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Exploring the Phillips Curve: Inflation and Unemployment Dynamics in Pakistan

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Using a strict analytical framework, this study investigates the dynamic link between inflation and several macroeconomic variables (unemployment, crude oil prices, and nominal exchange rate) in Pakistan from 1991 to 2019.Utilizing a diverse array of statistical methodologies, including unit root analysis, cointegration analysis, and dynamic ordinary least squares (DOLS), we assess the applicability of the Phillips Curve theory in predicting fluctuations in inflation. According to our findings, Pakistan exhibited a steady Phillips Curve over the study period, with all models demonstrating good tracking performance of changes in inflation. Furthermore, the CUSUM and CUSUMsq tests validate the stability of our estimates. This analysis contributes to our understanding of Pakistani inflation dynamics and has implications for economic policy in the nation.

1. Introduction

In the realm of economics, policymakers face the crucial task of balancing stable prices and promoting employment opportunities (Ayinde et al., 2021). These efforts are essential for fostering economic stability and societal advancement (Uralovich et al., 2023). Inflation and unemployment emerge as central challenges confronting policymakers worldwide (Audi & Ali, 2023). The delicate balance of maintaining low, single-digit inflation while aiming for an unemployment rate of around 5% is vital for promoting macroeconomic stability, economic growth, and overall development (Khan & Naushad, 2020). However, achieving this balance is often challenging, forcing policymakers to make difficult decisions between controlling inflation and ensuring full employment.

According to Rubbo (2023) "Networks, Phillips curves, and monetary policy" revisits the New Keynesian framework, theoretically and quantitatively, in an economy with multiple sectors and input-output linkages. Analytical expressions for the Phillips curve and welfare, derived as a function of primitives, show that the slope of all sectoral and aggregate Phillips curves is decreasing in intermediate input shares, while productivity fluctuations endogenously generate an inflation-output tradeoff—except when inflation is measured according to the novel divine coincidence index (Rubbo 2023). Consistent with the theory, the divine coincidence index provides a better fit in Phillips curve regressions than consumer prices. Monetary policy can no longer achieve the first-best, resulting in a welfare loss of 2.9% of per-period GDP under the constrained-optimal policy, which increases to 3.8% when targeting consumer inflation (Rubbo 2023). The constrained-optimal policy must tolerate relative price distortions across firms and sectors in order to stabilize the output gap, and it can be implemented via a Taylor rule that targets the divine coincidence index.

According to Hooper et al. (2020), Prospects for inflation in a high pressure economy: Is the Phillips curve dead or is it just hibernating?" reviews a substantial range of empirical evidence on whether the Phillips curve is dead, i.e. that its slope has flattened to zero. National data going back to the 1950s and 60s yield strong evidence of negative slopes and significant nonlinearity in those slopes, with slopes much steeper in tight labor markets than in easy labor markets. This evidence of both slope and nonlinearity weakens dramatically based on macro data since the 1980s for the price Phillips curve, but not the wage Phillips curve. However, the endogeneity of monetary policy and the lack of variation of the unemployment gap, which has few episodes of being substantially below zero in tis sample period, makes the price Phillips curve estimates from this period less reliable. At the same time, state level and MSA level data since the 1980s yield significant evidence of both negative slope and nonlinearity in the Phillips curve. The difference between national and city/state results in recent decades can be explained by the success that monetary policy has had in quelling inflation and anchoring inflation expectations since the 1980s. We also review the experience of the 1960s, the last time inflation expectations became unanchored, and observe both parallels and differences with today. Our analysis suggests that reports of the death of the Phillips curve may be greatly exaggerated.

For Pakistan, a developing economy, managing inflation and unemployment presents unique hurdles. The country has grappled with periods of both high inflation and unemployment

throughout its economic history, significantly impacting living standards and overall economic progress. Understanding the relationship between these economic indicators has been a subject of extensive research and debate, particularly concerning the Phillips Curve.

While Inflation and unemployment are said to be inversely correlated by the Phillips Curve, empirical evidence has provided mixed results. Some studies support this relationship, while others argue for a more nuanced and variable connection. Our research aims to enrich the current literature by investigating the association between inflation and unemployment in Pakistan from 1991 to 2019.

This research specifically aims to respond to the following questions:

- Is there evidence of a negative correlation between unemployment and inflation in Pakistan?
- Is there a firm trade-off between unemployment and inflation in the nation?
- If such a tradeoff exists, does it remain stable over time, or does it vary in response to changes in the macroeconomic environment?

To address these questions, advanced econometric techniques, including cointegration and DOLS methods, will be applied to analyze the Phillips Curve within the Pakistani context. By doing so, this study aims to provide reliable estimates of inflation-unemployment models and contribute valuable insights for policymakers, economists, and the academic community.

However, due to the limitations of current methods, obtaining these estimates is extremely challenging. The traditional assumptions of standard regression methods are frequently challenged by the non-stationarity of the economic variables used in the study, leading to inaccurate estimations. Further complicating the analysis is the potential endogeneity of regressors further complicates analysis, and small sample sizes amplify these issues, particularly in developing countries where statistical data is limited.

Despite these challenges, our study aims to overcome them by utilizing advanced modeling techniques to capture long-run or co-integrated relationships. By doing so, we aim to provide more accurate estimates of inflation and unemployment dynamics, especially in the context of developing economies like Pakistan. The findings of this study are expected to deepen our understanding of the challenges and tradeoffs involved in achieving macroeconomic stability in Pakistan, ultimately informing the development of more effective policy interventions.

2. Literature Review

A significant number of studies have explored the validity of the Philips curve in both developed and developing countries. During the late 1950s and the 1960s, many investigations scrutinized the relationship between inflation and unemployment across various nations, with the majority supporting an inverse correlation between these two variables. The policy implications of these findings were widely debated. Initially, the Philips curve appeared to offer policymakers a range of inflation and unemployment combinations from which they could select. In the 1960s, some economists argued that policymakers could maintain low

unemployment rates by tolerating modest levels of inflation. This belief gained support during a period when rising inflation coincided with declining unemployment. However, in subsequent decades, this negative relationship failed to hold (Abel and Bernanki, 2001).

Furuoka (2007) employed Johansen co-integration methods and Vector Error Correction Model (VECM) analysis to explore the relationship between unemployment levels and inflation rates in Malaysia spanning from 1973 to 2004. And highlights the Phillips curve significance for central banks in monetary policy they aim to stabilize prices by managing inflation but may prioritize low inflation rates over higher unemployment rates if there's an inverse relationship.The study revealed a negative long-term association between inflation and unemployment. Furthermore, the VECM outcomes suggested a short-term impact from unemployment to inflation, providing support for the existence of the Philips curve. In a separate investigation, Karanassou, Sala, & Snower (2008) analyzed the influence of US frictional growth on the interaction between inflation and unemployment using semi-annual data covering the period from 1960 to 2005. The results from generalized method of moments (GMM) and Structural vector autoregressions (SVAR) models collectively unveiled the principal factors affecting inflation and unemployment, emphasizing a significant interplay between the two variables in the long run.

Research on the correlation between unemployment and inflation has been extensive, but the debate surrounding the trade-off between inflation and unemployment remains a significant topic. Despite the US's low inflation and unemployment rates in the late 1990s, there is a lack of empirical analyses on the interaction between inflation and unemployment in developing countries, primarily focusing on developed nations. (Mankiw, 2001).

Hasan (1988) found a short-run Phillips curve in Pakistan from 1972-I to 1981-IV, indicating a trade-off between excess labor demand and inflationary expectations. Structural evidence suggests inertia in commodity prices due to labor market rigidities and long-term wage contracts. Laubach (2001) examined precise estimates of the Non-Accelerating Inflation Rate of Unemployment (NAIRU) for seven industrialized countries, finding that incorporating unemployment information in addition to inflation improved NAIRU estimates.

Mahmood et al. (2013) highlighted a unidirectional relationship, indicating that inflation influences unemployment in Pakistan, but not the other way around. Their findings underscored the necessity for policymakers in Pakistan to balance inflation, unemployment, and interest rates to buffer against economic shocks. Additionally, Zaman et al. (2011) utilized data from 35 years (1975-2009) to compute non-parametric estimates of the NAIRU. They identified a sustained causal link between inflation and unemployment over the long term, while the short-term connection was found to be transitory.

Haq et al. (2012) study on Pakistan's long-term relationship between unemployment and inflation from 1974 to 2010 found a positive correlation in both long and short terms, using the Johansen co-integration test and VECM. Afzal & Awais (2012) found empirical evidence supporting the existence of the Philips curve in Pakistan, highlighting the trade-off between inflation and unemployment. Ahmed (2020) conducted a study on the relationship between

inflation and unemployment in Pakistan, concluding that the Phillips curve exists, with empirical evidence supporting its existence in both short and long run. Empirical research on the trade-off between inflation and unemployment has yielded mixed results, with the relationship varying across different economies. The Philips curve hypothesis is still under discussion, and policymakers may worry about short-term effects of price stabilization policies on unemployment. However, the long-term unemployment rate is expected to stabilize around equilibrium, allowing policymakers to formulate monetary policies without considering adverse effects.

This study aims to address the lack of applied research on the Philips curve hypothesis in developing countries, where it is often primarily focused on developed nations. The findings could help policymakers formulate more effective policies for price stability and full employment in Pakistan. The study also aims to empirically re-examine the theoretical interactions between inflation and unemployment in Pakistan.

3. Data and Methodology

This research employs annual data on inflation, unemployment, crude oil prices, and nominal exchange rates. The data for inflation and unemployment are sourced from the World Development Indicators (WDI). The term "inflation" describes the gradual shift in the average price level. The unemployment rate is a measure of the percentage of people who are unemployed out of the total number of people in the workforce. It's important to note that this definition only includes individuals actively seeking employment. According to the International Labour Organization (ILO) definition, individuals who have not actively searched for a job during the specified period are not considered unemployed. The time series data spans from 1991 to 2019, encompassing 29 observations per variable. This comprehensive dataset allows for a thorough analysis of the dynamic relationships between these key economic indicators over the specified period.

3.1 Research Methodology

Extensive theoretical and empirical studies have been done on the Phillips curve. However, over time, modifications and extensions have been made to the original Phillips curve model to account for various factors and dynamics in the economy. The current research examines the connection between inflation and unemployment by estimating the Phillips curve, Expectation-Augmented Phillips curve and The Triangle model for Phillips curve.

3.2 Phillips Curve

The Phillips curve is an economic theory formulated by A. W. Phillips, which states a consistent and inverse correlation exists between inflation and unemployment.

$$\pi_t = \alpha - \beta u_t + \varepsilon_t \quad \ldots(1)$$

The equation represents the relationship between the inflation rate (π_t), the unemployment rate (u_t), positive constants (α and β), and the error term (ε_t).

3.3 Expectation-Augmented Phillips Curve

The Expectation-Augmented Phillips Curve (EAPC) can be mathematically represented in the following format:

$$\pi_t = \pi_t^e + \beta_2(U_t - U_{NR}) + \varepsilon_t \quad , \beta_2 < 0 \quad \ldots(2)$$

Since π_t^e is not directly observable, a simplifying assumption is made that $\pi_t^e = \pi_{t-1}$ implying that the expected inflation rate for the current year is equal to the inflation rate that prevailed in the previous year.

In this model, π_t represents the actual inflation rate at time t, indicates π_t^e the expected inflation rate at time t, U_t denotes the current unemployment rate at time t, U_{NR} stands for the natural rate of unemployment at time t, and $\varepsilon_t$refers to the stochastic error term.

After making this assumption, equation EAPC can be written as:

$$\pi_t = \pi_{t-1} + \beta_2(U_t - U_{NR}) + \varepsilon_t \qquad , \beta_2 < 0$$

To estimate U_{NR}, the model can be transformed to be:

$$\pi_t - \pi_{t-1} = \beta_1 + \beta_2 U_t + \varepsilon_t \qquad \ldots (2.1)$$

Where $\beta_1 = -\beta_2 U_{NR}$ which means that $U_{NR} = -\beta_1/\beta_2$. The expected signs of the parameters are: $\beta_1 > 0$, $\beta_2 < 0$ and U_{NR} is positive because of an inverse relationship between inflation and unemployment.

This work intends to thoroughly examine the inflation-unemployment trade-off and investigate how various factors and assumptions affect this connection through the estimation of these three models.

3.4 The Triangle Model for Phillips Curve

According to Gordon's (1988) triangle model, supply shocks, the output gap, and inertia—a lagged inflation—are the three factors that determine inflation. The model is expressed as follows.

$$\pi_t = \pi_{t-1} + \beta_1(U_t - U_{NR}) + \beta_2 oil_t + \beta_3 s_t + \varepsilon_t \qquad \ldots (3)$$

Here, π_t represents the inflation rate in effect at time t, and π_{t-1} The rate of inflation at time t-1, U_t - U_{NR}: It's the gap. ε_t : The stochastic error term, s_t: the nominal exchange rate, and oil_t: the price of crude oil.

An essential prerequisite for conducting time series analysis is understanding the potential issues that may arise during the estimation process. Ignoring certain rules can lead to spurious regressions, undermining the validity of the analysis.

The cointegration modeling technique is the estimating methodology used in this work. The procedure involves three primary steps: firstly, conducting unit root tests; secondly, performing cointegration tests; and thirdly, estimating the Dynamic OLS model.

3.5 Unit Root Test

Each time series under consideration is first evaluated for its stationarity properties using the econometric methodology. The Augmented Dickey-Fuller (ADF) unit root test is used in this study to determine whether the data series is stationary. Either an intercept or a linear

time trend can be integrated into the ADF test regression. Each of the three test regression variables listed below are taken into consideration in this ADF test implementation.

$$\Delta x_t = A + Bt + \varphi x_{t-1} + \sum_{j=1}^{n} \theta_j \Delta x_{t-j} + u_i$$

$$\Delta x_t = A + \varphi x_{t-1} + \sum_{j=1}^{n} \theta_j \Delta x_{t-j} + u_i$$

$$\Delta x_t = \varphi x_{t-1} + \sum_{j=1}^{n} \theta_j \Delta x_{t-j} + u_i$$

A unit root test is conducted on the regression coefficient of x_{t-1} in the ADF process. If the coefficient differs sufficiently from zero, stationarity is indicated, and the hypothesis that x_t has a unit root is rejected. In our analysis, we use cointegration analysis to investigate any long-term correlations among the variables in addition to evaluating the stationarity of each one individually. In this sense, the Augmented Dickey-Fuller (ADF) test is essential. It does this by looking for a unit root in the time series data of the variables to see if they show signs of stationarity. If stationarity is confirmed by the ADF test, it indicates that the variables are integrated of order zero. I(0). On the other hand, we continue differencing until the series becomes stationary if stationarity is not attained. This procedure is enhanced by cointegration analysis, which finds any enduring connections between the variables and offers insightful information about their dynamics over time.

3.6 Cointegration Analysis

It can be observed from a detailed analysis of the time series data that non-stationary behavior is displayed by variables including nominal exchange rates, unemployment, inflation, and crude oil prices. There is a considerable chance of spurious regression due to this non-stationarity. However, the Augmented Dickey-Fuller (ADF) test indicates that after differencing the variables, they show stationarity at the 5% significance level, indicating that they are integrated of order one (I(1)). Once unit roots are determined, the attention turns to cointegration analysis, which is essential for reducing the possibility of inappropriate regression.

3.6.1 Engle-Granger Test

One of the most important instruments for identifying cointegration is the Engle-Granger test. It entails creating residuals using a static regression model and then utilizing tests such as the Augmented Dickey-Fuller test to determine whether unit roots are present in these residuals. The time series may be cointegrated if the residuals show signs of near-stationarity.

3.6.2 The Stock Watson Dynamic Ols (Dols) Approach

Introduced by Stock and Watson in 1993, the Dynamic Ordinary Least Squares (DOLS) method provides an efficient alternative to more conventional methods such as maximum likelihood estimation and OLS. When there are dynamic sources of bias and limited sample sizes, this strategy is especially beneficial. Because DOLS uses a single-equation framework, unlike some other methods, it is resistant to mistakes with serial correlation and regressor endogeneity. To account for endogeneity concerns, DOLS incorporates leads and lags of first differences of regressors. To handle serial correlation, it applies a generalized least squares (GLS) approach. It is also a flexible tool for econometric analysis, sharing asymptotic optimality qualities with the Johansen distribution.

4. Empirical Analysis

4.1 The Result of Unit Root

We used the conventional econometrics approach, the Augmented Dickey-Fuller Test, to determine whether unit roots were present. We found that the variables have the same order of integration by taking a logarithmic form for the variables and examining their stationarity. Cointegration tests should be used to further investigate the possibility of a long-term link between the variables, as suggested by the stationary behavior at the first difference.

Table No 1: ADF Test for Unit Root: Analysis of Annual Data (1991-2019)

Variables		Constant	Trend	t-value	Critical Values	Result
Inflation	π_t	C	-	-2.15	-3.69	Unit root
	$\Delta\pi_t$	-	-	-5.17	-2.65	No Unit root
Unemployment	u_t	C	T	-0.10	-2.65	Unit root
	Δu_t	-	-	-4.75	-2.65	No Unit root
Crude Oil Price	$coil_t$	C	T	-1.92	-4.32	Unit root
	$\Delta coil_t$	-	-	-5.83	-2.65	No Unit root

Nominal Exchange Rate	s_t	C	T	-2.17	-4.32	Unit root
	Δst	-	-	-2.39	-1.95	No Unit root

The null hypothesis regarding the unit root of all time series is rejected when taking into account their first differences, as shown by Table 1's absolute values of the ADF t-statistics exceeding the critical values. As a result, the variables exhibit stationarity and share the same order of integration, I(1).

4.2 Ols Estimation of Phillips Curve

$$\pi_t = 1.97 - 0.25u_t \qquad (1.1)$$

$$(0.00)* \quad (0.05)**$$

The symbols *, **, and *** signify significance at the 1%, 5%, and 10% levels, respectively.

After estimating the Phillips curve using OLS, the regression residuals are subjected to the ADF test. Table 2 displays the results of the ADF test on the equation's residuals.

Table 2: ADF Test for Unit Root: Analysis of Annual Data (1991-2019)

Variables	Constant	Trend	t-value	Critical Values	Result
$\boldsymbol{\varepsilon_t}$	-	-	-2.04	-1.95	No Unit root

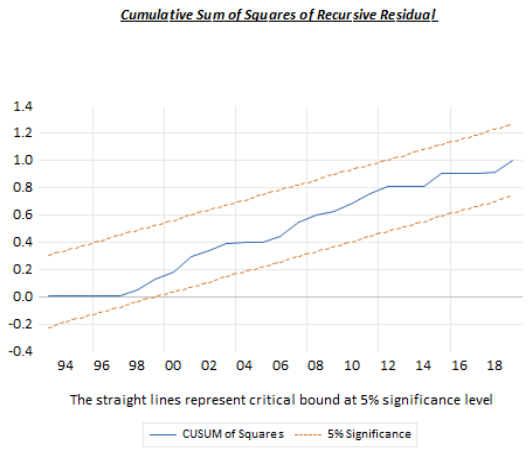
As predicted by theory, there is a negative association between unemployment and inflation since $\boldsymbol{\varepsilon_t}$ is stationary. Direct interpretation of the constants becomes difficult because of the logarithmic modification of the variables during estimate. In the absence of unemployment, it is commonly believed that inflation stays constant at 5.86% upon transformation back. On the other hand, since unemployment may be seen as elasticity directly, no such transformation is required. Inflation rises by 0.25 percent for every 1% fall in unemployment (U_t). But this simply captures the dynamics of inflation; it doesn't shed light on how inflation affects unemployment rates, as the Phillips curve suggests.

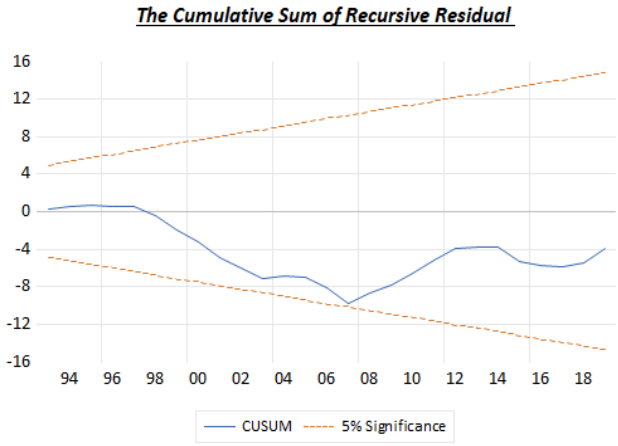
4.3 Diagnostic Test

The rapid structural changes in the economy make it necessary to evaluate the stability of the model. Regression findings may be difficult to interpret if the model is unstable. Cumulative Sum of Recursive Residual and Cumulative Sum of Squares of Recursive Residual tests are used to assess stability. The null hypothesis of model stability is rejected if these tests show deviation above the critical lines of the 5% significance level. The outcomes of these

experiments are shown in Figures 1 and 2, which demonstrate that the Phillips curve equation remained stable for the investigation.

Graph No 1: Structural Changes in The Economy





4.4 Results Dols Estimation of Phillips Curve

$$\pi_t = 1.8 - 0.46\, u_t \qquad (2.1)$$
$$(0.00)* \quad (0.05)**$$

To account for the effects of shocks, we first estimate the natural rate of unemployment (U_{NR}). Then, we include three event dummy factors (d_{1998}, d_{2004}, and d_{2015}) as exogenous variables. The estimated equation for regression is obtained by deriving the U_{NR} from the regression described in equation (2.1).

$$\pi_t - \pi_{t-1} = 0.12 + 0.18U_t - 0.64d_{98} + 0.95d_{04} - 1.36d_{015} \qquad (2.2)$$
$$(0.07)** \quad (0.00)* \quad (0.00)* \quad (0.003)* \quad (0.00)**$$

This implies that $U_{NR} = -0.18/(-0.93) = 5.1$

Consequently, UG is computed as ($U_t - U_{NR}$). Subsequently, the stationarity of the UG variable is assessed using the ADF Unit root test. The outcomes of the ADF test are presented in

Table No 3: ADF Unit Root Test

Variables		Constant	Trend	t-value	Critical Values	Result
Unemployment gap	UG	-	T	-1.23	-1.95	Unit root
	ΔUG	-	-	-4.75	-3.58	No Unit root

The test results indicate that the UG series is non-stationary at the initial level, but stationary after taking the difference. Subsequently, we proceed to estimate equation (2).

$$\pi_t - \pi_{t-1} = 0.000746UG$$

(0.98)

There is minimal significance in the UG coefficient. This suggests that the relationship between π_t and UG is not statistically significant.

4.5 Estimation Triangle Model for Inflation

$$\pi_t = 3.67 + 0.004u_t + 0.80oil_t - 1.13s_t \quad \text{---(3.1)}$$

$$(0.00)* \quad (0.93) \quad (0.00)* \quad (0.003)*$$

Analyze equation 3.1 to see how oil prices affect inflation rates positively while nominal exchange rates have a negative impact. The expected sign of nominal exchange rate is positive, but it has a negative influence and possible reason of negative impact of exchange rate is that it is managed floating, which means it is partially controlled in this regime. All coefficients except unemployment rate in the Triangle model are significant.

5. Conclusion

Our goal in this research investigation is to investigate the relationship between unemployment and inflation in Pakistan. Employing a methodological framework comprising cointegration analysis and Dynamic OLS, we analyzed annual observations spanning from 1991 to 2019. Our empirical findings confirm the presence of a Phillips curve phenomenon within Pakistan, shedding light on the dynamics between inflation and unemployment in the country.

By ADF Tests, we established that inflation, unemployment, and other shock variables are integrated in the first order. Further examination, including the Engle-Granger test, revealed a significant relationship between inflation and unemployment, affirming the relevance of the Phillips curve framework in our analysis.

Interestingly, our study found no evidence supporting the estimation of an inflation-output trade-off using the EAPC model or output gap estimate by OLS. Additionally, the application of the triangle model of inflation elucidated the relationship between inflation and two supply shocks, namely oil and nominal exchange rate.

These findings carry important implications for policymakers, suggesting that monetary policy can effectively address inflationary pressures without detrimental effects on unemployment rates. However, our study also underscores the need for further empirical research in this area to provide comprehensive guidance for economic policy designers and managers. In conclusion, our study contributes to the understanding of macroeconomic dynamics in Pakistan and highlights avenues for future research to explore the intricate relationship between inflation and unemployment in greater depth.

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