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DOES THE PHILLIPS CURVE EXIST? TRADE-OFF BETWEEN INFLATION AND UNEMPLOYMENT IN BANGLADESH

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Abstract

Two momentous economic indicators, namely unemployment and inflation rate, have performed a major preamble in the case of sustainable development. This exploration tries to investigate the subsistence of the Phillips Curve (PC) in the economy of Bangladesh. A sample of 30 years over the period of 1995-2024 was analyzed for conclusion. For testing unit root, The Augmented Dickey-Fuller (ADF) test is administered and found a mixed result. The ARDL (long run & short run test) bound test is applied for checking whether the long run along with the short run relationships remain or not. The ARDL ECM (error correction model) is also administrated to check the short run adjustment to the long run parity. Alongside this, the Wald test is administrated for checking the joint significance of the model. The tests of normality, serial correlation, heteroskedasticity, and stability are applied for the model specification, validity & durability. In every calculation, five percent level of significance has been applied. This study has revealed that the short run PC exists in Bangladesh at lag 2. In the long run, the ARDL test has found a negative but insignificant relationship. In a nutshell, it can be said that only a short run Phillips curve exists in the economy of Bangladesh. So, in the long run, the strategy of reducing unemployment at the cost of high inflation will not sustain.

Keywords: ARDL, Bangladesh, ECM, inflation, Phillips Curve, unemployment.

1. Introduction

INF (Inflation) and UNP (unemployment) are two momentous economic indicators for any country. The main target of a region is to have economic outgrowth with a natural rate of unemployment. There are many sectors, like the goods and service sector, the financial sector, the foreign trade sector and the labor market sector are influenced by the rate of UNP and INF in any country. Changes in monetary policies often influence the real condition of a country as a trade-off relationship between inflation and real unemployment via the classical PC (Phillips Curve). The Phillips

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curve is an economic theory positing an inverse relationship between inflation and unemployment, proposing that economic growth leads to inflation, which in turn reduces unemployment. This theory, introduced by economist William Phillips, was initially influential in shaping monetary policy.

Bangladesh is a small developing country. The economy of Bangladesh is one of the major economies of South Asia. Despite many problems, the economy of Bangladesh is called the second-largest economy in South Asia. Besides, the economy of Bangladesh has achieved 36th position in the world's largest economy in nominal terms, and 26th largest position in purchasing power parity. The economy of Bangladesh consists of a situations like price instability, budget deficit, government debt, rising poverty rate, political issues, corruption, capital shortages, a large population, natural calamities and underdeveloped infrastructure, etc. These factors influenced the liable authority of Bangladesh to think about steps out of the box, like open-up its economy, providing high duty on luxury product imports, controlling public debt, meeting the budget deficit through international and national loans, boosting Foreign Direct Investment, increasing loans from the IMF ($4.5 billion in July 2022) and increase privatization so that the mobility of the economy can continue. For this reason, increasing trends of inflation rate and of unemployment rate are main macroeconomic factors for Bangladesh as it is a developing country.

Today, the overall economy of that country faces the problems of declining the demand for exporting ready-made garments (RMG) products, share market degeneration, a collapse in remittances, raising questions about the liquidity in the banking industry and as consequences an increasing unemployment. Along with those vital problems, there exists inflationary pressure on the domestic economy. In such situation, if Bangladesh gets an exact result of the Phillips Curve, it will be able to focus on either unemployment or inflation that it should control first. The intention of the present paper is to examine the contemporaneous relationship between the INF and the UNP in the economy of Bangladesh from 1995 to 2024. To achieve this target, the following questions should be answered.

- Does the PC (Phillips Curve) exist in Bangladesh?
- Is there a negative relationship between the INF and the UNP rate for the short period of time (run) in Bangladesh?
- Is there a permanent trade-off relationship between the INF and the UNP rate for the long period of time (run) in Bangladesh?

In the next section, we will review the available literature along with theoretical framework, research gaps and important research hypothesis and questions. After that (3rd section) we have defined the data set and the related methodology that is needed to run the analysis. In the 4th section, we will briefly explain the result of the analysis. Finally, the findings and conclusions of the analysis is explained in the last chapter.

2. Literature Review

The larger the economy's INF rate, the smaller the UNP rate, and vice versa that is the main statement of the Phillips curve. Several studies have been conducted on this topic.

2.1 Theoretical framework

Unemployment and inflation are the most important topics for macroeconomics. In the year of 1958, William Phillips, an economist from New Zealand, argued that there existed an opposite concern between UNP and INF rate in the United Kingdom (UK). He completed & published as "The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom 1861-1957" in 1958. According to William Phillips, there is a dynamic trade-off concern between the UNP and INF in the specified country during the time roofed in his analysis. This negative concern selected by Phillips, is widely known as the PC (Phillips Curve). An important issue is that in 1920, another famous economist, Irving Fisher, had stated this result. William Phillips described the behavior of monetary wages in his study. According to his theory of an economy, there must exist an opposite concern between the selected variables, which means if the UNP rate rises, it must be the cause of the reduction of inflation rate.

In the year 1970, it was argued that the PC had broken down. In that period, stagflation, both unemployment and inflation rising. The result of stagflation as well as the breakdown of the Phillips curve made a new direction to investigate the topics of those exceptions in the concern between UNP and INF. This positive relationship has also been proved by many economists. (Friedman M. , 1968), (Lucas, 1972) did not find a stable and opposite relationship between the present UNP rate and future INF rate. Without it, some economists, Leijonhufvud (1968) and Brinner (1977), have investigated this type of relationship. They stated that the trade-off PC was not alive in industrialized and high-income countries. A well-known researcher, (Friedman M. , 1968) also further added that the PC might not be static in the long run. He showed his argument that the relationship isn't permanent and accidental. On the contrary, (Fuhrer & Moore, 1995) found the opposite explanation that the PC was alive and works well in the UK (United Kingdom). Malinov and Sommers (1997) also made a case that this opposite relationship or that the Phillips curve was not null and void as well as stable for most of the OECD countries. So, it makes an issue whether the Phillips curve really exists in a different country or not.

2.2 Recently completed previous work

The panel data from the Baltic States, Lithuania, Estonia and Latvia (Masso & Staehr, 2005) shows that total UNP rates have a very simple influence on increasing inflationary influences. They want to link the variables of excess capacity and inflation. They show that the labor market in the Baltic States is casual and fragmented. They used analysis tools separately for some states, but it is difficult, it can even be said that it is impossible to check the Phillips curves for each Baltic country differently. Reasons behind the problem are that the small sample and rumbustious data set indicate that most of the segments are inexactly selected. They use unit root test & GMM method as analysis tools and all methods provide a negative relationship. On the other hand, (Arratibel, Diego, & Christian, 2002) analyzed the New KPC (Keynesian Phillips curve) by using panel data of a set of data including the Baltic States, CEE5 and Southeast Europe. They found that the UNP rates ensure a significant association with INF rates by using the Balassa Samuelson Effect. The analysis used EU (European Union) countries like Europe, Central & Eastern, to conclude the relationship by using the data from 1990-2001.

(Furuoka, 2007) showed that there may exist a co-integrating relationship – as well as an abrupt concern - between INF rates and UNP rates. The report used VECM (Vector Error Correction Model) test to check the presence of the PC in Malaysia. The research also used AIC (Akaike Information Criterion), unit root test, Johansen co-integration test, and Granger causality tests. Their analysis proved that the PC exists in the long as well as in the short run in Malaysian economy. In Malaysian economy (TANG, 2007) also provides the evidence that the PC existed in the long as well as in the short run from 1970-2005 using the variables like INF rate, output gap, UNP rate, and M1 (money supply). They use different statistical models, like the KPSS stationary test, the Engle-Granger test, bivariate and multivariate models like CUSUM and CUSUM of Squares stability tests. The presence of a co-integration and etiological concern between INF and UNP, are proved and concluded that the PC exists in the Malaysian economy.

(Karahan, Çolak, & Bölükbaşı, 2012), examine the correlation between UNP and INF in Turkey. The ARDL model found the Phillips curve for the period of short run only but there is no result for the period of long run. In this study, the authors conduct the ARDL co-integration and bound test. This result provides an insignificant long-run association and a significant short-run negative relationship.

In the EU (European Union) and Romania, (Cioran, 2014) found the presence of the PC. This study uses the ADF unit root test, the Breusch-Pagan-Godfrey test, the Jarque-Bera test, the error mismatch hypothesis. Another research (Ormerod, B. Rosewell , & P. Phelps, 2013) try to find out existence of PC in the US (United States), Germany and the UK (United Kingdom) by using statistical techniques for the period of 1871-2009 and found that the opposite direction between UNP and INF is entirely lost that means Phillips Curves wasn't linked in the short run.

(Hongo, Fanglin Li, & Ssal, 2019) found existence of PC in Keniya using data from 2006 to 2016. They used many econometric tools, like the unit root test, the 2-SLS regression, diagnostic checks etc. to conclude the result. In the meantime, (Bhattarai, 2016) found the long-term and negative concern between INF rate and UNP rate in OECD countries. (Selvaraj, 2020) tried to find out the presence of PC in Canada and Belgium and concluded that no PC in those countries. They used 1975-2019 data for those developed countries.

(Alisa, 2015) had not found any prove of the presence of the PC in the long run but found existence of the PC in the short run in Russia. Employing non-linear least squares estimates. (VICTOR, FARKAS , & JEESON , 2018) studied the probability of the presence of PC, a negative concern between UNP and INF rates, in Hungary. By analyzing the data set from 1999–2017, the study concluded that a negative concern between the selected variables. ADF Unit Root Test, Johansen co-integration test result, VECM (Vector error correction model), Breusch-Pagan test, Durbin Watson test were applied for conclusion. This report states that a strong long run as well as short run PC exists in Hungary.

In the Jordanian economy (Al-zeaud & Al-hosban, 2015), there was an existence of the PC that had a strong negative relationship over the time frame of 1976-2013. This trade-off states that the authorities or government can focus on either low UNP or low INF, but not both. The analysis runs unit root tests, co-integration tests, VECM,

and linear and non-linear ordinary least square regression tests, Model Efficiency Tests like Normality Test, Heteroscedasticity Test & Autocorrelation Test. All those results ensure the existence of the PC.

In Turkey (NAR, 2021), the PC is still subsistent for the time frame from 1980-2019. This research found an opposite relationship by using the unemployment ratio (15+ age group) and inflation rate (consumer price index). The result, like an ongoing condition of INF by 1% can make pressure to the UNP to reduce by 0.028%. The research used a famous econometric model of the ADF unit root test, Zivot-Andrews unit root test (to check the ADF's result) and the Engle-Granger co-integration test. At the 10% significance level, this report provides a negative relationship between the variables. Use of those tools ensure the subsistence of PC in Turkey.

2.3 Previous works of the neighbor countries of Bangladesh

As this study wishes to conduct the analysis in Bangladesh, now it would like to focus on some previous work of neighboring countries. (Dua & Gaur, 20010) Found the PC for selected Asian countries by using 3 months data (1990s to 2005) for both forward-looking & backward-looking where the previous one's PC is better appropriate rather than backward-looking.

(Thiruneelakandan & Ullamudaiyar, 2018) found the presence of a Phillips Curve in India. To get this result, they used (2009-2017) data and found negative relationship between inflation and unemployment. (Behera, Wahi, & Kapur, 2018) suggested that both core INF and general INF proved a traditional PC. (Singh, A. Kanakaraj, & Sridevi, 2011) very beginning 3 month of 2004 to beginning 3 month of 2009 showed that PC exists in India. The researcher used quarterly data (1997-2010), conducting analysis by dividing the time period into two parts, where they focused on the association between INF & the gap of the output (a proxy of the unemployment rate). Some new models like the State Space Model (SMM), the HP method and the KALMAN method have been conducted for conclusion.

For the time period of 1991-2015 (25 years), an opposite relationship between INF rate and UNP rate existed in Pakistan (Mangnejo, Mahar, & Ahmed, 2020). The researchers used the ADF unit root test and found stationary data at 1st difference. After that, they estimated the Granger Causality Test. On the other hand, (Haq, Khan, Khan, & Ahmed, 2012) found the positive relationship in lieu of the Phillips curve. The data of Pakistan from 1974 to 2010 was analyzed and found positive relationships.

The PC was thriving in Malaysia only for the long period of time from 1991 to 2018 (Naqibullah, Rahmatullah, l Zmarai, Safiullah, & Ahad, 2020). In this report, analysts used the ADF (Augmented Dickey-Fuller) test, and the PP (Phillips-Perron) unit root test and found mixed results, called I (0) and I (1). After that, they used the ARDL Co-integration Bound Test, the Granger Causality ECT, the Short-term Bivariate Model, the WALD Test, the Multivariate Models, the Breusch-Godfrey Serial Correlation LM Test, the ARCH test, the CUSUM and CUSUM of square tests for concluding their opinion. They ensured that the short-term existence of the PC didn't exist in Malaysia.

An analysis shows (Illukkumbura & Peiris, 2021) the concern between the UNP rate and INF rate for the period of (1991-2000) in Sri Lanka. By using the ADF and the PP unit root tests, the Vector Autoregressive Model, the Johansen Co-integration Test, the Serial Correlation LM test, the Normality test, Granger Causality test, they found a strong positive relationship between the variables, which isn't supported by the Phillips Curve. On the other hand, it supports the Lucas Critique which portrays increasing the supply of money does not eventually end up in a fall in the UNP. Another research proved the result of the Phillips curve in Sri Lanka (Selvanayagam & . Mustafa, 2019).

2.4 Study on Bangladesh Context and the Research Gap

According to (Hassan, 2012), there is evidence of the Phillips curve in Bangladesh. The conclusion of this analysis ensures that the relationship between the variables is true only for a long period of time. For conclusion, he used the output gap, Annual GDP series, the exchange rate (nominal), import price index, unemployment rate as dependent variables and used only the unit root test & Johansen Jusilius Co-integration Test. This result also showed inflation is not caused by cost-push inflationary pressure in Bangladesh. There was an existence of significant long run, opposite relationship between INF and economic growth by (Ahmed & Mortaza, 2005). Meanwhile, (Rasna & Enam, 2010) analyzed the PC's probability to stay in Bangladesh for the period of 1996-2010 (only 14 years). This research used the Johansen multivariate model to check the co-integration and found no association like that, which indicates no long-run relationship between the variables.

From the above discussion, it can be said that the existence of Phillips curve in Bangladesh has not been tested using 30 years data from the year 1995 to 2024 with ARDL cointegration approach before. After finding this research gap, we decided to move ahead to explore the existence of PC with the dataset and econometric tests.

3. Data & Methodology

3.1 Data

This paper has covered the data set from the period of 1992 to that are collected from the secondary source (World Bank database).

Table 3.1: Data

Variables	Symbol	Revised data	Time frequency	Time period
Inflation Rate	INF_t	$LINF_t$	Annual	1995-2024
Unemployment Rate	UNP_t	$LUNP_t$	Annual	1995-2024

3.2 Unemployment Rate (UNP) and Inflation Rate (INF)

The UNP, rate can be measured as the portion of the, labor force without employment. It is an economic exponent that can rise or fall in the temptation of transforming the economic environment. When the economy is in dull conditions and sectors of work are limited, the UNP, rate can, be awaited to rise. For 2021, an unemployment rate of 5.23% was calculated. From 1995 to 2005, the unemployment rate provided an upward sloping trend. There was also an upward trend from 2006 to

2009 after a downward slope in 2006. 2010-2019 has a trend of fluctuation. But in 2020 & 2021, Bangladesh experienced a massive increase in the unemployment rate due to Covid 19 pandemic which was decreased after that.

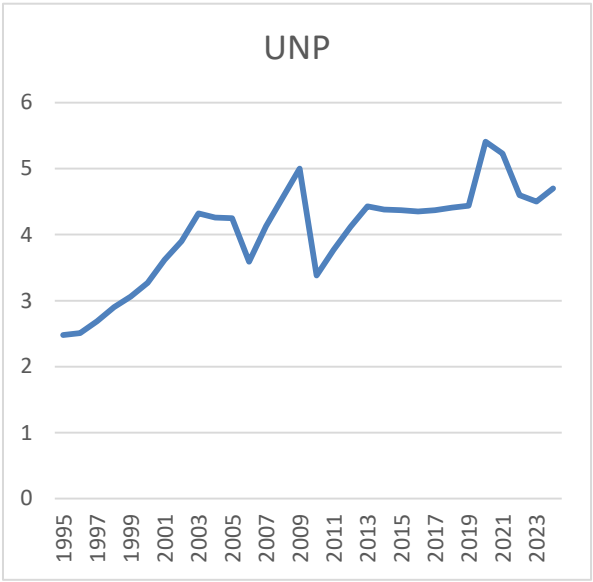


Figure 3.1 Time series of UNP

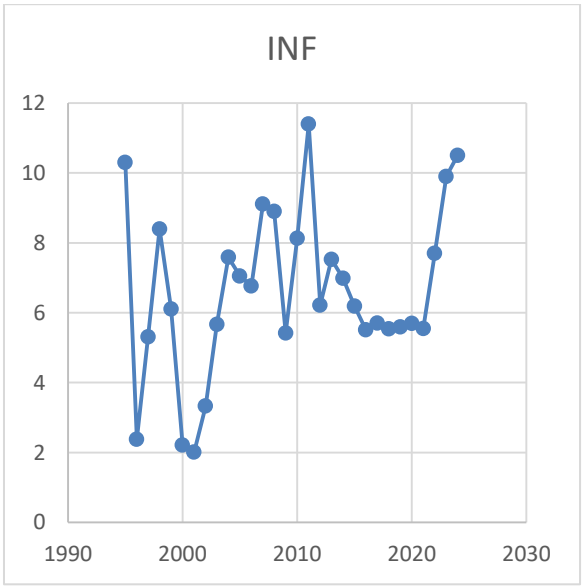


Figure 3.2 Time series INF

The CPI (consumer, price index) which depicts the typical variations in the cost of acquiring goods and services ca be utilized for determining inflation. It can be fluctuated gradually or in mixed intervals. Throughout the span of 30 years, the INF rate has varied between 2.0% and 11.4%. Bangladesh experienced different

variations of inflation rates in different years. But after 2016, there is a trend regarding the fluctuation of inflation rates. After 1995 (10.30%), it got a further double digit inflation rate in 2011(11.40%).

Now the data of both dependent and independent variables are transferred into the logarithm by following equation:

$$LUNP = \ln(UNP) = \ln\left(1 + \frac{UNP}{100}\right) \quad (3.2.1)$$

$$LINF = \ln(INF) = \ln\left(1 + \frac{INF}{100}\right) \quad (3.2.2)$$

We converted the data into logarithmic form to stabilize the variance. A log transform pulls high-value outliers closer to the rest of the data which is often used in statistical models.

From equation 3.2.1 & 3.2.2 the time series data are showed in following graph:

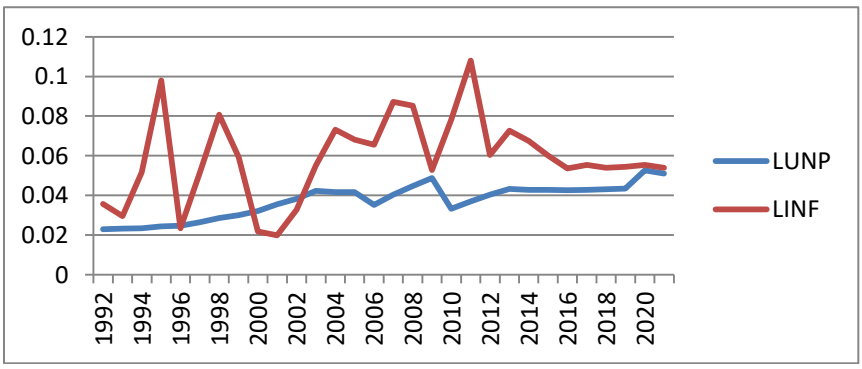


Figure 3.3 Time series of LUNP & LINF

3.3 Methodological Framework

The natural Phillips curve is calculated using the following equation:

$$UNP_t = \beta_0 + \beta_1 INF_t + \varepsilon_t \quad (3.3.1)$$

Here, the previous equation is re-embodied and designated so that the analysis can run purposely:

$$LUNP_t = \beta_0 + \beta_1 LINF_t + \varepsilon_t \quad (3.3.2)$$

where,

β_0 is constant (intercept coefficient), β_1 is slope coefficient, $LINF_t$ is inflation rate of Bangladesh at time t, $LUNP_t$ is unemployment rate of Bangladesh at time t, ε_t is error term at time t.

According to the equations, the following hypotheses are established for this analysis:

H_0: There exists no Phillips Curve in Bangladesh.

H_1: There exists Phillips Curve in Bangladesh.

Based on those hypotheses we have selected some econometric model and tried to make conclusion. In order, to assess the existence of the PC, we must apply certain

methods to check for the stationarity of data. The most commonly used method in literature is the Augmented Dickey-Fuller (ADF) unit root test (Dickey & Fuller, 1981). The ADF unit root test is estimated by using the following equation:

$$\Delta LINF_t = \mu + \beta_{t-1}t + \sum_{i-1}^{n} \gamma i \Delta LINF_{t-i} + \varepsilon_t \quad (3.3.3)$$

Where,

t = time trend, Δ = difference, operator, β, γ are the slope, coefficients.

After finding the stationary of data, the study needs to select an appropriate model for co-integration. The null hypothesis is:-

H_0: The variable's unit root is known.

H_1: The variable's unit root is not known.

If the series contain with different order, i.e. I(0) and I(1) of stationary, then a co-integration bound test is essential to find a long run relationship (Pesaran, Shin, & Smith, 2001). For checking the trade-off relationship, the ARDL bound, test approach of co-integration is used. The first part of this test is to make an unrestricted error correction model (UECM). In the second part, ARDL models are used to find a long-run and short-run relationship. UECM is estimated by the following equation:

$$\Delta LUNP_t = \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta LUNP_{t-1} + \sum_{i=0}^{n} \theta_i \Delta LINF_{t-1} + \mu_1 UNP_{t-1} + \mu_2 LINF_{t-1} + \varepsilon_t \quad (3.3.4)$$

Where,

β, θ narrates the short-term, coefficients

μ narrates the long-term dynamics

For solving the equation, the hypothesis of the Bound Test:

H_o: There is no co-integration.

H_1: There is co-integration.

That means we need to find the result of:

F-statistics> I (1) = H_o is rejected, which means there is co-integration

F-statistics< I (0) = H_o isn't rejected, which states that there is no co-integration

After finding a co-integration relationship from equation (3.3.4), the long-run association is calculated by:

$$LUNP_t = \alpha_0 + \sum_{i=1}^{m} \beta_1 LUNP_{t-1} + \sum_{i=0}^{n} \beta_2 LINF_{t-1} + \varepsilon \quad (3.3.5)$$

Where,

β = Long-term coefficients for the ARDL

m & n = The order of the ARDL model.

After completing the equation (3.3.5), the next step is to find the disequilibrium convergent toward equilibrium by constructing the following ECM:

$$\Delta LUNP_t = \alpha_0 + \sum_{i=1}^{m} \beta_1 \Delta LUNP_{t-1} + \sum_{i=0}^{n} \beta_2 \Delta LINF_{t-1} + \mu ECT_{t-1} + \varepsilon_t \quad (3.3.6)$$

Where,

ECT_{t-1} = Error Correction Term,

μ = Coefficient that represents the speed of adjustment towards equilibrium.

Then the paper uses some supportive tests so that it can argue about the validity of the model. Some diagnostic tests like Wald test, to check whether the model is jointly significant or not, Jarque-Bera normality test, to check whether the residuals are normally distributed or not, Breusch-Godfrey Serial Correlation LM Test, to check whether the residuals have autocorrelation or not, Breusch-Pagan-Godfrey test & the ARCH test, to check whether the residuals, are free from heteroskedasticity or not, CUSUM and CUSUMsq. Test, to check the stability of the coefficients.

4. Empirical Results

4.1 Descriptive statistics

As per the study, now we state the basic scenario of the data set called descriptive statistics (table 4.1). According to the table 4.1, the standard deviation of INF is 2.3694, the lowest indicator is 2.0 and the highest indicator is 11.4. The average of the inflation rate is 6.62, which is slowly increasing and decreasing over time. It moved 11.40% in 2011 & 2.01% in 2001. On the other hand, UNP has a standard deviation of 0.7628, where the lowest indicator is 2.48 and the highest indicator is 5.41. Besides, the average UNP rate is 4.03. From 3.8093% to the highest indicator of 5.41% reached in 2020.

Table 4.1: Descriptive Statistics from 1995 – 2024

Variable	Mean	Median	Maxi.	Mini.	Std. Dev.	Obs.
INF	6.6233	6.2050	11.4000	2.0100	2.3694	30
UNP	4.0336	4.2900	5.4100	2.4800	0.7628	30

4.2 Augmented Dickey-Fuller unit root test

Before calculating the co-integration analysis, the analysis of time series of inflation and unemployment is needed to check for the stationary. Here we solve the equation (3.3.3) to find the result for stationary. In this study, we use the Hannan-Quinn lag length criterion to balance model fit and the appropriate lag length is calculated 4 using E views 12 software (Appendix 7.1). In table 4.2, LINF, the statistics value (-3.50) is lower than 0.05 (-2.97) and MacKinnon (1996)'s one-sided p-value is 0.0152 which is also smaller than 0.05 (significant level) implying that the H_0 cannot be accepted at level. The null hypothesis assumes that the inflation rate doesn't have a unit root. Therefore, the LINF is stationary or not having a unit root at level I (0). On the other hand, the statistics value (-2.37) is bigger than the test critical value at 5% significant level (-2.9810) and MacKinnon (1996)'s one-sided p-value is 0.1589 which is larger than 0.05 (significant level) of LUNP. That means we cannot reject null hypothesis and LUNP is non-stationary or having a unit root at level. But when we calculate it for 1^{st} difference, the study may get a different result and that is the stationary data of LUNP. In this case, the statistical value (-5.44) is lower than the test critical value at 5% significant level (-2.9810) and MacKinnon (1996)'s one-sided p-value is 0.0002 which is smaller than 0.05 (significant level) implying that the H_0 cannot be accepted. And can be concluded that the LUNP is stationary or not having a unit root at 1^{st} difference, I (1).

Table 4.2: ADF unit root test

	LINF			**LUNP**		
	Statistics	Probability	Integration	Statistics	Probability	Integration
At level	-3.50(-2.97*)	0.0152	I(0)	-2.37(-2.98*)	0.1589	I(1)
At 1st difference	-6.39(-2.98*)	0.000		-5.44(-2.98*)	0.0002	
ADF critical values are significant at 5%.						

4.3 ARDL co-integration relationship with long and short run relationship

The outcome of the previous test (the unit root test) is mixed, now the study can proceed with the ARDL bound test so that we can investigate the long-run relationship between the variables. In table 4.3 presents the ARDL Co-integration Bound Test & the ARDL (long-run) Test estimation. In this analysis, we get an F-statistic value is 7.61 which is much more larger than the upper bound (4.16) of the critical value. As the F statistic is larger than the upper bound at 5% significance level, the H_0 cannot be accepted which confirms that there is a long-run relationship existing between the variables. After this long-run relationship, now the study would like to find out the direction of the relationships. According to table 4.3.1, a long-run relationship exists and the consequence of this direction is negative (-1.69) which is desired. But this result is not significant because P value (0.51) > 0. 05. As this relationship is insignificant, we cannot explain the negative long run relationship present between the variables as the theory wanted. In a nutshell, we get long run relationship but the probability value of this calculation is more than the accepted level. That's why we can conclude that the long run relationship is insignificant.

Table 4.3: ARDL Co-integration Bound Test

Test Statistic	Value	Significant	Lower Bound I(0)	Upper Bound I(1)
F-statistic	7.619556	10%	3.02	3.51
K	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
Critical values are significant at 5%.				

Table 4.3.1: ARDL (long-run) Test estimates

Variable	Coefficient	t-Statistic	Probability
LINF	-1.690773	-0.658756	0.5184
C	0.166631	0.882373	0.3892
EC= LUNP- (-1.690773*LINF + 0.166631) *Critical values are significant at 5%*.			

In table 4.4, it focuses on the ARDL short run relationship between LUNP and LINF. Here the coefficient of LINF at level data narrates a negative relationship with an insignificant probability value (0.05=0.05). In the case of LINF at lag 1, we also get the same result. Here is the coefficient is positively related with a statistically insignificant result (0.09>0.05). On the other hand, LINF at lag 2 has a significant negative relationship where the probability value (0.002) is lower than, the significant level of 5% or 0.05.

Table 4.4: ARDL (short-run) Test estimates

Variable	Coefficient	t-Statistics	Probability
LUNP(-1)	0.392041	2.372882	0.0290
LUNP(-2)	0.129311	0.581823	0.5679
LUNP(-3)	-0.435788	-2.059697	0.0542
LUNP(-4)	0.811238	4.621912	0.0002
LINF	-0.109129	-2.136838	0.0466
LINF(-1)	0.093865	1.795726	0.0893
LINF(-2)	**-0.159221**	**-3.609634**	**0.0020**
C	0.017196	3.540495	0.0023
R^2 = 0.772821 Adjusted R^2 = 0.684473		F- statistic =8.747504 Probability =0.000103	
Critical values are significant at 5%.			

Table 4.5 states the ECM (Error Correction Model) between LUNP and LINF, which indicates the speed of adjustment. Here the CointEq (-1) represents the Error Correction coefficient is -0.1032 with the P value of the t-statistics of 0.001 that narrates the previous disequilibrium between the variables is corrected by 10.32 percent each year. CointEq (-1) is less than one and negative, as well as the probability value of the t-statistics is significant (0.001<0.05), indicating the disequilibrium is convergent toward equilibrium condition by 10.32% per year.

Table 4.5: Error Correction Model (ECM) between LUNP and LINF

Variable	Coefficient	t-Statistics	Probability
D(LUNP(-1))	-0.504761	-3.406416	0.0031
D(LUNP(-2))	-0.375450	-2.433420	0.0256
D(LUNP(-3))	-0.811238	-5.197055	0.0001
D(LINF)	-0.109129	-2.917667	0.0092
D(LINF(-1))	0.159221	4.256552	0.0005
CointEq(-1)*	-0.103199	-5.039694	0.0001
R-squared 0.694159 Adjusted R-squared 0.617699 Durbin-watson stat 2.006046		Mean dependent var 0.000667 S.D dependent var 0.004639 Akaike info criterion -8.671019	
Critical values are significant at 5%.			

4.4 Wald test estimation

In table 4.6, the study represents the Wald test. Here, the probability value is 0.02, which is lower than a 0.05. So, this probability value cannot accept the null hypothesis, and no join statistical significant, which means that, the ARDL model is jointly significant (statistically). This test ensures that LUNP & LINF are significant to prove the model fit.

Table 4.6: Wald Test

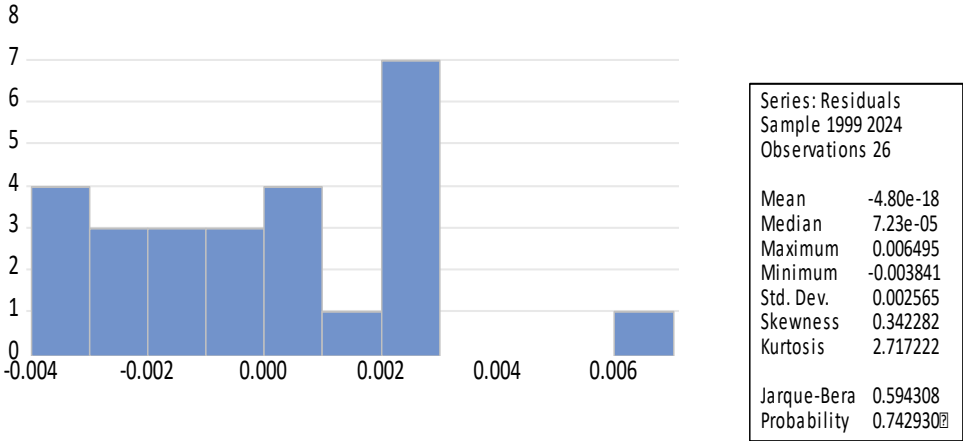
Test Statistic	Value	Probability
F-statistic	4.0042	0.0240
Chi-square	12.0126	0.0073

4.5 Others important diagnostic tests

For the normality test, we use the Jarque-Bera normality test (Cioran, 2014). According to this test, the shape of the histogram must be as like as bell side by side, the Jarque-Bera statistic must be insignificant. The probability value is 0.74 >0.05, stating that the condition of the residuals are in the position of normally distributed as the probability value is insignificant, and the histogram is bell-shaped.

For autocorrelation, we use the Breusch-Godfrey Serial Correlation LM Test (Cioran, 2014). The F-Statistics value is 0.07. Besides, the probability, value is 0.79, which can accept the $H_{0.}$ Moreover, the study confirms that the residuals have no autocorrelation.

If a uniform variance is missing in a sequence of the variables, which is measured as an error, it is called Heteroskedasticity (Al-zeaud & Al-hosban, 2015). For the Heteroskedasticity test, we use both the Breusch-Pagan-Godfrey test & the ARCH test. The Breusch-Pagan-Godfrey test, F-statistics is 0.14 & the P value is 0.99. On the other hand, in ARCH test, F-statistics is 0.07 & the probability value is 0.9608. In both cases, we can accept the $H_{0.}$ Besides, the study confirms that residuals, are free from heteroskedasticity as well as they are homoscedasticity which is needed to prove homogeneity in variance.



Heteroskedasticity test: Breusch-Pagan-Godfrey & ARCH test			
F-statistic	0.142878	Prob. F(7,18)	0.9930
Obs*R-squared	1.368607	Prob. Chi-square(7)	0.9865
F-statistic	0.517696	Prob. F(4,17)	0.7239
Obs*R-squared	2.388850	Prob. Chi-square(4)	0.6646

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.066655	Prob. F	0.7994
Obs*R-squared	0.101544	Prob. Chi-square	0.7500

4.6 Stability Tests

For testing the position of stability cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) tests are used (Pesaran, Shin and Smith 2001, Cioran, 2014, Naqibullah, Rahmatullah, l Zmarai, Safiullah, & Ahad, 2020). Those tests are based on recursive residuals. Here both CUSUM & CUSUMsq lines stay within the 5% critical lines. That means we cannot reject the null hypothesis that indicates stability in the coefficients.

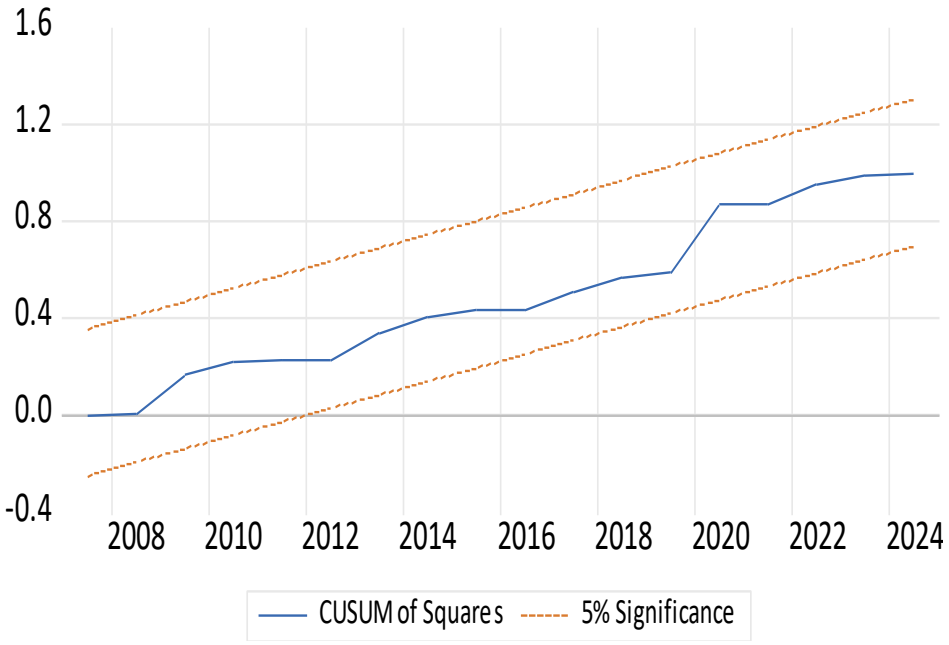


Figure 4.1 CUSUMsq Test's outcome

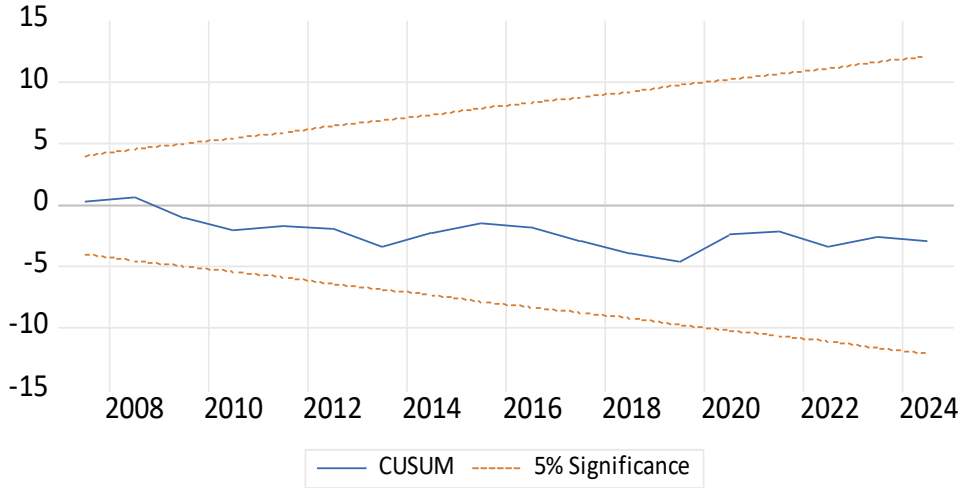


Figure 4.2 CUSUM Test's outcome

5 Findings & Conclusion

5.1 Findings

The Phillips Curve, an important theory in economics provided by William Phillips, is becoming a crucial issue for policy makers. A lot of research has proved the existence and non-existence of the PC (Phillips Curve) in different economies. By focusing on this debate regarding the presence of the PC, this analysis estimates it in a developing country, more specifically in the economy of Bangladesh.

The main findings of this analysis are: First, for the period 1995 – 2024 there exists a co-integration between LUNP and LINF. For concluding, this study used the ADF Unit root test and the ARDL bound test. Then, we need an exact lag length criterion. In this study, we used the Hannan-Quinn lag length criterion and the appropriate lag length is 4. After that, the ADF unit root test is used to check the stationarity of the variables. As the unit root test provides mixed results called I (0) & I (1), the ARDL bound test is applied to find the long run relationship between the variables (Karahan, Çolak, & Bölükbaşı, 2012) (Pesaran, Shin & Smith 2001, Naqibullah, Rahmatullah, l Zmarai, Safiullah, & Ahad, 2020).

Second, the presence of the PC in Bangladesh provides different results for the short run and for the long run. According to the study, in the long run the Phillips curve does not exist in Bangladesh. Because the ARDL (long run) estimation tests provide a negative, but insignificant result for the data set from 1995-2024 in Bangladesh. That means UNP is negatively related to INF, which was the main requirement for the Phillips Curve but statistically the relationship is insignificant. (Karahan, Çolak, & Bölükbaşı, 2012 & Azam, Khan, & Khan, 2022) also found these types of result where either the long run or short run insignificant results had occured. (Friedman 1968) also stated that Phillips curve cannot stay in the long run. On the contrary, this study finds the presence of PC in Bangladesh for a short period, of time. The ARDL (short run) estimation test ensures the trade-off relationship between LUNP and LINF in the short run. But this negative short run relationship is proved in LINF at lag 2. (Ismael, Mohanad and Sadeq, & Tareq, 2016) found a negative relationship on 6

period lag data. (Alisa, 2015) also ensured the only short run presence of the PC. According to the result, the negative relationship between inflation and unemployment in the economy of Bangladesh exists in short run.

5.2 Conclusion and policy implications

The doctrine of PC, trade-off relationship between UNP and INF, has become an important tool for the policymakers to choose between two extremes. It has played a supportive role to undertake the development process. Bangladesh is a developing country containing with various problems and prospects which are needed to control the raising rate of inflation & unemployment. In spite of having a strong debate about original Phillips curve doctrine, many researches have already done in this field at advanced economy as well as developing economy.

The target of this analysis is to go into the presence of PC in case of developing country like Bangladesh. For this analysis we have used ADF unit root test for checking the stationary of the data, ARDL bound test for long run as well as for the short run association. When this study uses ADF unit root test, it finds LINF as stationary at level but LUNP as stationary at 1^{st} difference, I (1). This mixed result and small data set motivate the study to conduct ARDL bound test. In the case of bound test, the study finds a long run relationship as F statistic value is 5.11 which is greater than, upper bound (4.16) of critical value. But, when ARDL long run association are estimated by the analysis, a negative but insignificant relationship is found. For this kind of result we cannot reject the proposed null hypothesis means there has been no long run Phillips Curve in Bangladesh. Moreover, as this relationship is not significant, it can be said that Phillips Curve's long run existence in Bangladesh is not true.

On the other hand, in short run, this study finds a negative and significant relationship between UNP and INF. At lag 2, LUNP is negatively related with LINF which is stated that the PC in Bangladesh exists in short run only. In case of short run, the null hypothesis is rejected. The error correction model of ARDL also provides a significant result and coefficient is less than 1 which indicates the disequilibrium is convergent toward equilibrium condition by 3.90% per year. Whereas Wald test is administrated for checking the joint significance of the model to prove the validity of this model. This study also has used Jarque-Bera normality test for normality test, Breusch-Godfrey Serial Correlation LM Test for autocorrelation, both Breusch-Pagan-Godfrey test & ARCH test For Heteroskedasticity test, cumulative sum and the cumulative sum of squares tests for stability test. All of those tests ensure the specification, validity & stability of the model. Finally, it can be said that the PC exists in the short run in Bangladesh but does not exist in the long run.

The policymakers of Bangladesh can lower unemployment at the cost of higher inflation, but only in short term. For this purpose, expansionary fiscal and monetary policies can be taken. As, long run evidence for the Phillips curve is unavailable, this trade-off will not sustain in the long run. Then, inflation will increase and unemployment will also increase. So, in the long run, the increased inflation can be curtailed using monetary tools by the central bank and new sources of employment can be created through promoting entrepreneurship to combat the unemployment.

References

Ahmed, S., & Mortaza, M. (2005). Inflation and Economic Growth in Bangladesh: 1981-2005. *Policy Analysis Unit (PAU) of Bangladesh Bank*.

Alisa, M. (2015). The Relationship between Inflation and Unemployment: A Theoretical Discussion. *Journal of International Business and Economics*, 89-97.

Al-zeaud, D. H., & Al-hosban, S. (2015). DOES PHILLIPS CURVE REALLY EXIST? AN. *European Scientific Journal, 10*(11), 253-275.

Arratibel, O., Diego, R.-P., & Christian, T. (2002). Inflation dynamics and dual inflation in accession. *ECB Working Paper, No. 132, European Central Bank (ECB), Frankfurt a. M*.

Azam, M., Khan, R., & Khan, S. (2022). Does the Phillips Curve Exist? *Journal of Central Banking Theory and Practice*, 59-78.

Basu, S., & G. Fernald, j. (2009). What Do We Know (And Not Know). *Federal Reserve Bank of St. Louis Review, 91*(4), 187-213.

Behera, H., Wahi, G., & Kapur, M. (2018). Phillips Curve Relationship in India:. *SSRN Electronic Journal, 80737*.

Bhattarai, K. (2016). Unemployment-inflation trade-offs in OECD countries. *Economic Modelling, 58*, 93-103.

Cioran, Z. (2014). Monetary Policy, Inflation and the Causal Relation between the Inflation Rate and Some of the Macroeconomic Variables. *Procedia Economics and Finance*, 391-401.

Dickey, D. A., & Fuller, W. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: journal of the Econometric Society*, 1057-1072.

Doloriel, N. S., Salvaleon, R., O. Ronquillo, A., & R. Estal, B. (2014). FRACTAL ANALYSIS OF PHILIPINES INFLATION RATE. *SDSSU Multidisciplinary Research Journal, 2*(1), 178-182.

Družić, I., Tica, J., & Mamić , A. (2006). The Challenge of Application of Phillips Curve: The Case of Croatia. *Zagreb International Review of Economics & Business,, SCI*(1), 45-59.

Dua, P., & Gaur, U. (20010). Determination of Inflation in an Open Economy Phillips Curve Framework:. *Macroeconomics and Finance, 3*(1), 33–51.

Friedman, M. (1968). The Role of Monetary Policy. *The American Economic Review, 58*.

Fuhrer, J. C., & Moore, G. (1995). Monetary policy trade-offs and the correlation between nominal interest rates and real output. *The American Economic Review*, 219-239.

Furuoka, F. (2007). Does the "Phillips Curve" Really Exist? New Empirical. *ECONOMICS BULLETIN, 5*(16), 1-14.

Haq, I. U., Khan, S., Khan, A., & Ahmed, E. (2012). Phillips Curve or Locus Critique: Time Series Evidence from Pakistan. *Journal of Economics and Behavioral Studies, 4*(4), 190-193.

Hassan, M. M. (2012). Searching For a Philips Curve for Bangladesh:. *European Journal of Economics, Finance and Administrative Sciences*(49), 49-55.

Hongo, D. O., Fanglin Li, & Ssal, M. W. (2019). Trade-Off Phillips Curve, Inflation and Economic Implication: The. *International Journal of Economics and Finance;, 11*(4), 60-73.

Illukkumbura, I. M., & Peiris, T. (2021). Modeling Inflation Rate and Unemployment. *EasyChair Preprint, 6961*, 1-6.

Ismael, Mohanad and Sadeq, & Tareq. (2016). Does Phillips Exist in Palestine? An. *Munich Personal RePEc Archive*(70245), 1-11.

Karahan, Ö., Çolak, O., & Bölükbaşı, Ö. F. (2012). TRADEOFF BETWEEN INFLATION AND UNEMPLOYMENT. *The Emprical Economics Letter, 9*(11), 973-980.

Kitov, O., & Kitov, I. (2011). Inflation and unemployment in Switzerland: from 1970 to 2050. *arXiv preprint arXiv, 1102*.

Lucas, R. (1972). Expectations and the Neutrality of Money. *Journal of, 4*, 103-124.

Mangnejo, D. G., Mahar, S. W., & Ahmed, B. (2020). Inflation and Unemployment in Pakistan: An

Empirical Analysis. *Pakistan Social Sciences Review, 4*(2), 306-318.

Masso, J., & Staehr, K. (2005). Inflation dynamics and nominal adjustment in the Baltic States. *Research in International Business & Finance*, 281-303.

Naqibullah, H., Rahmatullah, P., l Zmarai, M., Safiullah, S., & Ahad, Z. A. (2020). The Long-Run Determinant of Inflation in Malaysia:. *European Journal of Molecular & Clinical Medicine, 7*(11), 4549-4563.

NAR, M. (2021). Analysis of the Phillips Curve: An Assessment of Turkey. *Mehmet NAR / Journal of Asian Finance, Economics and Business, 8*(2), 65-75.

Ormerod, P., B. Rosewell , & P. Phelps. (2013). Inflation/unemployment regimes and the instability of the Phillips curve. *Applied Economics, 45*(12), 1519-1531.

Pesaran, M. H., Shin, Y., & Smith, R. (2001). Bounds testing approaches to the analysis of level relationships. *The Journal of Applied Econometrics*.

Qianyi, W., & Q Fei. (2013). The research on inflation rate and unemployment rate in china. *International Conferance on Social Science Research*, 202-220.

Rasna, & Enam, F. (2010). The Applicability of Phillips Curve to Bangladesh. *DIU Journal of Business and Economics, 5*(1&2), 32-53.

Recher, V., Marina, M., & Petra, P. (2017). ANALYSIS OF THE RELATIONSHIP OF UNEMPLOYMENT AND INFLATION IN CRISIS CONDITIONS: THE EXAMPLE OF CROATIA. *Economic Review, 68*(1), 32-58.

Salunkhe, B., & Patnaik, A. (2019). Inflation Dynamics and Monetary Policy in India: A New Keynesian Phillips Curve Perspective. *South Asian Journal of Macroeconomics and Public Finance, 8*(2), 144-169.

Schreiber, S., & Wolters, J. (2007). The long-run Phillips curve revisited: Is the NAIRU. *journal of Macroeconomics, 29*(2), 355-367.

Selvanayagam, S., & . Mustafa, A. (2019). THE IMPACT OF UNEMPLOYMENT AND INTEREST RATE ON INFLATION IN. *Journal of Management, 14*(2), 1-12.

Selvaraj, S. (2020). The Traditional Phillips Curve – Evidence. *Journal of International Economics, 11*(2), 56-68.

Sergo, Z., Saftic, D., & Tezak, A. (2012). STABILITY OF PHILLIPS CURVE:THE CASE OF CROATIA. *Economic Research - Ekonomska Istrazivanja, 25*(1), 65-85.

Singh, B. K., A. Kanakaraj, & Sridevi, T. (2011). Revisiting the Empirical Existence of the Phillips Curve for India. *Journal of Asian Economies, 22*(3), 247-258.

TANG, C. F. (2007). Is the Phillips Curve Stable for Malaysia? *Malaysian Journal of Economic Studies, 44*(2).

Thiruneelakandan, D. M., & Ullamudaiyar, D. (2018). A STUDY ON UNEMPLOYMENT AND INFLATION IN INDIA: THE SHORT RUN. *THE SHORT RUN, 05*(02), 692–697.

Touny, M. A. (2013). Investigate the Long-Run Trade-Off between Inflation and Unemployment. *International Journal of Economics and Finance, 5*(7), 115-125.

Vermeulen, J. (2017). Inflation and unemployment in South Africa: Is the. *Southern African Business Review, 21*(1), 20-54.

VICTOR, V., FARKAS , M. F., & JEESON , F. (2018). Inflation unemployment dynamics in Hungary –. *Theoretical and Applied Economics, XXV*(2(615)), 195-204.

Zayed, N. M., l Islam, M. R., & Hasan, K. R. (2018). TESTING PHILLIPS CURVE. *Academy of Accounting and Financial Studies Journal, 22*(5), 1-9.

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7 Appendices

7.1. Lag length criteria

VAR Lag Order Selection Criteria
Endogenous variables: LUNP LINF
Exogenous variables: C
Date: 02/24/23 Time: 01:25
Sample: 1992 2021
Included observations: 24

Lag	LogL	LR	FPE	AIC	SC	HQ
0	149.8456	NA	1.53e-08	-12.32047	-12.22230	-12.29442
1	162.1018	21.44833	7.70e-09	-13.00848	-12.71397	-12.93035
2	167.9284	9.225395	6.68e-09	-13.16070	-12.66984	-13.03047
3	170.2304	3.261225	7.87e-09	-13.01920	-12.33200	-12.83689
4	182.5716	15.42645*	4.10e-09*	-13.71430*	-12.83076*	-13.47989*
5	183.2011	0.681942	5.82e-09	-13.43342	-12.35354	-13.14693
6	185.5626	2.164752	7.46e-09	-13.29688	-12.02066	-12.95830

7.2.1 Inflation: level with intercept(ADF unit root test)

Null Hypothesis: LINF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on HQ, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.927132	0.0055
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

7.2.2Unemployment: level with intercept

Null Hypothesis: LUNP has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on HQ, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.315427	0.6068
Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

*MacKinnon (1996) one-sided p-values.

7.2.3 Unemployment: First difference with

Null Hypothesis: D(LUNP) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on HQ, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.329417	0.0002
Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

*MacKinnon (1996) one-sided p-values.

7.3 ARDL Co-integration Bound Test

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.112516	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58

7.3.1 ARDL (long-run) Test estimates

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF	-3.901904	12.55085	-0.310888	0.7595
C	0.339421	0.959691	0.353678	0.7277

EC = LUNP - (-3.9019*LINF + 0.3394)

7.3.2 ARDL (short-run) Test estimates

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LUNP(-1))	-0.490461	0.172928	-2.836217	0.0110
D(LUNP(-2))	-0.466725	0.191334	-2.439322	0.0253
D(LUNP(-3))	-0.750142	0.190185	-3.944274	0.0010
D(LINF)	-0.053642	0.033468	-1.602819	0.1264
D(LINF(-1))	0.095316	0.032385	2.943250	0.0087
CointEq(-1)*	-0.038999	0.009447	-4.128162	0.0006

R-squared	0.541019	Mean dependent var	0.001018
Adjusted R-squared	0.426273	S.D. dependent var	0.004424
S.E. of regression	0.003351	Akaike info criterion	-8.359950
Sum squared resid	0.000225	Schwarz criterion	-8.069620
Log likelihood	114.6793	Hannan-Quinn criter.	-8.276345
Durbin-Watson stat	2.214706		

* p-value incompatible with t-Bounds distribution.

7.3.4 ARDL Error Correction Model (ECM)

Dependent Variable: LUNP
Method: ARDL
Date: 02/16/23 Time: 11:44
Sample (adjusted): 1996 2021
Included observations: 26 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Hannan-Quinn criterion (HQ)
Dynamic regressors (4 lags, automatic): LINF
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(4, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LUNP(-1)	0.470540	0.186942	2.517033	0.0215
LUNP(-2)	0.023737	0.246226	0.096402	0.9243
LUNP(-3)	-0.283417	0.245995	-1.152126	0.2643
LUNP(-4)	0.750142	0.206390	3.634578	0.0019
LINF	-0.053642	0.044038	-1.218083	0.2389
LINF(-1)	-0.003211	0.038899	-0.082535	0.9351
LINF(-2)	-0.095316	0.037706	-2.527870	0.0211
C	0.013237	0.004600	2.877873	0.0100

7.4 Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

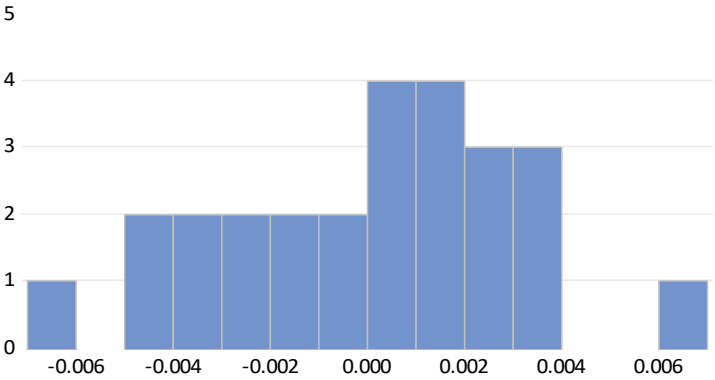
F-statistic	1.760899	Prob. F(4,14)	0.1928
Obs*R-squared	8.702575	Prob. Chi-Square(4)	0.0690

7.5 Wald test

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	415.9928	(8, 18)	0.0000
Chi-square	3327.942	8	0.0000

7.6 Jarque-Bera normality test



Series: Residuals	
Sample 1996 2021	
Observations 26	
Mean	-5.42e-19
Median	0.000337
Maximum	0.006448
Minimum	-0.006513
Std. Dev.	0.002997
Skewness	-0.204364
Kurtosis	2.714353
Jarque-Bera	0.269374
Probability	0.873989

7.7 Breusch-Pagan-Godfrey Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.523008	Prob. F(7,18)	0.8057
Obs*R-squared	4.394404	Prob. Chi-Square(7)	0.7334
Scaled explained SS	1.805380	Prob. Chi-Square(7)	0.9698

7.7.1 ARCH test

Heteroskedasticity Test: ARCH

F-statistic	0.149166	Prob. F(4,17)	0.9608
Obs*R-squared	0.745971	Prob. Chi-Square(4)	0.9455