The Impact of Unemployment Rates on Inflation Rates in OECD Countries: An Empirical Analysis

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Abstract:

This study examines the relationship between unemployment and inflation rates in OECD countries from 1992 to 2023, extending beyond the traditional Phillips Curve framework. Using panel data analysis and incorporating additional macroeconomic variables such as GDP, annual wages, and exchange rates, the research provides comprehensive insights into inflation dynamics in advanced economies. Results indicate significant temporal dependencies in inflation patterns and a complex relationship with unemployment, challenging simple interpretations of the Phillips Curve. The findings suggest that while the unemployment-inflation trade-off exists, its nature varies across time and countries, with implications for monetary policy in OECD nations.

Keywords: Phillips Curve, Inflation, Unemployment, OECD Countries, Panel Data Analysis

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1. Introduction

The relationship between unemployment and inflation has been a cornerstone of macroeconomic thought, epitomized by the Phillips Curve, which posits an inverse relationship between these two indicators. This theory has significantly shaped economic policy by highlighting the trade-offs between inflation and unemployment. However, its stability and relevance have been questioned, especially with evolving economic structures and global markets.

This study explores the unemployment-inflation relationship within OECD countries, a group of advanced economies pivotal to global economic trends. Analyzing this dynamic in the OECD context is crucial due to their developed economic structures, reliable data availability, and relevance for macroeconomic policymaking.

While the Phillips Curve provides a foundational framework, real-world inflation dynamics involve additional complexities. Factors like GDP, annual wages, exchange rates, and monetary policy significantly influence inflation. This research moves beyond a simple bivariate analysis to incorporate these macroeconomic variables, aiming for a comprehensive understanding of inflation in advanced economies. Specifically, the study will:

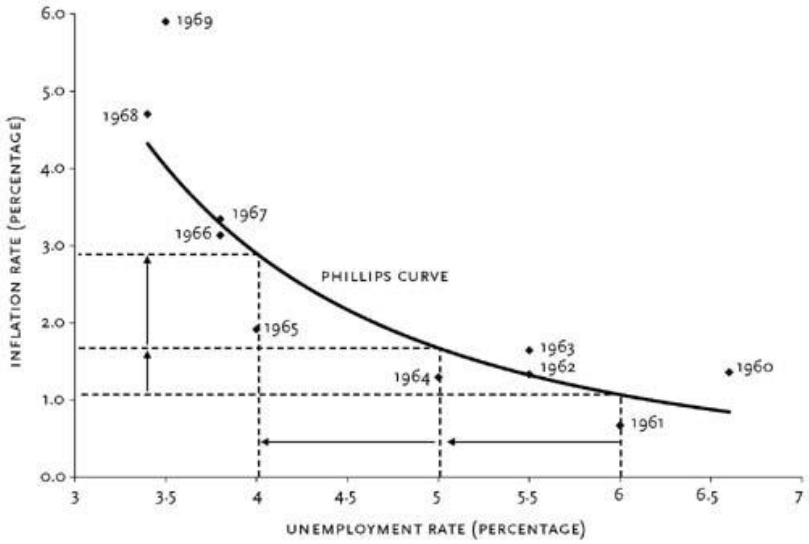
- Re-examine the Phillips Curve's relevance in OECD countries (1992–2023).
- Investigate the impacts of GDP, wages, exchange rates, and interest rates on inflation.
- Quantify the relative importance of these factors in inflation dynamics.
- Provide empirical insights relevant to policymaking.

Using annual data (1992–2023) from the OECD Data Explorer, this project employs econometric techniques in R to analyze these relationships. The following sections cover theoretical foundations, data preparation, econometric modeling, empirical analysis, and a conclusion summarizing the findings and their implications.

2. Theoretical Framework

Understanding the dynamics between inflation and various macroeconomic variables is essential for effective economic policy formulation. This section delves into the theoretical underpinnings of these relationships, drawing from established economic theories and empirical studies.

2.1 The Phillips Curve



The Phillips Curve illustrates an inverse relationship between unemployment and inflation, suggesting that lower unemployment rates correlate with higher inflation, and vice versa. This concept originated from A.W. Phillips' 1958 study, which analyzed wage inflation and unemployment in the UK from 1861 to 1957. Phillips observed that when unemployment was low, wages increased rapidly, leading to higher inflation; conversely, high unemployment was associated with slower wage growth and lower inflation [1]

However, the stability of the Phillips Curve has been questioned, particularly during periods like the 1970s stagflation, where high inflation and high unemployment coexisted, challenging the inverse relationship. This led to the development of the expectations-augmented Phillips Curve, which incorporates inflation expectations, suggesting that the trade-off between inflation and unemployment may not hold when inflation expectations adjust.[2]

2.2. GDP and Inflation

GDP represents the total value of goods and services produced within an economy and serves as a primary indicator of economic health. The relationship between GDP and inflation is complex. Generally, robust economic growth can lead to higher inflation if aggregate demand outpaces aggregate supply, causing upward pressure on prices. Conversely, during economic downturns, reduced demand can lead to lower inflation or deflation. Recent research suggests that rising inflation can depress GDP by leading to banking sector losses, prompting banks to reduce lending and ultimately affecting economic activity. [3]

2.3. Annual Wages and Inflation

Wage levels significantly influence inflation. Higher wages increase consumers' purchasing power, potentially boosting demand for goods and services, which can drive prices up, leading to inflation. This wage-price spiral suggests a positive feedback loop between wages and inflation. However, if wage growth outpaces productivity, it can lead to cost-push inflation, where increased production costs are passed on to consumers in the form of higher prices. [4]

2.4. Exchange Rates and Inflation

Exchange rates affect inflation through their impact on import and export prices. A depreciation of the domestic currency makes imports more expensive, contributing to higher inflation (imported inflation). Conversely, an appreciation can lower import prices, exerting downward pressure on inflation. The relationship between exchange rates and inflation is influenced by factors such as interest rates, economic growth, and political stability. [5]

Expected Relationships and Hypotheses

Based on the theoretical insights:

- Unemployment Rate: An inverse relationship with inflation is anticipated, aligning with the Phillips Curve framework.
- GDP: A positive relationship with inflation is expected, as higher economic growth can lead to increased demand and upward price pressures.
- Annual Wages: A positive correlation with inflation is anticipated, given that rising wages can boost consumer spending and demand-pull inflation.
- Exchange Rates: Depreciation of the domestic currency is expected to correlate with higher inflation due to increased import prices.
- Interest Rates: A negative relationship with inflation is expected, as higher interest rates can dampen economic activity and reduce inflationary pressures.

These hypotheses will be empirically tested in the subsequent analysis to assess their validity within the context of OECD countries from 1992 to 2023.

3. Data Preparation

The data used in this study was sourced from the OECD Data Explorer [5], a comprehensive repository of economic indicators. The dataset spans 1992 to 2023 and includes annual observations for multiple variables: unemployment rates, inflation rates, GDP, annual wages, exchange rates, and interest rates. However, the raw data was organized into separate files for each variable, necessitating extensive preprocessing to prepare it for regression analysis.

3.1. Data Collection and Initial Reshaping

Initially, each variable was extracted as a separate Excel file. Since the data spanned a broader time range than required, the first step involved selecting the desired period (1992–2023). This was done by manually reshaping the data in Excel, including transposing it to align rows and columns consistently across files.

3.2 Data Integration in R

After reshaping the data in Excel, the files were imported into R for further preprocessing. To combine the datasets into a single file, it was necessary to transform the data from a panel format (wide format) to a pivot-long format. This transformation ensured that all variables were consolidated under a unified structure, where each observation (a country-year combination) was represented as a single row, with columns for each variable. This format is essential for running multivariate regressions in R, facilitating the modeling of relationships across variables.

3.3 Addressing Missing Values

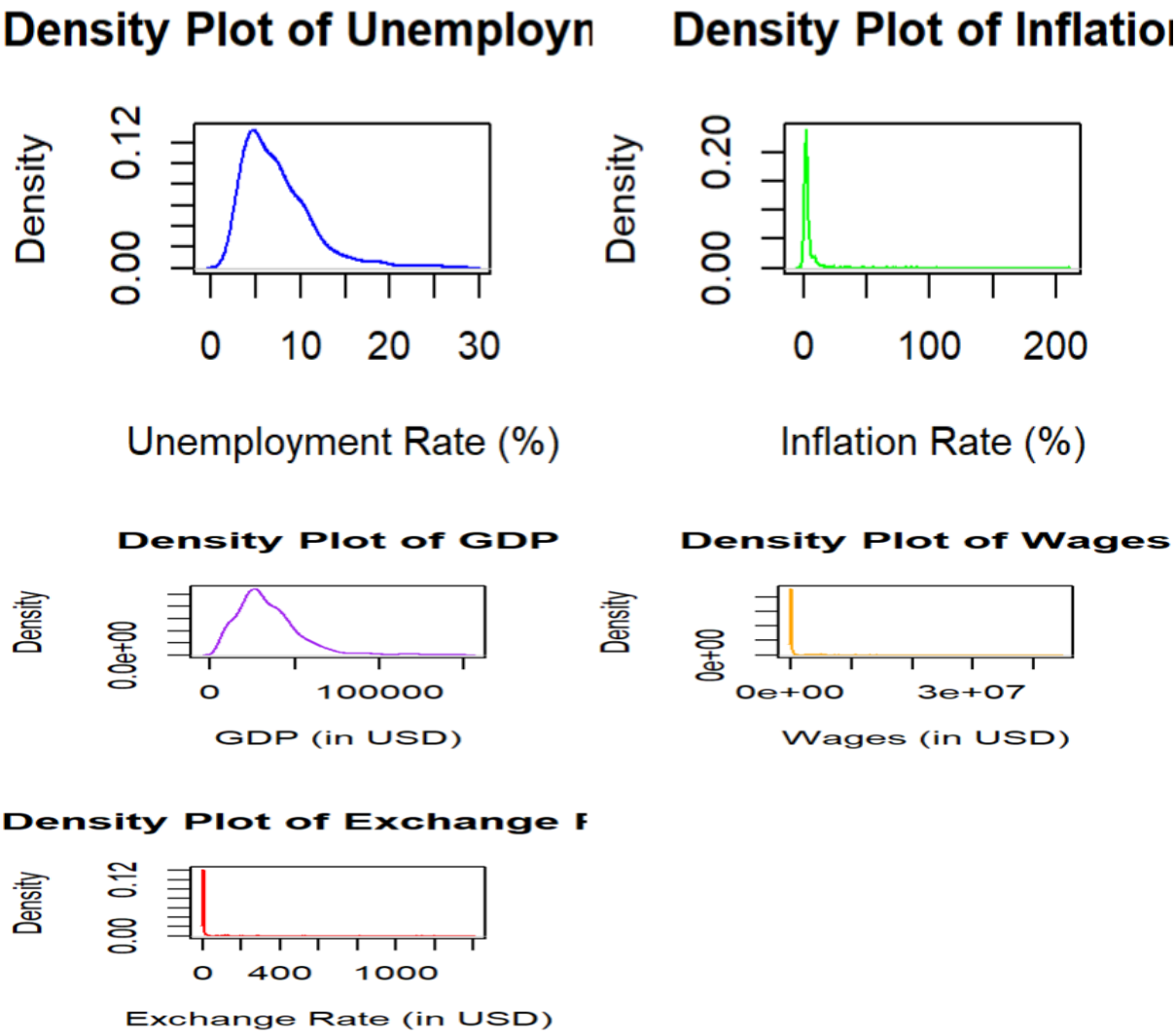
One of the challenges encountered during data preparation was missing values in some variables for certain countries and years. Missing values can significantly affect the validity of regression results if left unaddressed. To handle this, mean imputation was applied. For each country, the mean value of the respective variable over the available years was calculated and used to replace the missing entries. This method, while simple, maintains the dataset's internal consistency and ensures that the analysis remains representative.

3.4 Final Dataset

After addressing missing values, the data was finalized for regression analysis. The dataset now includes all variables in a unified, long-format structure, ready to explore the relationships between unemployment, inflation, and other macroeconomic indicators. The preprocessing steps ensured the dataset's usability and integrity, enabling the subsequent econometric modeling to produce reliable and insightful results.

Summary:

Variable	Min	1st Quartile	Median	Mean	3rd Quartile	Max	NA Count
Year	1992	1999	2007	2007	2015	2022	0
Unemployment	1.805	4.580	6.665	7.437	9.367	27.686	0
Inflation	-4.448	1.277	2.293	4.551	3.919	209.934	1
Exchange Rate	0.0069	0.8403	1.0827	63.8282	6.7628	1403.1833	2
GDP	5742	21473	30199	33845	42325	145971	10
Wages	1939	26584	43531	1535809	212035	44583494	36



4. Model Specification

The econometric analysis began with a simple framework inspired by the Phillips Curve, modeling inflation as a function of unemployment rates. This foundational model aligns with classical economic theory, aiming to validate the inverse relationship between these two variables. However, initial results showed that unemployment rates were statistically insignificant, raising concerns about the adequacy of the simple Phillips Curve model for capturing inflation dynamics in OECD countries.

4.1 Initial Model

The initial model was specified as follows:

$$Inflationt = \beta 0 + \beta 1 Unemploymentt + \epsilon t$$

While theoretically sound, this model failed to produce significant results, even after incorporating additional explanatory variables such as GDP, wages, and exchange rates. These variables, hypothesized to have meaningful relationships with inflation, also lacked statistical significance, suggesting a need for model refinement.

4.2 Model Refinements

Incorporating Lagged Values

Based on insights from subsequent literature reviews and studies[6][8], the model was extended to include lagged values of both inflation and unemployment rates. This adjustment was motivated by findings that inflation and unemployment rates often exhibit delayed effects on current inflation dynamics. Lagged values account for persistence in inflation and potential delayed impacts of macroeconomic factors, aligning the model with more sophisticated econometric approaches.

Transforming Variables

To address the insignificance of other variables, transformations were applied to GDP, wages, and exchange rates. Following best practices in the literature[7][9][10], first differences (denoted as Δ\DeltaΔ) were calculated to capture their dynamic changes rather than absolute levels. These transformations help isolate the effect of changes in these variables on inflation, removing potential biases arising from multicollinearity or non-stationarity.

4.3 **Final Model**

The final model took the following form:

$$Inflationt = \beta 0 + \beta 1 Inflationt - 1 + \beta 2 Inflationt - 2 + \beta 3 Unemploymentt - 1 + \beta 4 Unemploymentt + \beta 5 Unemploymentt - 2 + \beta 6 \Delta ExchangeRatet + \beta 7 \Delta GDPt + \beta 8 \Delta Wagest + \epsilon$$

5. Results

5.1 Simple Model Analysis

$$\boldsymbol{Inflation = \beta 0 + \beta 1 Unemployment + \epsilon}"$$

Regression Summary

Variable	Estimate	Std. Error	t-value	p-value	Significance
(Intercept)	3.6972	0.7342	5.036	5.6×10−75.6 \times 10^{-7}	***
Unemployment	0.1148	0.0870	1.320	0.187	Not significant

RSE: 11.25, R^2: 0.0017, Adjusted R^2: 0.0007 ,F-statistic: 1.741 (p = 0.1872)

Key observations:

- The unemployment rate was statistically insignificant ($p>0.05p > 0.05$), suggesting it did not effectively explain inflation in this specification.
- The R2R^2 value was close to zero, indicating the model explained almost none of the variation in inflation.
- Highlighted the limitations of a simple Phillips Curve framework for this dataset.

5.2 refined model

$$\boldsymbol{Inflation = \beta 0 + \beta 1 Unemployment + \beta 2 \Delta Exchange\ Rate + \beta 3 \Delta GDP + \beta 4 \Delta Wages + \epsilon}$$

Regression summary:

Variable	Estimate	Std. Error	t-value	p-value	Significance
(Intercept)	3.7650	0.7308	5.151	3.09×10−73.09 \times 10^{-7}	***
Unemployment	0.1068	0.0866	1.232	0.218	Not significant
ΔExchange Rate	-0.000844	0.01021	-0.083	0.934	Not significant
ΔGDP	-0.0001219	0.00003483	-3.498	4.88×10−44.88 \times 10^{-4}	***
ΔWages	0.0000001128	0.0000003886	0.290	0.772	Not significant

RSE: 11.2, R^2: 0.0132, Adjusted R^2: 0.0095, F-statistic: 3.513 (p = 0.00739)

Key Observations

• Transforming variables into first differences (Δ\Delta) improved the model slightly, with Δ\DeltaGDP becoming highly significant ($p<0.001p < 0.001$).

• The adjusted R2R^2 increased, showing a better model fit compared to previous iteration.

• Suggested the importance of focusing on changes rather than absolute levels for certain macroeconomic variables**.**

5.3 Final model

$$\boldsymbol{Inflation = \beta 0 + \beta 1 Inflationt - 1 + \beta 2 Inflationt - 2 + \beta 3 Unemployment + \beta 4 Unemploymentt - 1 + \beta 5 Unemploymentt - 2 + \beta 6 \Delta Exchange\ Rate + \beta 7 \Delta GDP + \beta 8 \Delta Wages + \epsilon}$$

Regression summary

Variable	Estimate	Std. Error	t-value	p-value	Significance
(Intercept)	1.2800	0.5954	2.150	0.0318	*
Inflationt−1_{t-1}	0.4737	0.0302	15.670	<2×10−16< 2 \times 10^{-16}	***
Inflationt−2_{t-2}	0.2234	0.0301	7.423	2.37×10−132.37 \times 10^{-13}	***
Unemployment	0.3052	0.1921	1.589	0.1124	Not significant
Unemploymentt−1_{t-1}	-0.8833	0.2926	-3.018	0.0026	**
Unemploymentt−2_{t-2}	0.5923	0.1874	3.160	0.0016	**
ΔExchange Rate	-0.007381	0.007932	-0.931	0.3523	Not significant
ΔGDP	-0.00005145	0.00002810	-1.831	0.0673	.
ΔWages	0.0000004562	0.0000003021	1.510	0.1313	Not significant

RSE: 8.662 , R^2: 0.4127, Adjusted R^2: 0.4082, F-statistic: 91.62 ($p < 2.2\times10-162.2 \times 10^{-16}$)

6. Result Analysis

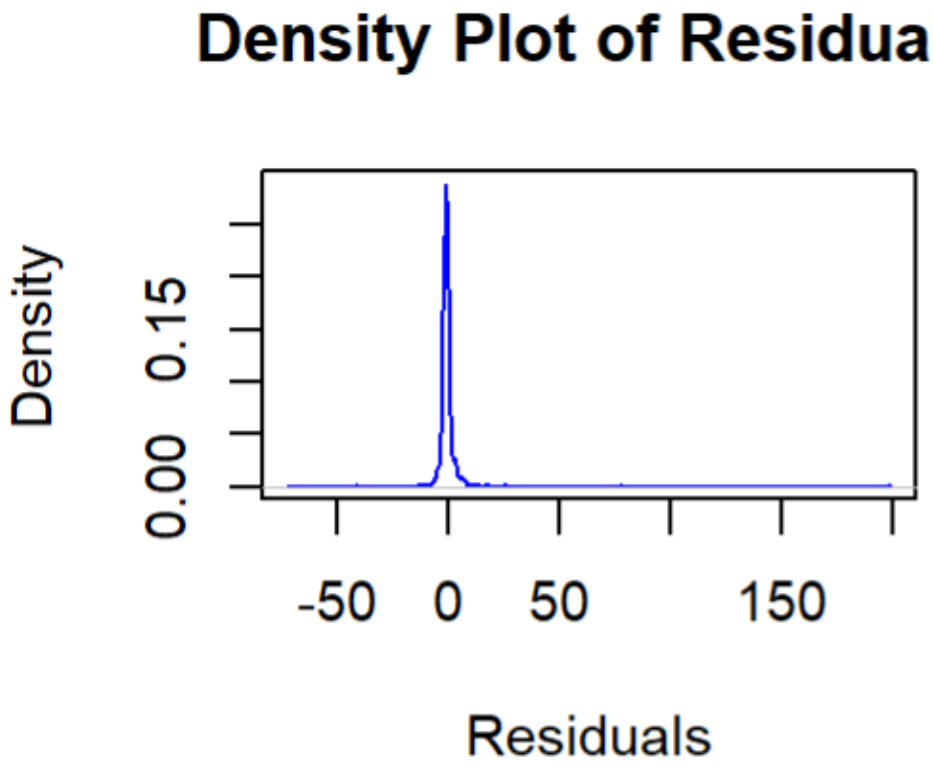
This study examined inflation dynamics in OECD countries, focusing on its relationship with unemployment and other macroeconomic variables like GDP, wages, and exchange rates. A robust methodology—featuring lagged variables and transformations—yielded valuable insights, including the persistence of inflation and the limited direct impact of current unemployment rates. The findings suggest that inflation is heavily influenced by past conditions, while changes in GDP consistently emerged as significant. The results also highlight inter-country variability, reflecting the influence of local economic factors such as monetary policies and labour market structures.

Key findings include:

- Significance of Lagged Variables: Inflation and unemployment exhibit temporal dependencies.

- Limited Role of Current Unemployment: Direct effects of unemployment on inflation are weaker than expected.
- Dynamic Role of GDP: Changes in GDP were consistently significant in explaining inflation.
- Inter-country Variability: Inflation dynamics differ significantly among countries due to local factors.
- Modelling Refinements: Iterative adjustments improved explanatory power, with an R2R^2 of 0.4127.

Despite these advances, limitations such as the use of annual data and aggregated analysis suggest the need for future research using higher-frequency data and country-specific models.



7. Conclusion

This study examined inflation dynamics in OECD countries from 1992 to 2023, focusing on its relationship with unemployment and other macroeconomic variables like GDP, wages, and exchange rates. The analysis revealed that:

1. **Phillips Curve Validity**: Current unemployment rates were consistently insignificant, challenging the traditional trade-off between inflation and unemployment.

2. **Impact of Additional Variables**: Changes in GDP (Δ\DeltaΔGDP) showed the strongest relationship with inflation, while transformations of other variables improved their relevance.
3. **Lagged Effects**: Lagged inflation and unemployment significantly influenced inflation, highlighting its persistence and dependence on past conditions.
4. **Inter-country Differences**: Inflation dynamics varied across OECD countries, driven by unique economic structures and policies.

The findings underscore the complexity of inflationary processes and suggest that effective policymaking requires a broader focus beyond unemployment. Future research should explore higher-frequency data and country-specific models to refine these insights. By addressing the multifaceted determinants of inflation, this study provides a clearer understanding of its drivers in advanced economies.

8.Appendix

[1] https://www.econlib.org/library/Enc/PhillipsCurve.html?utm

[2] https://www.brookings.edu/articles/the-hutchins-center-explains-the-phillips-curve/?utm

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