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A Multiple Linear Regression Model for Inflation Rate in the UK

Shihan Miah, Daniel Ata-Baah

School of Computing and Engineering, University of West, London, UK

Email: shihan.miah@uwl.ac.uk, daniel.ata@uwl.ac.uk

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Abstract

In this study, the key factors influencing the yearly inflation rate in the United Kingdom (UK) have been investigated using data spanning from 1974 to 2023. A range of economic factors, including interest rates (IR), unemployment rates (UR), exchange rates (EXR), gross domestic product (GDP), consumer price index (CPI), retail price index (RPI), value-added taxes (VAT), producer price index (PPI), and GDP growth (GDPG) has been chosen as predictor variables to analyze the model under consideration. Using these factors, a multiple linear regression without interaction and another model with interaction have been constructed and investigated using least squares methods to estimate the coefficients and identify the most significant determinants of inflation. The interaction model yields better performance, with a high coefficient of determination ($R^2 = 0.979$), indicating that the most impactful variables are interactions between the Producer Price Index (PPI) and GDP, the Retail Price Index (RPI) and GDP, the RPI and inflation rate (IR), the PPI and IR, as well as GDP itself. These outcomes offer valuable insights into the complex dynamics driving the inflation rate in the UK.

Keywords

Inflation, Simple Linear Regression, Multiple Linear Regression, Statistical Significance, Variance Inflation Factor

1. Introduction

In recent years, inflation has been a worrying factor for every country, which has become particularly high due to various unexpected events, including COVID-19 and the Ukraine-Russia war. Inflation is a factor measured by the rate of increase in goods and services over a period. A higher inflation rate reduces the purchasing power of the currency. In the UK, the Consumer Price Index (CPI) is a vastly used

measure of inflation that tracks the average change of prices in time of approximately 700 goods and services purchased by households. As an alternative to CPI, the Consumer Price Index including owner-occupiers' housing costs (CPIH) is also a measure of inflation in the UK which provides a wider outlook by including additional housing-related costs for house owners who live and maintain their houses. Another measure of inflation is the Retail Price Index (RPI), which tracks the change of price of a basket of goods and services over time by applying an alternative method of calculation to CPI. Core inflation aims to capture the underlying persistent trend in inflation by excluding volatile components, such as food and energy prices [1]. This approach includes excluding these components, using trimmed means of price changes, or estimating the persistent component directly through statistical techniques [1].

Inflation can be categorized depending on the drivers of inflation, the rate of inflation, and the predictability of inflation. The drivers of inflation are mainly demand-pull inflation, which occurs due to lack of supply compared to demand [2]; cost-push inflation, which occurs when the cost of production increases [3]; built-in inflation, resulting from higher wages [4]; and imported inflation, induced by the risen cost of imported goods or depreciation of currency [5]. Based on the rate, inflation is classified as creeping inflation if the rate increases gradually, ranging from 1% to 3% per annum [6]; walking inflation when increases between 3% and 10% per year leading to a decline in purchasing power [7]; galloping inflation refers to a situation in which the annual inflation rate rises to double- or triple-digit levels, resulting in severe financial disruption [8]. Hyperinflation refers to an extremely high rate of inflation, typically defined as exceeding 50% per month, which triggers extreme economic instability [9]. Based on predictability, inflation can be categorized as anticipated inflation and unanticipated inflation. An anticipated inflation is expected and allows for planning [10] whereas an unanticipated inflation is unexpected, leading to uncertainty and economic disruptions [11].

Numerous factors such as Demand-pull, Cost-push, or the increase in the price of imported goods and services [12] [13] contributed to the rise in inflation in the UK. The Demand-Pull caused to rise in food prices by up to 22% in 2022 and the energy price rose due to supply and demand issues contributing to a rise in CPI inflation to 11.1% in the same period. Higher interest rates caused higher mortgage payments and rents. These factors eventually contributed to higher CPIH measures compared to CPI. Due to staff shortages, hiring and retaining staff became costly and hence the service sector price increased by 5.7% in May 2022.

It is important for policymakers to understand the relationship between the economic factors that influence inflation to make effective policy. By concentrating on core inflation, one may better understand the sustained trend without the noise inserted by sudden price shock. Policymakers can take contingency measures against the adverse effects of inflation by identifying the driving factors. Inflation in the UK is controlled by managing the money supply, adjusting interest rates, and implementing fiscal policies. The Bank of England (BoE) closely monitors

these indicators to maintain price stability and support economic growth [14]. Additionally, the BoE aims to keep a stable economic environment for the country by keeping inflation under control. Their recent target is to keep the figure around 2% for the CPI, because high inflation may increase uncertainty and cost, while deflation may lead to economic inefficiencies. Hence, BoE continuously keeps tracking inflation indicators and makes adjustments in monetary policies accordingly to create an economic environment that fosters growth while inflation remains in control.

Over the years, the UK government presented multiple arguments to identify the factors affecting the inflation rate. Among them, one of the major factors they identified is the justification for austerity measure implementation. They argue that austerity reduces public spending and hence reduces the demand in the economy [15] and ultimately lowers the inflation rate. The underlying logic is that by lowering government expenditure, the fiscal deficit is reduced, resulting in lower money supply, which keeps demand-pulling inflation down. Although the cut in public spending can reduce demand-pull inflation, it can also have negative effects on growth and services, such as higher unemployment rate, consumer confidence, and reduced GDP growth and per capita income [16].

The Brexit policy introduced in 2020 aimed to boost growth, which was partially justified on economic grounds. The advocates of Brexit claimed that leaving the EU would allow the UK to control its economic policies more efficiently and potentially reduce inflation [17]. The rationale was that Brexit would give an opportunity to renegotiate its trade deal to reduce the regulatory burden and manage immigration independently may boost the economy. In reality, Brexit has inserted significant trade barriers with the EU which causes an increase in costs for businesses and consumers and adds to inflationary pressures [18]-[22].

The COVID-19 pandemic is another factor that the government often blames for higher inflation. Due to the pandemic, the supply chain was disrupted, resulting in a shortage of goods and services and leading to a rise in inflation. The UK government stressed that these operational hindrances on the supply side have contributed to inflation. Additionally, the significant stimulus provided during the pandemic to support businesses and households, for which the government had to borrow money, led to an increase in public debt as a result of intervention to curb inflation, making it urgent. Although stimulus support was needed to prevent economic collapse, it has created a complex challenge in balancing the withdrawal of stimulus with the need to sustain economic recovery.

In addition to the pandemic, Ukraine has been identified as another factor in the inflation driver. Since February 2022, continuous conflict in Ukraine has strengthened inflationary trends by elevating oil and gas prices. Due to the ongoing conflict, the supply chain of energy has been disrupted, triggering a surge in oil and gas costs, thereby contributing to rising overall inflation not only in the UK but in the entire world. Such an external impulsive shock emphasizes the exposure of the economy to global disturbances and reveals the need for a holistic framework to reduce the effects of such events in the long run. Researchers in

economics have long studied the factors involved in driving inflation by examining a comprehensive spectrum of economic data through diverse theoretical frameworks. Over the last century, our understanding of inflation dynamics has advanced considerably to respond to major economic shocks and shifts in policy approaches [23]-[26].

In this study, a multiple linear regression model without interaction and another model with interaction effect have been constructed to identify the most significant factors affecting the inflation rate in the UK. Using the data from government websites such as Office for National Statistics (ONS), Bank of England (BOE), reputable international financial institution and published papers for 50 years both models has been analysed. The result shows that the model with interaction effect is more capable to capture yearly inflation rate in the UK. Although the relationships between inflation and key macroeconomic indicators such as GDP growth, interest rates, and price indices are well established in the literature, this study contributes by examining these interactions over an extended historical period (1974 to 2023) and by explicitly incorporating interaction terms in the regression framework. By doing so, the study highlights the interconnectedness of economic drivers and demonstrates that accounting for such interdependencies improves model performance. This methodological contribution provides a valuable baseline for evaluating UK inflation dynamics and may inform future forecasting and policy-oriented studies.

2. Data Collection and Sampling Method

We collected quantitative data from existing sources and applied this secondary data to analyze both models. The selection of explanatory variables in this study is informed by both economic theory and prior empirical research. Interest rates are central to monetary policy and influence inflation through demand-side channels, consistent with monetarist and New Keynesian models. GDP growth reflects overall economic activity and aggregate demand, aligning with Keynesian perspectives on inflationary pressures. Price indices, such as consumer or producer prices, are directly connected to cost-push inflation theories and capture the influence of supply-side shocks. Taken together, these predictors enable the model to represent both demand-pull and cost-push drivers of inflation, while the inclusion of interaction terms allows us to evaluate how these drivers reinforce or offset one another in shaping inflation dynamics.

The rationale behind using secondary data to ensure a comprehensive dataset without the need for primary data collection is to allow us to save time and resources [18]. We have identified reputable databases and publications for this research so that the sources provide reliable economic indicators, such as government statistical agencies, international financial institutions, and academic research repositories. The collected data includes various macroeconomic variables relevant to this study, such as interest rates (IR), unemployment rates (UR), exchange rates (EXR), gross domestic product (GDP), consumer price index (CPI),

retail price index (RPI), value-added taxes (VAT), producer price index (PPI), and GDP growth (GDPG).

To ensure the data is representative, we have collected 50 years of data for our sample. After acquiring the data from the respective websites, it was filtered for the required time period, cleaned, and merged. The important steps we have taken during this process include data aggregation and alignment, handling missing data, data cleaning, and standardization [27]. For example, some of the variables have monthly data, and some others have quarterly data. These monthly and quarterly data have been converted to yearly data by using suitable methods to create uniformity and facilitate the analysis. The converted annual data helped to remove short-term volatility and provided a more coherent picture of the long-term inflation trend. We have applied interpolation and extrapolation methods to address gaps in the data where necessary, which is a widely accepted technique in data analysis, especially when dealing with time series data [27]. Moreover, where data was missing, we have identified other reliable external sources to replace the dataset, ensuring consistency and completeness across all variables.

3. Linear Regression Model

Simple linear regression models the relationship between a dependent variable Y and one independent variable X . Mathematically, the model is expressed as

$$Y = \beta_0 + \beta_1 X + \epsilon, \quad (1)$$

where β_0 is the intercept, β_1 is the slope of the line, and ϵ is the error term representing the difference between the observed and predicted values. β_0 and β_1 are unknown parameters of the model which will be estimated using the least square method. Suppose,

$$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i, \quad (2)$$

be the prediction for the independent variable Y based on the i^{th} observation of the dependent variable X , where $\hat{y}_i$ represents the prediction of Y on the basis of $X = x_i, i \in [1, n]$ and $\hat{\beta}_0, \hat{\beta}_1$ are the estimated coefficients. Then

$$\epsilon_i = y_i - \hat{y}_i \quad (3)$$

represents the i^{th} error or residual, *i.e.*, the difference between the observed and the predicted value of the simple linear regression model. The residual sum of squares can be written as

$$\text{RSS} = \epsilon_1^2 + \epsilon_2^2 + \dots + \epsilon_n^2 = \sum_{i=1}^n \epsilon_i^2 = \sum_{i=1}^n (y_i - \hat{y}_i)^2 \quad (4)$$

The least squares approach specifies that the coefficients should be estimated in a way that minimises the residual sum of squares (RSS). As a result, the coefficients $\hat{\beta}_0, \hat{\beta}_1$ obtained through this method are known as the least squares estimated coefficients, given by

$$\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \cdot \bar{X} \quad \text{and} \quad \hat{\beta}_1 = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sum_{i=1}^n (X_i - \bar{X})^2}$$

Multiple linear regression extends this to model the relationship between a dependent variable Y and multiple independent variables $X_1, X_2, \dots, X_n$, expressed as

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \epsilon \quad (5)$$

The coefficients in (5) can be estimated using the least squares method as discussed above. For our data, the model equation is written as :

$$\begin{aligned} \text{Inflation Rate} = & \beta_0 + \beta_1 (\text{UR}) + \beta_2 (\text{GDPG}) + \beta_3 (\text{CPI}) + \beta_4 (\text{EXR}) + \beta_5 (\text{RPI}) \\ & + \beta_6 (\text{IR}) + \beta_7 (\text{PPI}) + \beta_8 (\text{VAT}) + \beta_9 (\text{GDP}) + \epsilon \end{aligned} \quad (6)$$

The linear model introduced in Equations (1) and (5) assumes that the predicted variables are independent. However, this assumption may not always hold true. For instance, exchange rate fluctuations could influence the impact of GDP on inflation [28]. This phenomenon is known as interaction, where the effect of one causal variable on the outcome depends on the state of a second causal variable.

Model with Interactions

In multiple linear regression, the interaction terms are responsible for the combined effect of two independent variables on the dependent variable. These terms are added to the model to capture the effect that one predictor variable has on the relationship between another predictor variable and the response.

Mathematically, this is represented as:

$$Y \approx \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{12} (X_1 X_2)$$

where $X_1 X_2$ is the interaction term and β_{12} is the interaction coefficient. Including interaction terms allows the model to reflect more complex relationships where the effect of one predictor on the response depends on the level of another predictor. This approach can provide a more accurate representation of real-world phenomena where predictors do not operate independently but rather interact with each other to influence the outcome.

4. Statistical Testing

We have implemented a range of rigorous statistical tests to enhance the robustness and credibility of the outcome of the study. Different characteristics of the data were tested by suitable tests, ensuring the validation of assumptions and allowing for a broad and sophisticated examination.

4.1. Significance Test

To assess the significance of a predictor variable, we define the following hypotheses:

$$H_0 : \beta_i = 0 \text{ and } H_a : \beta_i \neq 0$$

Using a t -test, we examine the p -value of the coefficient for the corresponding predictor variable. If the p -value is less than 0.05, we reject the null hypothesis,

indicating that the predictor variable has a significant relationship with the response variable. Otherwise, we fail to reject the null hypothesis, suggesting that the corresponding variable has no significant effect on the response variable.

4.2. Coefficient of Determination

To evaluate how well the model fits the data, we use a metric called the coefficient of determination, denoted by R^2 . This metric represents the proportion of the total variation in the observed data that is explained by the regression model. The value of R^2 ranges between 0 and 1, with a higher value indicating better performance in predicting the response variable based on the predictors.

4.3. Multicollinearity Test

To check for multicollinearity among independent variables, the Variance Inflation Factor (VIF) is used. As defined:

$$VIF_i = \frac{1}{1 - R_i^2}$$

where R_i^2 is the coefficient of determination of the regression of the i th independent variable on all other independent variables. VIF values below 10 indicate no significant multicollinearity, ensuring that the regression coefficients are reliable and stable [29].

5. Regression Models and Findings

5.1. Simple Linear Regression

Initially, we begin by examining the impact of each individual factor on the inflation rate. This step helps us understand how each variable influences inflation when considered in isolation. By identifying which factors have a significant effect, we can determine the most relevant variables to include in our multiple regression model. Including only significant variables ensures that the model captures the key drivers of inflation, improving its accuracy and predictive power. This process lays the foundation for building a more comprehensive and reliable regression model that accounts for the combined effects of multiple factors.

5.1.1. Inflation and Unemployment

The first factor we look at is the unemployment rate as the predictor variable for our simple linear regression model for the inflation rate in the UK. **Table 1** shows that there is an inverse relation between Inflation and unemployment rate.

The coefficient for unemployment rate, β_1 , is estimated at -0.1694 . This suggests that for each one-unit increase in the unemployment rate, the inflation rate is expected to decrease by 0.1694 units, holding other factors constant. The standard error for this estimate is 0.322, and the t-statistic is -0.526 . The p-value for the unemployment coefficient is 0.601, which is much higher than the conventional significance level of 0.05. Thus, the coefficient for unemployment rate is not statistically significant, indicating that there is no strong evidence to suggest that

unemployment has a meaningful impact on inflation in this model. The R^2 value is 0.006, indicating that only 0.6% of the variability in inflation can be explained by the unemployment rate. This low R^2 value suggests that unemployment rate is not a good predictor of inflation in this model. The F-statistic is 0.2771, with an associated p-value higher than 0.05, indicating that the overall model is not statistically significant. This means that the regression model, as a whole, does not provide a better fit to the data than a model with no predictors. The overall model explains very little of the variance in inflation, suggesting that other factors not included in this model may be more important determinants of inflation.

Table 1. Estimated parameter and statistical values obtained from simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{unemployment}$.

$Y = \text{Inflation}, X = \text{unemployment}$				
Coeff	Est	Std Err	T- stat	P-val
$\hat{\beta}_0$	6.4056	2.332	2.747	0.008
$\hat{\beta}_1$	-0.1694	0.322	-0.526	0.601
R square = 0.006			RSE = 5.25182	
Adj R square = -0.015			F-stat = 0.2771	

5.1.2. Inflation and Interest Rate

The second factor we looked at is the Interest rate as a predictor variable for the inflation rate. **Table 2** presents the results of a linear regression analysis where the dependent variable is inflation (Y) and the independent variable is the interest rate (IR). The coefficient for the interest rate, β_1 , is estimated at 0.712 which shows a positive relationship between Inflation and Interest rate. The estimate suggests that for each one-unit increase in the interest rate, the inflation rate is expected to increase by 0.712 units, holding other factors constant. The p-value for the interest rate coefficient is less than 0.001, which is much lower than the conventional significance level of 0.05. Thus, the coefficient for the interest rate is statistically significant, indicating that there is strong evidence to suggest that the interest rate has a meaningful impact on inflation in this model. The R^2 value is 0.419, indicating that 41.9% of the variability in inflation can be explained by the interest rate. This relatively high R^2 value suggests that the interest rate is a strong predictor of inflation in this model.

Table 2. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{Interest Rate}$.

$Y = \text{Inflation}, X = \text{Interest Rate}$				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	0.72	0.927	0.777	0.441
$\hat{\beta}_1$	0.712	0.122	5.823	<0.001
R square = 0.419			RSE = 3.915	
Adj R square = 0.407			F-stat = 33.906	

Similarly, we have analyzed all other selected predictor variables for the inflation rate, with their results presented below in **Tables 3-9**. Our findings indicate that the interest rate (IR), value-added tax (VAT), gross domestic product (GDP), producer price index (PPI), retail price index (RPI), and consumer price index (CPI) are the most significant predictors of the inflation rate.

Table 3. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{Per Capita Income}$.

Y = Inflation, X = CPI (Consumer Price Index)				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	3.393	1.020	3.326	0.002
$\hat{\beta}_1$	0.011	0.004	2.517	<0.015
R square = 0.117			RSE = 5.002	
Adj R square = 0.098			F-stat = 6.335	

Table 4. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{Exchange Rate}$.

Y = Inflation, X = Exchange Rate				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	5.222	0.75	6.959	0.001
$\hat{\beta}_1$	-0.041	0.065	-0.624	0.536
R square = 0.008			RSE = 5.3	
Adj R square = -0.013			F-stat = 0.389	

Table 5. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{GDP}$.

Y = Inflation, X = GDP				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	25.347	5.179	4.894	0.001
$\hat{\beta}_1$	-0.008	0.002	-3.913	<0.001
R square = 0.242			RSE = 4.633	
Adj R square = 0.226			F-stat = 15.311	

Table 6. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{GDP Growth}$.

Y = Inflation, X = GDP Growth				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	5.994	0.898	6.673	0.001
$\hat{\beta}_1$	-0.381	0.261	-1.459	0.151
R square = 0.042			RSE = 5.207	
Adj R square = 0.022			F-stat = 2.128	

Table 7. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{Producer Price Index}$.

$Y = \text{Inflation}, X = \text{PPI (Producer Price Index)}$				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	13.894	1.509	9.208	0.001
$\hat{\beta}_1$	-0.119	0.019	-6.177	<0.001
R square = 0.443			RSE = 3.972	
Adj R square = 0.431			F-stat = 38.155	

Table 8. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{Retail Price Index}$.

$Y = \text{Inflation}, X = \text{RPI (Retail Price Index)}$				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	10.797	1.223	8.827	0.001
$\hat{\beta}_1$	-0.007	0.001	-5.214	<0.001
R square = 0.362			RSE = 4.252	
Adj R square = 0.348			F-stat = 27.199	

Table 9. Estimated parameter and statistical values obtained from a simple linear regression model $Y = \beta_0 + \beta_1 X$ with $Y = \text{Inflation}$, $X = \text{Value Added Tax}$.

$Y = \text{Inflation}, X = \text{VAT (Value Added Tax)}$				
Coeff	Est	Std Err	T-stat	P-val
$\hat{\beta}_0$	24.562	2.448	10.035	0.001
$\hat{\beta}_1$	-0.1171	0.145	-8.056	<0.001
R square = 0.575			RSE = 3.469	
Adj R square = 0.566			F-stat = 64.899	

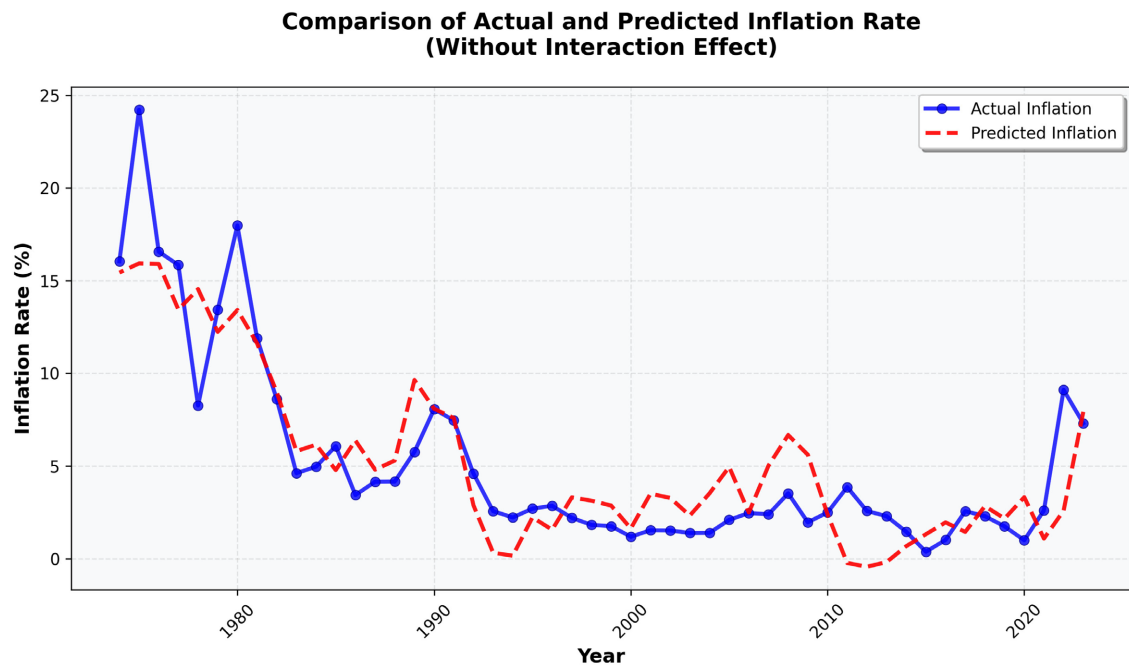
5.2. Multiple Linear Regression without Interaction

Now we first test the multiple regression model for inflation which includes all 9 predictors described by Equation (6). The least-square estimates of the coefficients for multiple regression model are shown in **Table 10**. The coefficient of determination R^2 and adjusted R^2 values are higher than the individual simple models but is not enough to use for prediction purpose. We can, however, comment on the individual significance of the factors in the analysis. The least squares estimates indicate that only two factors—interest rate (IR) and value added taxes (VAT)—are statistically significant in explaining variations in the inflation rate. These factors have a clear and measurable impact. On the other hand, the remaining variables in the model do not show significant contributions, implying they do not strongly influence the inflation rate within the given dataset.

Table 10. Inflation with all Factors (without interaction).

Y = Inflation, X = UR, GDPG, CPI, EXR, RPI, IR, PPI, VAT, GDP				
Coeff	Est	Std Err	T-stat	P-val
β_0	-59.905	31.299	-1.914	0.063
β_{UR}	-0.320	0.506	-0.633	0.530
β_{GDPG}	-0.133	0.168	-0.792	0.433
β_{CPI}	0.004	0.005	0.801	0.428
β_{EXR}	-0.045	0.037	-1.121	0.234
β_{RPI}	-0.023	0.019	-1.185	0.243
β_{IR}	0.701	0.184	3.809	0.001
β_{PPI}	0.176	0.236	0.747	0.460
β_{VAT}	-0.951	0.299	-3.180	0.003
β_{GDP}	0.024	0.012	1.993	0.053
R square = 0.74		RSE = 2.874		
Adj R square = 0.68		F-stat = 12.352		

To better understand how well the model performs, we plotted a graph in **Figure 1**, showing Inflation rate for both the observed and predicted values. The model's predicted values generally follow the overall trend of the actual inflation data, but it sometimes misses certain fluctuations, such as sharp dips and rises seen in the observed data. This suggests that while the model captures some patterns, there is room for improvement. Refining the model or adjusting the input factors could help make it more accurate in predicting the inflation rate.

**Figure 1.** Comparison of actual and predicted inflation rate without interaction effect.

5.3. Multiple Regression with Interaction

We now construct a multiple linear regression model to predict inflation rate (INF), using the six significant variables identified from the simple linear regression analysis: Interest Rate (IR), Value-Added Tax (VAT), Gross Domestic Product (GDP), Producer Price Index (PPI), Retail Price Index (RPI), and Consumer Price Index (CPI). In this model, we also account for interactions between the predictor variables by considering all possible combinations of interactions. That is,

$$\begin{aligned} INF = & \beta_0 + \beta_{IR} IR + \beta_{VAT} VAT + \beta_{GDP} GDP + \beta_{PPI} PPI + \beta_{RPI} RPI + \beta_{CPI} CPI \\ & + \beta_{IR:VAT} IR * VAT + \beta_{IR:GDP} IR * GDP + \beta_{IR:PPI} IR * PPI + \beta_{IR:RPI} IR * RPI \\ & + \beta_{IR:CPI} IR * CPI + \beta_{VAT:GDP} VAT * GDP + \beta_{VAT:PPI} VAT * PPI \\ & + \beta_{VAT:RPI} VAT * RPI + \beta_{VAT:CPI} VAT * CPI + \beta_{GDP:PPI} GDP * PPI \\ & + \beta_{GDP:RPI} GDP * RPI + \beta_{GDP:CPI} GDP * CPI + \beta_{PPI:RPI} PPI * RPI \\ & + \beta_{PPI:CPI} PPI * CPI + \beta_{RPI:CPI} RPI * CPI \end{aligned}$$

The least squares estimates of the model coefficients are presented in **Table 11**, providing insight into the strength and significance of each predictor and interaction term in the model.

Table 11. Inflation onto five significant factors with interaction.

$Y = \text{INF}, X = \text{IR, VAT, GDP, PPI, RPI, CPI,}$ $\text{IR:VAT, IR:GDP, IR:PPI, IR:RPI, IR:CPI,}$ $\text{VAT:GDP, VAT:PPI, VAT:RPI, VAT:CPI, GDP:PPI,}$ $\text{GDP:RPI, GDP:CPI, PPI:RPI, PPI:CPI, RPI:CPI,}$				
Coeff	Est	Std. Err.	T-stat	P-val
β_0	28.687	10.339	2775	0.010
β_{IR}	1.601	0.569	2.815	0.009
β_{VAT}	-0.650	0.395	-1.644	0.111
β_{GDP}	-2.133	0.786	-2.713	0.011
β_{PPI}	-0.168	0.190	-0.884	0.384
β_{RPI}	-0.015	0.011	-1.274	0.213
β_{CPI}	-0.092	0.084	-1.922	0.064
$\beta_{IR:VAT}$	-0.027	0.046	-0.599	0.064
$\beta_{IR:GDP}$	-0.049	0.043	-1.136	0.265
$\beta_{IR:PPI}$	-0.038	0.019	-1.983	0.057
$\beta_{IR:RPI}$	0.002	0.001	2.071	0.047
$\beta_{IR:CPI}$	0.001	0.001	1.178	0.248
$\beta_{VAT:GDP}$	-0.033	0.065	-0.497	0.623
$\beta_{VAT:CPI}$	0.004	0.003	1.298	0.205
$\beta_{GDP:PPI}$	0.063	0.018	3.484	0.002

Continued

$\beta_{\text{GDP:RPI}}$	-0.003	0.001	-2.522	0.017
$\beta_{\text{GDP:CPI}}$	0.003	0.001	2.797	0.009
$\beta_{\text{PPI:RPI}}$	0.000	0.000	4.015	<0.001
$\beta_{\text{PPI:CPI}}$	0.001	0.001	0.971	0.339
$\beta_{\text{RPI:CPI}}$	0.000	0.000	-1.172	0.251
R square = 0.979		RSE = 0.73		
Adj R square = 0.966		F-stat = 72.470		

The coefficient of determination for this model is $R^2 = 0.979$, and the adjusted $R^2 = 0.966$, making it the best-performing model among those discussed so far. These values indicate that 97.9% of the variability in inflation can be explained by the predictors in the model, and the adjusted R^2 accounts for the number of predictors, confirming that the model performs well even when adjusted for complexity. This suggests that incorporating interaction terms significantly improves the model's predictive accuracy compared to previous models used in the study.

Similar to the previous model, a corresponding graph is plotted in **Figure 2** to provide a visual representation of performance. The curve obtained aligns more closely with the real-world data compared to the model without interaction, as shown in **Figure 1**. This improved fit corroborates the higher R^2 value observed for the current model.

**Comparison of Actual and Predicted Inflation Rate
(With Interaction Effect)**

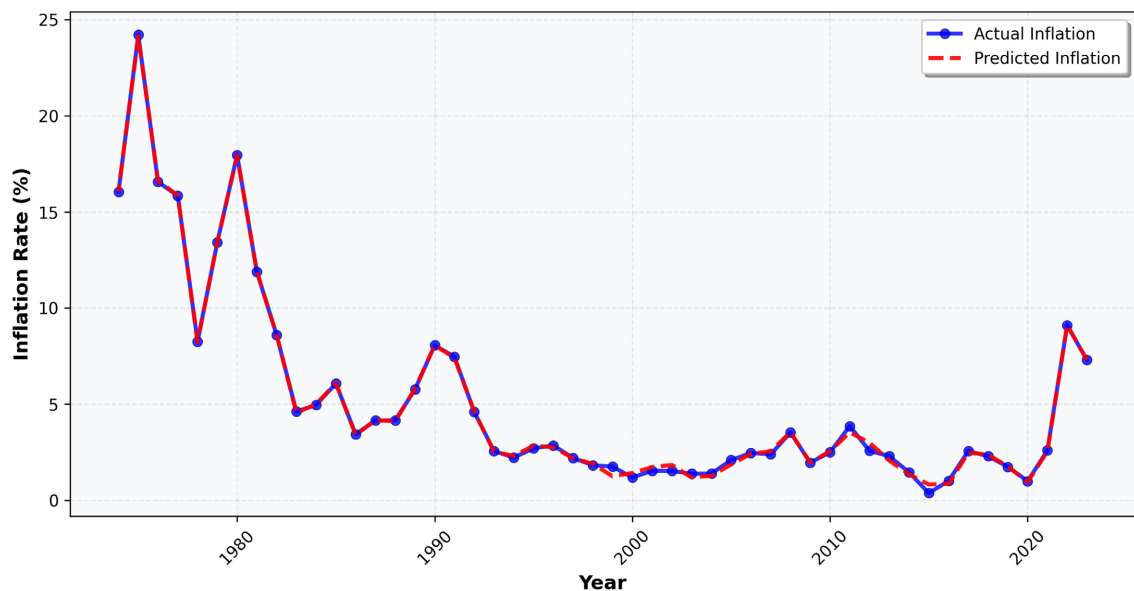


Figure 2. Comparison of actual and predicted inflation rate with interaction effect.

Table 11 reveals that only 7 out of the 21 predictors demonstrate a statistically significant relationship with the response variable, inflation rate. Among these,

Gross Domestic Product (GDP) and interest rate (IR) stands out as the sole predictor exhibiting a strong association with inflation. This observation shows that the interest rate (IR) is the common significant factor for inflation rate derived from individual factor simple linear regression models and the multiple linear regression model without interaction terms.

Among the 15 interaction terms analyzed, only 5 exhibit statistically significant associations with the inflation rate: the interactions between interest rate (IR) and retail price index (RPI), gross domestic product (GDP) and producer price index (PPI), gross domestic product (GDP) and retail price index (RPI), gross domestic product (GDP) and consumer price index (CPI), and producer price index (PPI) and retail price index (RPI). These significant interaction terms are most probably the contributors to the improved model's predictability, as indicated by the higher R^2 value. It is worth noting that the interaction terms between value-added tax (VAT) and producer price index (PPI), as well as VAT and RPI, were excluded from **Table 11** because multicollinearity exists among these variables.

During the feature selection process to identify the most relevant factors for this model, it might look logical to exclude all individual factors except GDP and IR, but it contradicts the hierarchical principle. This principle states that the inclusion of interaction terms in a model makes it essential to retain in the model due to the retention of their corresponding main effects regardless of the statistical significance of their coefficients. Specifically, if the interaction between two variables (e.g., X_1 and X_2) is deemed significant, the main effects of X_1 and X_2 must also be included in the model, even if their individual p-values are not statistically significant.

Excluding individual terms can distort the interpretation and effects of the interaction terms, potentially compromising the model's validity. To adhere to this principle and ensure accurate representation of relationships, the refined model is expressed through the following equation:

$$\begin{aligned} INF = & \beta_0 + \beta_{IR} IR + \beta_{GDP} GDP + \beta_{PPI} PPI + \beta_{RPI} RPI + \beta_{CPI} CPI \\ & + \beta_{IR:RPI} IR * RPI + \beta_{GDP:PPI} GDP * PPI + \beta_{GDP:RPI} GDP * RPI \\ & + \beta_{GDP:CPI} GDP * CPI + \beta_{PPI:RPI} PPI * RPI \end{aligned}$$

5.4. Discussion

The results confirm that interest rates, GDP growth, and price indices are significant drivers of UK inflation, consistent with macroeconomic theory. Importantly, the inclusion of interaction terms reveals that these variables do not operate in isolation: for example, the influence of GDP growth on inflation is amplified when interest rates are low, reflecting the role of monetary policy in conditioning demand-pull pressures. Similarly, price index effects interact with GDP growth, highlighting how supply shocks may translate into stronger inflationary outcomes during periods of economic expansion.

From a policy perspective, these findings suggest that inflation management in the UK requires a holistic view that considers the combined effects of monetary

policy, economic growth, and cost shocks. For instance, raising interest rates may be less effective in curbing inflation if supply-side pressures dominate. Conversely, coordinated policies that address both demand and supply channels may yield better inflation outcomes. These insights underscore the value of incorporating interaction effects in empirical inflation modeling and provide relevant lessons for the Bank of England in its efforts to maintain price stability.

While linear regression provides a transparent and interpretable framework for understanding inflation dynamics, it is important to recognize that inflation may follow nonlinear trajectories. Nonlinearities may arise from threshold effects (e.g., when inflation accelerates beyond certain interest rate levels), structural breaks, or interactions with global shocks. Future research could extend this work by employing nonlinear econometric techniques, such as threshold autoregression, vector error correction models, or regime-switching frameworks, as well as machine learning approaches that can capture complex interactions without presupposing linearity.

6. Limitations and Future Works

Several limitations of this study should be acknowledged. The analysis relies on secondary macroeconomic data, which may be subject to measurement inconsistencies and revisions over time. The extended period under consideration also encompasses major structural breaks in the UK economy, including the global financial crisis of 2008, Brexit, and the COVID-19 pandemic, all of which may have affected the stability of the estimated relationships. Moreover, the use of multiple linear regression imposes the assumption of linearity between predictors and inflation, a simplification that may not adequately reflect the nonlinear or regime-dependent nature of inflation dynamics. The relatively narrow set of predictors considered in this study further raises the risk of omitted variable bias, as global influences such as exchange rate fluctuations, energy prices, and international supply chain disruptions also play important roles in shaping inflation.

Future research could address these limitations by employing nonlinear econometric models, such as threshold autoregression, vector error correction, or regime-switching approaches, which are better suited to capture nonlinearities and structural breaks. Incorporating a broader set of predictors, including global economic indicators, financial market variables, and measures of external shocks, would enhance the robustness and generalizability of the results. Additionally, comparative studies across countries or time periods could provide deeper insights into the heterogeneity of inflation dynamics and the extent to which the UK experience reflects broader international patterns. By pursuing these directions, future work can build upon the present findings and provide a more comprehensive understanding of the complex forces driving inflation.

7. Conclusions

In this research, we have thoroughly investigated the factors that contribute to the

inflation rate in the UK using multiple regression analysis, with and without interaction terms. The first linear model without interactions indicated that the interest rate (IR) and value-added tax (VAT) are the most significant contributors to the inflation rate of the UK. However, the predictive capability of this model is below the level of expectation as indicated by $R^2 = 0.74$ and adjusted $R^2 = 0.68$, and insufficient to capture the complex dynamics of the inflation rate.

Incorporating interaction terms significantly improved the model's explanatory power ($R^2 = 0.979$), adjusted ($R^2 = 0.966$). The inclusion of interactions revealed five significant combinations, such as $IR \times RPI$ and $GDP \times PPI$, which underscored the importance of exploring relationships between predictors to better understand their joint effects on inflation. The outcome of the analysis demonstrated the significant role of incorporating interaction terms in the model in capturing the complexity and interdependence of drivers of the inflation rate, offering a more comprehensive framework for analysis.

In summary, the findings of this study highlight the limitations of models excluding interaction terms and the potential for more accurate predictions when interactions are properly accounted for. Future work could explore nonlinear relationships, extend the dataset, or examine additional predictors to further enhance the understanding of inflationary mechanisms. These results serve as a foundation for more informed economic decision-making and model development in the study of inflation.

Conflicts of Interest

The authors confirm that there are no conflicts of interest to disclose in relation to this research. Moreover, publicly available secondary data has been used for this research.

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