The Validity of the Phillips Curve Relationship: An Econometric Study on Moroccan Data

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Abstract. The Phillips curve is a key tool in the formulation of economic policies. The primary objective of this study is to examine the validity of this curve in the Moroccan context. To this end, we employ an ARDL model, applied to annual data covering the period from 1991 to 2023. The results reveal a co-integration relationship, indicating a stable and long-term link between inflation and unemployment. However, contrary to the classical predictions of the Phillips curve, the analysis shows a significant positive impact of inflation on unemployment: a 1% increase in unemployment leads to a 1.22% rise in inflation in the short term, and 1.51% in the long term. These findings challenge the applicability of the Phillips curve in Morocco, highlighting that local economic dynamics deviate from the traditional trade-off between inflation and unemployment. This divergence underscores the urgent need to redefine Morocco's economic policies by adopting integrated and balanced monetary and fiscal strategies to effectively address these two major challenges.

Keywords: ARDL, Inflation, Phillips curve, Unemployment.

1. INTRODUCTION

The relationship between inflation and unemployment, illustrated by the famous Phillips curve, has been a central issue in economic policies since William Phillips' foundational work in 1958. While this curve has long served as an analytical framework for reconciling price stability and full employment, its validity and form have sparked numerous debates. Indeed, inflation and unemployment, two key indicators of economic health, directly influence purchasing power, growth, and employment, making it particularly challenging to achieve a balanced equilibrium (GRUEN et al., 1999).

Initially, the Keynesian theory represented by Phillips suggested a stable inverse relationship between these two variables, allowing for a potential trade-off between inflation and unemployment. However, this view was challenged by monetarist economists, such as Milton Friedman (1968), who introduced the concept of the "natural rate of unemployment." According to them, any trade-off would be illusory in the long run, with the Phillips curve becoming vertical. Monetary policies, therefore, would only have a temporary effect on economic activity. Later, models incorporating rational expectations, such as those developed by Lucas, further complicated this relationship by emphasizing the crucial role of economic agents' expectations in the formation of inflation (PARKIN, 1998).

Empirical studies have provided mixed results, partly confirming the predictions of various theories but also revealing the diversity of economic situations. The relevance of the Phillips curve thus varies depending on national contexts and periods, influenced by structural, institutional factors, and the prevailing economic policies.

In Morocco, unemployment and inflation remain crucial issues that deeply affect economic and social stability. As a developing country, Morocco has relatively high rates of both unemployment and inflation, often interlinked. This situation highlights the complex challenges faced by policymakers, especially since the economic policies implemented so far have failed to provide sustainable solutions. In this context, analyzing the relationship between unemployment and inflation, as represented by the Phillips curve, is of strategic importance. This analytical tool provides a valuable framework to guide policy decisions aimed at reconciling two fundamental goals: price stability and full employment. Therefore, a key question arises: to what extent can Moroccan public authorities rely on the Phillips curve to develop effective economic policies and address these structural challenges?

The main objective of this study is to evaluate the contribution of the Phillips curve to economic policy formulation in Morocco. By focusing on the relationship between inflation and unemployment, it aims to determine how useful this theoretical model can be as an analytical framework for policymakers. Such an exploration will help better understand the mechanisms through which economic policies are transmitted and identify the most effective levers for achieving key objectives.

To achieve this, we will begin by reviewing the empirical literature on the Phillips curve, to set the theoretical framework and examine previous studies. Next, we will present the methodology adopted, detailing the econometric model and the data used. Finally, we will analyze the results obtained and discuss their implications for economic policies in Morocco.

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2. LITERATURE REVIEW

On the empirical front, research into the Phillips curve has undergone a marked evolution, highlighting the dynamic and contextual nature of the relationship between inflation and unemployment. Studies show that this complex relationship varies according to the economic specificities of each country as well as the periods analyzed, and its validity is subject to regional and temporal fluctuations. For example, Ogbonna, Ahamuefula E. et al. (2024) re-examine this hypothesis in 29 African economies, incorporating the impact of fluctuations in world oil prices on inflation forecasts. Their results show that the Phillips curve is valid in certain economies in Central Africa (Cameroon, Central African Republic, Chad, and Republic of Congo), East Africa (Rwanda), North Africa (Algeria), Southern Africa (Botswana, Malawi) and West Africa (Burkina Faso, Mauritania). However, this relationship does not hold true in other countries, where inflation seems to be driven more by costs than by demand, underlining the importance of considering national economic particularities when designing monetary policies.

In a complementary fashion, Keshab Bhattarai (2016) examines the long-term relationships between inflation and unemployment in OECD countries for the period 1990-2014. Using cointegration and Granger causality tests, he finds that the Phillips curve remains significant in 28 of the 35 countries studied, both in country-specific analyses and through panel data. This indicates the persistence of this relationship in developed economies, despite structural differences between countries.

Following on from this work, Shaari, Mohd Shahidan et al (2017) also explored the existence of the Phillips curve, but focusing on a sample of 10 high-income countries for the period 1990-2014. Their analysis, based on panel data techniques, revealed a notable result: a bidirectional relationship between the unemployment rate and the inflation rate, in both the short and long term. The results highlight a negative correlation between these two variables, confirming the validity of the Phillips curve over both time horizons. These findings highlight a major policy challenge for governments, faced with the trade-off between stabilizing inflation and reducing unemployment.

In a similar context, Khanssa et al (2018) highlight a long-term unidirectional relationship running from unemployment to inflation in Lebanon, while Bildirici and Özaksöy (2016) find a bidirectional relationship in Canada, highlighting the influence of labor market structures on inflation-unemployment dynamics. Similarly, AL-ZEAUD Hussein and AL-HOSBAN Saleh (2015) confirm the validity of the Phillips curve in Jordan, demonstrating a negative, non-linear relationship between inflation and unemployment. Fumitaka Furuoka (2007) reinforces this perspective by finding a long-term relationship between these two variables in Malaysia.

Recent work confirms the complexity of the relationship between inflation and unemployment, while highlighting the particularities according to national contexts. For example, Mohammed Ait LAHCEN et al. (2022) find a positive correlation between expected inflation and unemployment in the United States, where the labor market remains sensitive to economic shocks in an inflationary environment. In Iran, JALAEE Sayyed Abdolmajid et al. (2019) use artificial neural networks to model interactions between inflation, unemployment and other macroeconomic variables, revealing a situation of persistent stagflation. In addition, Dritsaki Chaido and Dritsaki Melina's (2013) analysis in Greece shows that, although the Phillips curve does not apply in the short term, a long-term relationship exists between inflation and unemployment, suggesting that macroeconomic adjustments may vary according to the duration and economic characteristics of each country.

These studies highlight the complexity of the relationship between inflation and unemployment, with results confirming the validity of the Phillips curve in some cases, while others reveal significant variations according to national contexts and methodologies. On the basis of this theoretical and empirical review, the main hypothesis of the study can be formulated as follows:

Drawing on Phillips' basic theory as well as existing empirical studies, we reformulate the main hypothesis as follows:

$H_{.1}$.*Unemployment has a negative effect on inflation*

3. METHODS

This study uses the ARDL (AutoRegressive Distributed Lag) model to analyze the relationship between inflation and unemployment. ARDL is particularly well-suited to non-stationary but potentially cointegrated time series, enabling both short- and long-term effects to be studied. Its flexibility means it can handle integrated variables of order 0 or 1 (I(0) or I(1)), but does not apply to I(2) variables. In addition, its robustness to specification and its ability to deliver reliable results with moderate sample sizes make it a preferred tool for Phillips curve estimation.

This study analyzes the relationship between inflation, measured by the consumer price index, and unemployment, defined as the proportion of the working population who are unemployed but available and looking for work, in Morocco between 1991 and 2023. The annual data, from the World Bank and the Haut-Commissariat au Plan, are expressed in logarithms to improve the linearity of the relationships and facilitate interpretation of the results. Econometric analysis is carried out using Eviews 12 software, with a model specifically developed for this purpose.

$$\text{LogInflation}_t = \alpha + \beta\,\text{Log. unemployment}_t + \varepsilon_t$$

Where α: The constant, β: The directing coefficient, ε: The error term, *Log:* neperian logarithm.

The equation will be specified using the ARDL model for this analysis:

$$\Delta \text{LogInflation}_t = C + \sum_{i=1}^{p} \beta_1 \Delta \text{LogInflation}_{t-i} + \sum_{i=0}^{q} \beta_2 \Delta \text{Log. unemployment}_{t-i} + \alpha_1 \text{LogInflation}_{t-1} + \alpha_2 \text{Logunemployment}_{t-1} + \varepsilon_t$$

Where Δ: The first difference, β_1, β_2: Short-term dynamic coefficients, α_1, α_2: Long-term dynamic coefficients, p and q: Maximum number of delays.

4. RESULTS OF EMPIRICAL TESTS

Descriptive statistics for the inflation and unemployment variables, presented in the table below, reveal distinct volatility profiles. Inflation, with its higher standard deviation, shows greater variability, reflecting more pronounced price fluctuations. Unemployment, on the other hand, has a more stable distribution.

In terms of distribution, inflation shows a relatively homogeneous distribution around a central value, while unemployment is characterized by a more marked dispersion of values. These characteristics indicate that both variables deviate slightly from the normal distribution, displaying more dispersed and less concentrated distributions around their mean. However, Jarque-Bera tests show that this deviation from normality is not significant for our further analyses.

Table 1: Descriptive statistics for the variables used.

Variables	Mean	Max.	Min.	Std. dev.	Skewness	Kurtosis	Prob. JB
Inflation	0.585078	2.077711	−1.192749	0.850742	0.044885	2.173998	0.622129
Unemployment	2.479387	3.129389	2.187174	0.265476	0.724640	2.427066	0.188302

To ensure the reliability of the results of our econometric model, it is essential to verify the stationary of the variables. To this end, we applied the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, whose results, presented in Table 2, reveal distinct orders of integration: unemployment is stationary in first difference (I(1)), while inflation is stationary in level (I(0)). This combination of stationary levels justifies the use of the ARDL model in our analysis.

Table 2: ADF and PP test results.

In level						
Model	**M2**		**M3**		**M1**	
Variables	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**
Unemployment	−1.575327 (0.4833) 1.521669	−1.544857 (0.4985) 1.521669	0.113085 (0.9959) 0.991308	−0.831096 (0.9518) 0.079972	−0.573441 (0.4610)	−0.612816 (0.4440)
Inflation	−3.760530 (0.0077) 2.031310	−3.710426 (0.0087) 2.031310	−3.667778 (0.0396) −0.828411	−3.631274 (0.0428) −0.828411	−3.016852 (0.0037)	−2.872973 (0.0055)
First difference						
Unemployment	−6.368364 (0.0000) −0.385242	−6.331107 (0.0000) −0.385242	−4.075359 (0.0185) 3.409743	−6.605636 (0.0000) 1.248242	−6.454867 (0.0000)	−6.404938 (0.0000)

Determining the optimal lag is essential in time series modeling, as it influences not only the quality of estimates, but also the number of co-integration relationships. In this study, the information criteria (AIC, SC, HQ, LogL, FPE, LR) unanimously indicate that a lag of 1 is optimal, showing that using the ARDL model with this lag provides the best results.

Table 3: Delay number determination results.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−34.87818	NA	0.037014	2.379237	2.471753	2.409395
1	−8.130519	48.31835*	0.008541*	0.911646*	1.189192*	1.002119*
2	−5.999926	3.573898	0.009679	1.032253	1.494830	1.183042

The estimated econometric model turns out to be globally significant, as indicated by the probability associated with the Fisher statistic (Prob (F-statistic) = 0.011609), below the 5% threshold, thus validating the model as a whole. This suggests that unemployment has a significant influence on inflation. The adjusted correlation coefficient of (0.213856) shows that the model explains around 21.39% of the variance in inflation, a modest but relevant result for this analysis. Furthermore, the Durbin-Watson statistic, close to 2, indicates the absence of significant autocorrelation of first-order errors. Estimation of the coefficients reveals a significant positive correlation between unemployment and inflation, with a probability associated with the t-statistic of 0.0402, i.e. less than 5%.

Table 4: ARDL model estimation results.

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
Inflation (-1)	0.190900	0.178882	1.067185	0.2947
Unemployment	1.225228	0.570318	2.148324	0.0402
C	-2.590283	1.369041	-1.892042	0.0685
R-Squared	0.264575	F-Statistic		5.216482
Adjusted R-Squared	0.213856	Prob(F-Statistic)		0.011609
Durbin-Watson stat		2.025097		

The results of the co-integration test presented in the table below indicate that the F-statistic, which reaches 6.821806, exceeds the critical values at the 1%, 2.5%, 5% and 10% thresholds, enabling us to reject the null hypothesis of no co-integration. This confirms the existence of a long-term equilibrium relationship between the inflation rate and unemployment in Morocco for the period 1991-2023. This relationship is established without requiring a specific order of integration of the variables, which reinforces the robustness of the results obtained.

Table 5: Bounds co-integration test results.

F-Bounds test				
Test Statistic	Value	Meaning	I(0)	I(1)
F-statistic	6.821806	10%	3.02	3.51
K	1	**5%**	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58

The short-term dynamic coefficients of the ECM equation reveal a significant adjustment towards long-term equilibrium, with an error correction coefficient of -0.8091. This coefficient shows that around 80% of the difference between inflation and unemployment in the previous year is corrected in the following year. This confirms the existence of a stable long-term relationship between the two variables. In other words, inflation in Morocco tends to return spontaneously to its equilibrium level, adjusting effectively to past imbalances.

In this context, short-term results also reveal that unemployment has a positive and statistically significant impact on inflation. In concrete terms, a 1% increase in unemployment leads to a 1.22% rise in inflation. This observation underlines the interdependence between unemployment and inflation, reinforcing the idea that fluctuations in unemployment can directly influence short-term inflation levels.

Similarly, the empirical results of long-term estimation corroborate this dynamic, showing that inflation and unemployment move in the same direction. Indeed, this positive relationship is statistically significant at the 5% threshold, as the probability associated with the t-statistic (0.0203) is below this threshold, confirming the relevance of this relationship. Note that a 1% increase in unemployment leads to a 1.51% rise in inflation.

Table 6: Short-term and long-term dynamics results.

Estimation of short-term relationship				
Variable	Coefficient	Std. error	t-Statistic	Prob.
C	-2.590283	1.369041	-1.892042	0.0685
Unemployment	1.225228	0.570318	2.148324	0.0402
CointEq (-1)	-0.809100	0.172986	-4.677267	0.0001
Estimation of long-term relationship				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Unemployment	1.514311	0.616447	2.456514	0.0203
C	-3.201438	1.529869	-2.092623	0.0452

To ensure the robustness and reliability of our ARDL model, a series of rigorous diagnostic tests were carried out. The results show that the residuals are normally distributed homoscedastic and not auto correlated, which guarantees the quality of the estimates. The Ramsey test revealed no omissions of relevant variables, reinforcing the relevance of the chosen functional form. Finally, the CUSUM and CUSUMQ structural stability tests detected no breaks, attesting to the model's stability over the entire period studied. These tests validate the robustness and reliability of the ARDL model.

Table 7: Model validation test results.

Validation test	T-calculated	P-value	Conclusion
Normality (Jarque-Bera test)	0.755535	0.685390	Residuals follow a normal distribution
Heteroscedasticity (White's test)	1.340329	0.2788	No heteroscedasticity
Autocorrelation (Breusch-Godfrey Serial Correlation LM test)	0.529048	0.4730	No serial correlation
Functional form test (Ramsey test)	1.173771	0.2879	The model is correctly specified

The graphical representations of the CUSUM and CUSUMQ stability tests are shown below.
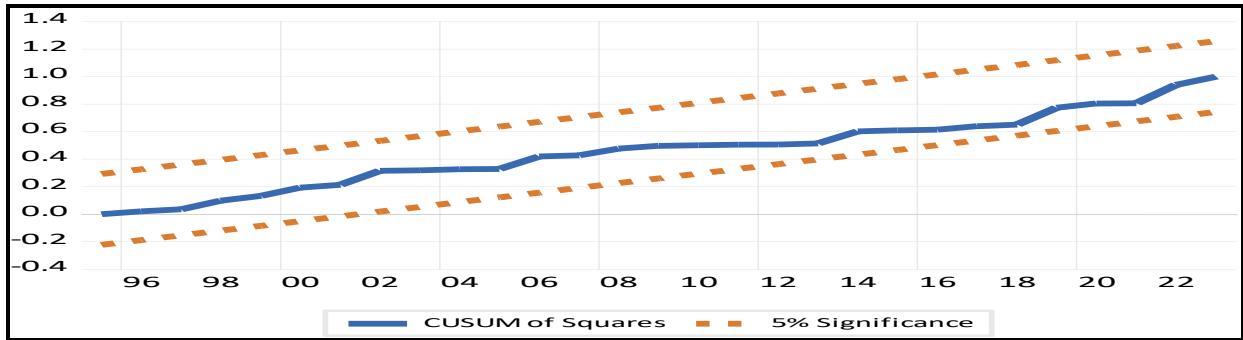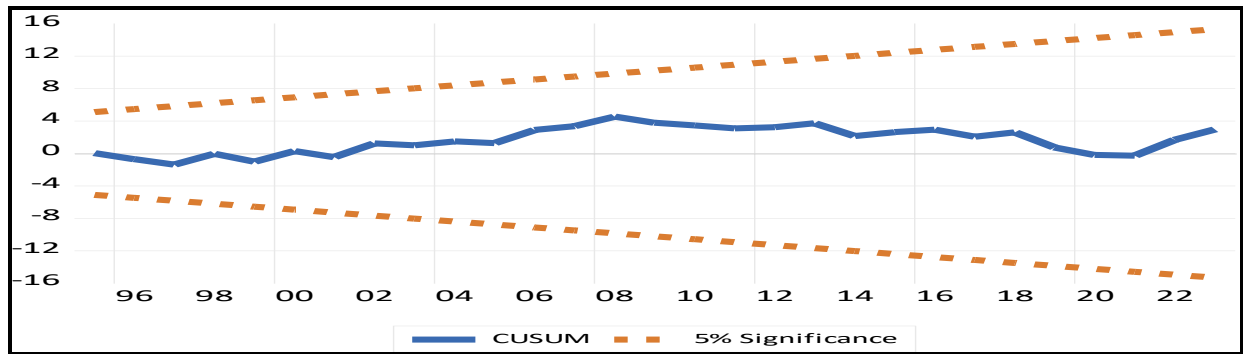
Figure 1: CUSUMQ stability test.

Figure 2: CUSUM stability test.

Finally, we applied the Granger causality test to explore potential causal relationships between the variables in the study. The results, presented in the table below, indicate the absence of a significant causal relationship between inflation and unemployment. Indeed, the p-values are above the 5% threshold, which means that the results do not allow us to reject the null hypothesis of non-causality between these variables.

Table 8: Results of Granger causality test.

Null Hypothesis	Observation	F-Statistic	Prob.
Chômage does not Granger Cause inflation	32	2.43972	0.1291
Inflation does not Granger Cause unemployment		0.01401	0.9066

5. DISCUSSION

This study revisits the Phillips curve relationship in Morocco, a crucial issue for economic policies. Our results show a positive and significant correlation between these two variables, challenging the classical Phillips curve theory, which assumes an inverse relationship between inflation and unemployment. This phenomenon is not isolated, as it has also been observed in other countries, such as the United States (Mohammed Ait LAHCEN et al., 2022) and Iran (Jalaee Sayyed Abdolmajid et al., 2019), where inflation contributed to an increase in unemployment, particularly in contexts of structural rigidities and supply shocks. These observations support the idea that inflation, in certain economic situations, can exacerbate unemployment, questioning the universality of the Phillips curve and highlighting the importance of considering local specificities in economic analysis.

In the case of Morocco, several structural factors explain this atypical relationship between inflation and unemployment. The Moroccan labor market, characterized by a large proportion of informal workers, moderates the impact of inflation on real wages and, consequently, on unemployment. Unlike formal economies, where moderate inflation can temporarily reduce unemployment through a decrease in real wages, inflation in Morocco does not significantly affect labor costs in the informal sector. At the same time, labor market rigidities, such as minimum wages and collective agreements, limit the necessary flexibility to adjust wages to price increases, which can lead to layoffs and increase unemployment. Finally, the Moroccan economy remains vulnerable to supply shocks, particularly due to rising import prices for raw materials, which contribute to inflation while reducing production capacity and employment.

These results call for a reevaluation of Moroccan economic policies. It is crucial to introduce structural reforms aimed at enhancing labor market flexibility to allow for more effective wage adjustments during periods of inflation. At the same time, it is important to promote the creation of formal jobs and encourage the transition of informal workers into more stable and better-regulated sectors. Economic diversification is also necessary to reduce dependence on imports and strengthen the competitiveness of local businesses, which would help Morocco better withstand external shocks. Moreover, proactive management of supply shocks is essential. Implementing policies to better manage global price fluctuations, by strengthening domestic production and reducing import dependency, would help mitigate the negative effects of inflation on employment.

This study highlights the importance of adapting Moroccan economic policies to local specificities. Structural

reforms, such as improving labor market flexibility, diversifying the economy, and strengthening resilience to external shocks, are key measures for achieving a balance between price stability and unemployment reduction, while addressing the unique challenges facing the Moroccan economy.

6. CONCLUSION

This study aims to examine the applicability of the Phillips curve in the Moroccan context, a key model for analyzing the relationship between inflation and unemployment. Through an econometric analysis using the ARDL model, covering the period from 1991 to 2023, we observed a positive and significant relationship between these two variables. This result contradicts the traditional hypothesis of an inverse trade-off between inflation and unemployment, highlighting specific economic characteristics of Morocco that deviate from classical theoretical models.

The absence of Granger causality between inflation and unemployment, as well as the observed relationship, underscores the complexity of Morocco's economic mechanisms. Several explanatory factors emerge, such as structural rigidities in the labor market, frequent supply shocks, significant dependence on imports, and low economic diversification. These elements suggest that classical economic approaches, often tailored to Western contexts, cannot be directly applied to an emerging economy like Morocco, thus highlighting the need for a more contextualized analysis.

The implications for Moroccan policymakers are significant. It is crucial to rethink economic policies by moving away from standardized models to design strategies suited to local specifics. This includes structural reforms aimed at increasing labor market flexibility, enhancing the competitiveness of local businesses, and diversifying the productive base to reduce vulnerability to external shocks. Such an approach would allow for better management of inflationary dynamics while limiting their impact on employment.

However, this study has some limitations. While the ARDL methodology is useful for analyzing long-term relationships, it does not capture nonlinear dynamics or the complex interactions between inflation and unemployment. Additionally, the absence of data on institutional, social, and political dimensions may limit the scope of our conclusions.

This study also opens avenues for future studies. A more in-depth analysis of the determinants of inflation and unemployment in Morocco, incorporating institutional and structural variables, is necessary for a finer understanding of the underlying mechanisms. Furthermore, a comparison with other emerging economies could enrich the analysis and offer new perspectives for developing economic policies better adapted to Morocco's realities.

REFERENCES

Al-zeaud, H., & Al-hosban, S. (2015). Does Phillips curve really exist? Empirical evidence from Jordan. *European Scientific Journal*, 11(10). Retrieved from https://eujournal.org/index.php/esj/article/view/5424

Bhattarai, K. (2016). Unemployment–inflation trade-offs in OECD countries. *Economic modelling*, 58, 93-103. https://doi.org/10.1016/j.econmod.2016.05.007

Bildirici, M., & Özaksoy, F. (2016). Non-linear analysis of post Keynesian Phillips Curve in Canada labor market. *Procedia economics and finance*, 38. https://doi.org/10.1016/S2212-5671(16)30209-X

Dritsaki, C., & Dritsaki, M. (2013). Phillips curve inflation and unemployment: an empirical research for Greece. *International Journal of Computational Economics and Econometrics*, 3(1-2), 27-42. https://doi.org/10.1504/IJCEE.2013.056265

Friedman, M. (1977). Nobel lecture: inflation and unemployment. *Journal of political economy*, 85(3). https://doi.org/10.1086/260579

Friedman, M. (1977). Nobel lecture: inflation and unemployment. *Journal of political economy*, 85(3). https://doi.org/10.1086/260579

Furuoka, F. (2007). Does the "Phillips curve" really exist? New empirical evidence from Malaysia. *Economics Bulletin*, 5(16), 1-14. Retrieved from http://economicsbulletin.vanderbilt.edu/2007/volume5/EB-07E20006A.pdf

Gruen, D., Pagan, A., & Thompson, C. (1999). The phillips curve in australia. *Journal of Monetary Economics*, 44(2), 223-258. https://doi.org/10.1016/S0304-3932(99)00024-0

Jalaee, S. A., Lashkary, M., & GhasemiNejad, A. (2019). The Phillips curve in Iran: econometric versus artificial neural networks. *Heliyon*, 5(8). https://doi.org/10.1016/j.heliyon.2019.e02344

Khanssa, M., Nasser, W., & Mourad, A. (2018). An econometric analysis of inflation and unemployment in Lebanon: A vector error correction model (VECM). *International Journal of Economics and Finance*, 10(2). https://doi.org/10.5539/IJEF.V10N2P133

Lahcen, M. A., Baughman, G., Rabinovich, S., & van Buggenum, H. (2022). Nonlinear unemployment effects of the inflation tax. *European Economic Review*, 148. https://doi.org/10.1016/j.euroecorev.2022.104247

Ogbonna, A. E., Farag, M., Akintande, O. J., Yaya, O. S., & Olubusoye, O. E. (2024). Re-validating the Phillips Curve hypothesis in Africa and the role of oil prices: A mixed-frequency approach. *Energy*. https://doi.org/10.1016/j.energy.2024.131862

Parkin, M. (1998). Unemployment, inflation, and monetary policy. *The Canadian Journal of Economics/Revue canadienne d'Economique*, 31(5). https://doi.org/10.2307/136457

Phillips, A. W. (1958). The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957. *Economica*, 25(100), 283-299. https://doi.org/10.2307/2550759

Romaniello, D. (2024). The Longer, the Weaker? Considering the Role of Long-Term Unemployment in an 'Original' Phillips Curve. *Review of Political Economy*, 1-34. https://doi.org/10.1080/09538259.2023.2286460

Shaari, M. S., Abdullah, D. N. C., Razali, R., & Saleh, M. L. A. H. M. (2018). Empirical analysis on the existence of the Phillips curve. In *MATEC Web of Conferences*, Vol. 150, p. 05063). EDP Sciences. https://doi.org/10.1051/matecconf/201815005063