was also conducted by first dividing the sample period into periods of 4 decades and periods of 3 quarters to estimate the trend line and then comparing it with the trend line for the whole sample period. Decade and quarter wise analysis shows that the Phillips curve has not been stable and has witnessed a change in the slope and has also been shifted. Several possible reasons for such behavior discussed in the literature are globalization, productivity and supply shocks. Such graphical analysis helps to give a clearer picture of the empirical analysis by showing that the values obtained by empirical analysis might not be true for the whole sample period. Since only annual data was available, shortage of data points was a restriction in carrying out empirical analysis for the sub-samples.

A good prospect for future researches could be to dig deep into microeconomics to determine the exact causes that have made the Phillips curve shift and change its slope over time to have a better understanding of how external shocks can be shielded to protect the efficiency of the policies formulated.

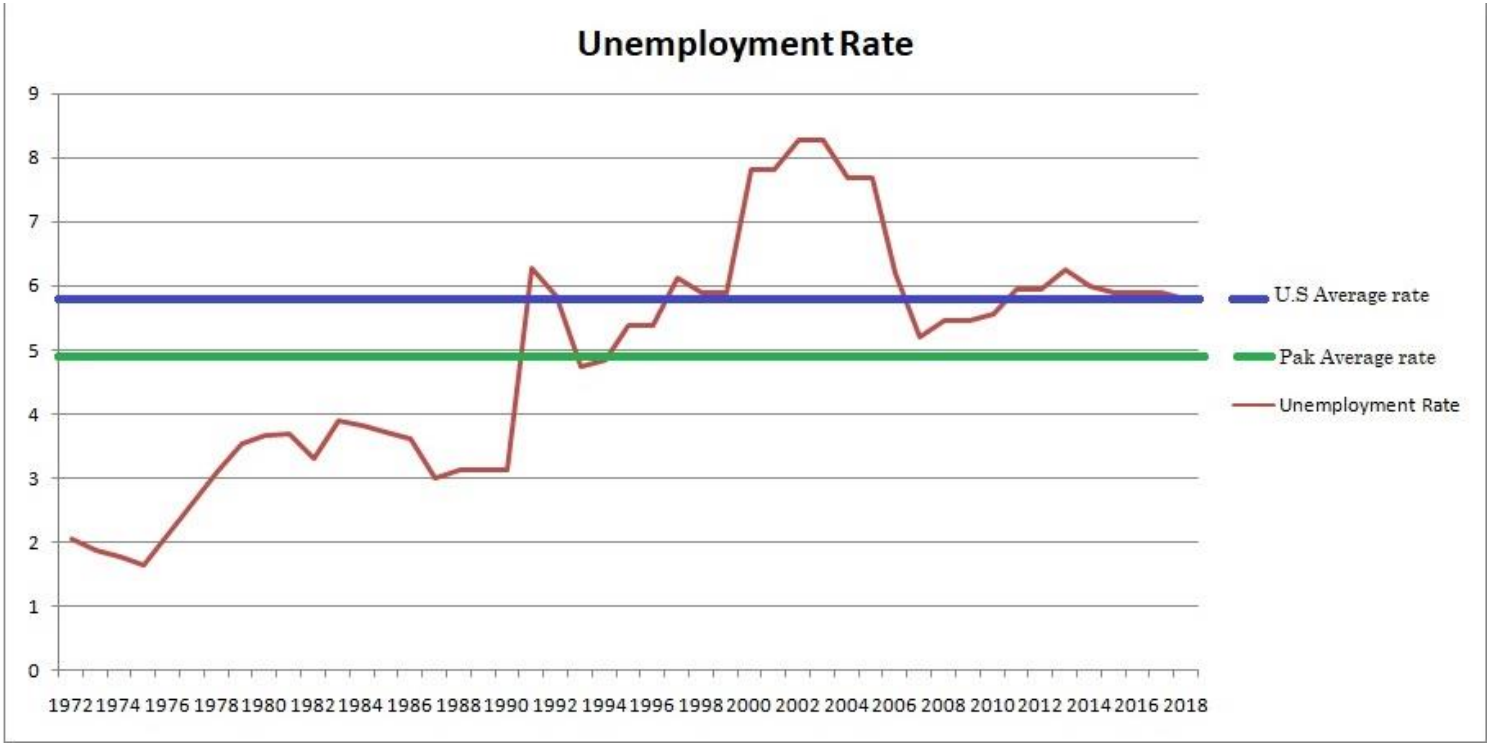
Furthermore, in order to get more robust estimates that can be used for efficient policy making it is pertinent for the authorities responsible for collecting and publishing data regarding

unemployment to carry out labor force surveys regularly so it is possible to have a better understanding of how well the economy is doing.

Appendix

Data for unemployment

Year	Data	Year	Data	Year	Data	Year	Data
1972	2.05	1985	3.73	1998	5.89	2011	5.95
1973	1.89	1986	3.63	1999	5.89	2012	5.95
1974	1.79	1987	3.01	2000	7.82	2013	6.24
1975	1.65	1988	3.13	2001	7.82	2014	6
1976	2.13	1989	3.13	2002	8.27	2015	5.9
1977	2.62	1990	3.13	2003	8.27	2016	
1978	3.11	1991	6.28	2004	7.69	2017	
1979	3.55	1992	5.85	2005	7.69	2018	5.8
1980	3.67	1993	4.73	2006	6.2		
1981	3.7	1994	4.84	2007	5.2		
1982	3.31	1995	5.37	2008	5.46		
1983	3.9	1996	5.37	2009	5.46		
1984	3.82	1997	6.12	2010	5.55		


Unemployment Rate
9
8
7
6
5
4
3
2
1
0
1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018
U.S Average rate
Pak Average rate
Unemployment Rate

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