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IFP 6014 FINANCE AND ECONOMICS INDEPENDENT RESEARCH PROJECT

ANALYSIS OF GROWTH REGRESSION: EXAMINING THE RELATIONSHIP BETWEEN GDP AND INFLATION

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ABSTRACT

This research analyses the relationship between inflation and gross domestic product (GDP) growth in the United Kingdom, with a multiple linear regression model. The data used in the research spans from 2012 to 2023, and is obtained from the Office for National Statistics (ONS) and the Bank of England. The regression model investigates the impact of inflation, interest rates, trade balance, and gross fixed capital formation on GDP growth. The analysis of the model shows a significant positive relationship between inflation and GDP growth, suggesting that a 1% increase in the inflation rate corresponds to a 0.808 increase in the natural logarithm of GDP. Robustness tests confirm the validity of the regression model, presenting no problems of multicollinearity, omitted variable bias, outliers, heteroskedasticity, or non-normality. However, autocorrelation was detected, which was remedied by using the Newey-West HAC method for estimation. The findings contribute to the understanding of the role of inflation, in the economic growth, contradicting with some of the earlier studies about the topic (Barro, 1996). Policy recommendations include considering the positive impact of inflation on GDP growth, when forming monetary policies and constantly evaluating the inflation values for GDP targets. Further research is suggested to include longitudinal studies across multiple countries and sector-specific evaluations to improve the understanding and universality of the findings.

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1. INTRODUCTION

1.1 Preamble

Economic growth is a strong indicator of economic welfare; thus, it is often considered one of the crucial concepts in the field of economics. Considering the current economic state of the UK, an analysis of the relationship between economic growth and inflation rates becomes crucial, in order to understand the g dynamics in the nation's financial climate. Real GDP growth is a perfect tool to measure economic growth and has several microeconomic and macroeconomic factors that influence it. In this research, real GDP serves as the indicator of economic growth. Therefore, whenever GDP is mentioned, it implies real GDP. Inflation rate is certainly one of these macroeconomic factors and the relationship between it and GDP growth often draws the interest of researchers. A multiple regression model is the best tool to investigate such a relationship.

1.2 Background

According to the Quantity Theory of Money developed by Friedman (1956), there is a direct relationship between the quantity of money in an economy and the level of prices. Consequently, economic growth and inflation rate, which is an indicator of the level of prices should have a clear relationship according to that theory. Another seminal work that supports Friedman's theory is Barro's investigation, which is based on 30 years of data from around 100 countries (1995), a 10 percent increase in the inflation rate is associated with decrease in the growth rate of GDP per capita by around 0.2 percent. Barro (ibid) continues his argument by claiming that this negative relationship is valid for both high and low inflation rates. Since Barro analysed a very large data set, his work is crucial about the field and should be considered during the policy making processes.

In the exploration of the causal relationship between inflation and economic growth, Sarel's (1996) work illuminates the dynamics between them to some extent, by investigating the possibility of nonlinear effects, such as a threshold value that changes the impact of inflation on economic growth from positive to negative. The study (ibid) identifies that there is a point of transformation at an inflation rate of 8%. Below this threshold, inflation effect on GDP growth is insignificant and negligible; however, above this threshold, the effect of inflation rate becomes significant and extremely powerful (ibid).

A later research made by Arai, Kinnwal, and Thoursie (2004) investigated the same relationship and resulted that there is no significant evidence that supports the view that the high inflation rate is harmful to GDP growth. While the results seems contradictory against Barro's investigation, it is not clear whether the impact of inflation is significant or not.

1.3 Aim of the Research

The main goal of the research is to analyse the effect of inflation on gross domestic product (GDP) in the UK, determining both the direction and significance of this relationship. The direction of the relationship is going to be evaluated by the sign and the magnitude of the coefficient of inflation in the regression model. For the significance of the relationship, the t-value of the inflation variable will be assessed. With the outcomes of this investigation, policy makers can develop efficient strategies for diminishing negative impacts on GDP growth, and therefor improve economic health.

1.4 Outline

The first chapter of the research paper was the introduction. The next part is the literature review, which will focus on the previous academic works about inflation's influence on GDP growth. The third chapter is the methodology which aims to explain the multiple linear regression model that was used in the study and give insights about the data set. The fourth chapter is the findings and discussion. That part of the paper provides the analysis of the data and the regression results. The final chapter is the conclusion which sums up the paper and gives further suggestions.

2. LITERATURE REVIEW

2.1 Introduction

The relationship between GDP and inflation is a pivotal subject in the economic literature. The topic draws large attention due to its usefulness for the policy making processes in the areas of economic growth and price stability. This chapter of the study seeks to provide a comprehensive overview of seminal theories and academic works about the understanding of this relationship, while also emphasizing their relevance to this research project, which focuses on analysing GDP's relation to inflation in the UK. The studies of the relationship between GDP and inflation have evolved over the years, as economists adopting different theories and methodologies to examine those two notions. The Monetarist Theory emphasizes the role of money supply in determining inflation levels, while the Keynesian Theory shows the impact of aggregate demand and the effect of government intervention on economic trends.

Thematically, the literature shows some different opinions between Monetarist and Keynesian perspectives. The Monetarists prioritize monetary policy and claim that it has a dominant role in terms of controlling the inflation. They state that a stable money supply is essential for maintaining the price stability and having an economic growth which is also sustainable. On the other hand, Keynesians argue for active fiscal policies and interventions to manage economic environments. They state that government intervention is necessary to loosen economic fluctuations.

Methodologically, the literature includes both qualitative and quantitative approaches. Monetarists often use quantitative models to investigate the relationship between GDP growth and inflation, also applying econometric techniques to test hypotheses empirically. Keynesians on the other hand, often work with more qualitative assessments, to study the

impact of fiscal policies on GDP growth. Their work highlight s the role of expectations and preferences in the shaping of the structure of the economy.

The evolution of the perspectives on the relationship between GDP and inflation can be traced back. First debates between Monetarists and Keynesians in the mid-20th century established developments in the economic theory. Nowadays, economists have incorporated insights from both views, leading to a more integrated way of understanding of the factors influencing inflation and economic growth.

2.2 Body

The history about the relationship between GDP and inflation is enhanced by several theoretical perspectives and empirical studies. Those works illuminate the complex and crucial nature of their relationship. Monetarist and Keynesian theories offer foundational frameworks, while empirical investigations provide important information about the dynamics.

Monetarists, including influential figures like Milton Friedman and Robert E. Lucas Jr., emphasize the crucial role of money supply in determining the inflation levels and inflation targets. Their works underline the significance of controlling the money growth, in order to maintain the prices stable. Additionally, empirical studies such as Lucas (1973) provide different perspectives to the field. Lucas (ibid) argues that for the high inflation variance countries, demand shifts usually have large impact on the prices but little impact on the money output parameters like GDP. On the other hand, low inflation variance countries usually experience larger impacts on money output by the demand curves (ibid). It should be

acknowledged that Lucas' findings do not claim that inflation has insignificant effect on money output, but gives a different viewpoint to look from.

Conversely, Keynesian perspectives, explained by academics such as John Maynard Keynes and Jordi Galí, highlight the importance of fiscal and monetary policies in managing economic fluctuations. Keynes' foundational contributions emphasize the role of government intervention during the periods of recession orn high inflation. Galí's modern perspective emphasizes incorporating expectations into inflation dynamics, highlighting the complexities of policy formulation.

Moreover, empirical investigations further enrich our understanding of the GDP-inflation relationship. Studies such as Koulakiotis et al. (2011) have very similar explore the causal relationship between inflation and GDP for European countries. Authors (ibid) state that there is a significant and positive relationship between inflation and GDP, while stating that their research is limited to one continent and further research should be made for a larger geographical scale. Similarly, Ramallari and Merko (2023) examine the relationship between inflation and GDP in the context of Albania's economy. Ramallari and Merko's study shows similar findings but goes the extra mile during the discussion, by stating that the causal relationship between the two factors are caused by the increase in production. This research should be considered seminal, as it further improves the explanation of the relationship.

Furthermore, studies like Arai et al. (2006) challenge the conventional wisdom, by examining cyclical and causal patterns of inflation and GDP growth. Their findings suggest nuanced relationships influenced by factors such as country heterogeneity and time-specific shocks.

Similarly, Živkov et al. (2020) investigate the effects of inflation and inflation uncertainty on GDP growth in Central and Eastern European countries. They argue that countries with smaller economies experience larger effects from high inflation rates and inflation uncertainty in both upturn and downturn conditions (ibid).

Additionally, Sarel (1996) explores nonlinear effects of inflation on economic growth, revealing a significant finding in the relationship between inflation and growth rates. His findings also show the importance of considering nonlinear dynamics in the relationship and that it should be considered as a deep study. Sarel's work (1996) is still considered as one of the milestones of the field.

2.3 Relevance to the Study

Understanding these theoretical frameworks is crucial for analysing the relationship between GDP and inflation in the UK. Monetarist perspectives argue for controlling money supply to decrease the effects of the problems caused by inflation, which aligns with policies aimed at stabilizing prices in the UK economy. On the other hand, Keynesian viewpoint emphasize the role of government intervention in managing economic fluctuations by considering the importance of fiscal policies in addressing inflationary trends in the UK.

Several studies have examined the relationship between inflation and GDP in the UK and other countries, and they provide valuable insights for this research and for the topic in general. For instance, studies that analyse historical data on inflation and GDP growth rates in the UK offer empirical evidence to support existing theories. Additionally, comparative

studies across different economies may show how effective various policy approaches are, regarding economic growth and management of inflation.

2.4 Conclusion

In conclusion, the literature on the relationship between GDP and inflation includes diverse theoretical perspectives and methodological approaches which shows the complexity of this subject. By integrating insights from Monetarist and Keynesian theories, scholars can develop an integrated understanding of the factors influencing inflation and economic growth. Future research should continue to refine existing models, address the limitations in the existing studies, and explore the influence of additional factors affecting the relationship.

In this study, the relationship between the factors is investigated through a multiple linear regression model. Therefore, methodological limitations of some of the research are not faced. Research that use different data analysis tools and support vector machines can be given as examples. While some works such as Arai et al. (2006) and Živkov, Kovačević and Papić-Blagojević (2020) focus on a large number of countries for their analysis, this research focuses solely on the UK. Consequently, the findings of this research can be more suitable for country specific policy making. On the contrary, larger scaled research might be better for the generalization of the findings and the development of the theoretical background.

3. DATA AND METHODOLOGY

3.1 Research Design

In the exploration of the relationship between inflation and economic growth, Sarel's (1996) work illuminates the dynamics between these factors to some extent, by investigating the possibility of nonlinear effects. According to Sarel (ibid), there is a threshold value of inflation, that changes the direction of the impact of it on economic growth. Inflation rate and gross domestic product (GDP) are indicators of the wealth of people, and the wealth of the nation respectively. Even though these factors are different, they are highly related. This research aims to investigate the causal relationship between inflation rate and GDP in the UK with a multiple linear regression model. Along with inflation, the other explanatory factors are added as trade balance, gross fixed capital formation, and the interest rate; and the explained variable in the model is GDP. The data is obtained in the form of time series data, from the Office for National Statistics and the Bank of England. The data is collected from 2012 to 2023, and processed with STATA. The analysis explains whether the variables inflation, interest, gross fixed capital formation, and trade balance have an impact on GDP, and whether it is positive or negative.

3.2 Data Analysis Technique

3.2.1 Hypotheses

The hypotheses under investigation regarding the relationship between the inflation rate and GDP growth is as follows:

H0: There is no causal relationship between the inflation rate and the GDP growth for the UK.

H1: There is a positive relationship between the inflation rate and the GDP growth for the UK.

The hypotheses will be tested with a multiple linear regression model through STATA.

3.2.2 Regression Model

$$\ln(gdp_t) = \beta_0 + \beta_1 * inf_t + \beta_2 * inter_t + \beta_3 * \frac{trade_t}{gdp_t} + \beta_4 * cap_t$$

t: Time trend

gdp: Gross domestic product

inf: Retail Prices Index as inflation

cap: Gross Fixed Capital Formation

inter: Interest Rate

trade: Trade Balance = Net Exports – Net Imports

3.2.3 Variables

Gross Domestic Product (GDP): GDP represents the total monetary value of all finished goods and services produced in a country, in a specific time period (Bank of England, 2019).

Retail Prices Index (inf): Inflation, as measured by the Retail Prices Index (RPI), represents the rate the level of prices for goods and services is rising, leading to a decrease in purchasing power over time (Bank of England, 2022). Inflation impacts consumer spending behaviour, business investment decisions, and overall economic stability (ibid).

Interest Rate: An interest rate tells you how high the cost of borrowing is, or high the rewards are for saving (Bank of England, 2023). Even a small change in interest rates can have a big impact. It is important to keep an eye on whether they rise, fall or stay the same (ibid).

Trade Balance: The trade balance is the difference between the value of the goods that a country (or another geographic or economic area) exports and the value of the goods that it imports (Eurostat, 2013).

Gross Fixed Capital Formation: Gross fixed capital formation, consists of the investments of the producers, deducting disposals, in fixed assets during a given period. It also includes certain additions to the value of non-produced assets realized by producers or institutional units (Eurostat, 2023).

3.2.4 Robustness Tests

The robustness tests are applied, in order to check the validity of the model, which included assessing multicollinearity using the VIF test, detecting omitted variable bias through the

Ramsey RESET Test, identifying outliers with Added Variable Plots, checking for heteroskedasticity with the Breusch-Pagan Test, examining serial correlation using the Breusch-Godfrey Test, and assessing the normality of residuals with a Kernel Density Plot. The results of these tests provided information on the potential issues of the model.

3.3 Data and Source of Data

3.3.1 Source of Data

Secondary data from the UK was used in the research. The time of the data spans from 2012 to 2023. The variables GDP, inflation rate, gross fixed capital formation, and trade balance are collected from the Office for National Statistics. The interest rate is collected from the Bank of England.

3.3.2 Sample and Observations

There are 47 observations, representing a quarter of a year, spanning from the first quarter of 2012, to the third quarter of 2023. There are no missing observations in the data set.

3.3.3 Data Modifications

Since the interest rate is not a variable that can be observed quarterly, the average of monthly interest rate of 3 months in each quarter is used.

The original model was as follows:

$$\ln(GDP) = \beta_0 + \beta_1 * inflation + \beta_2 * interest + \beta_3 * \frac{trade}{gdp} + \beta_4 * capital + \beta_5 * unemployment$$

However, according to the VIF test, it is observed that multicollinearity was present in that model. With the correlation matrix, it is established that the multicollinearity problem was between the capital variables (unemployment rate and gross fixed capital formation). Thus, the unemployment rate was removed from the model.

3.4 Limitations

As some of the research in the literature suggests, the direction of the relationship between developed and developing countries can contradict. Our research solely focuses on the UK; therefore, its findings cannot be interpreted for all countries.

The research does not include any tests to measure stationarity.

4. FINDINGS AND DISCUSSION

4.1 Descriptive Analysis

The research is conducted with time series data. The aim is to investigate the relationship between GDP growth and inflation rate. As we can see from Figure 1, both the inflation rate and the GDP follows both increasing and decreasing trends in the selected time period.

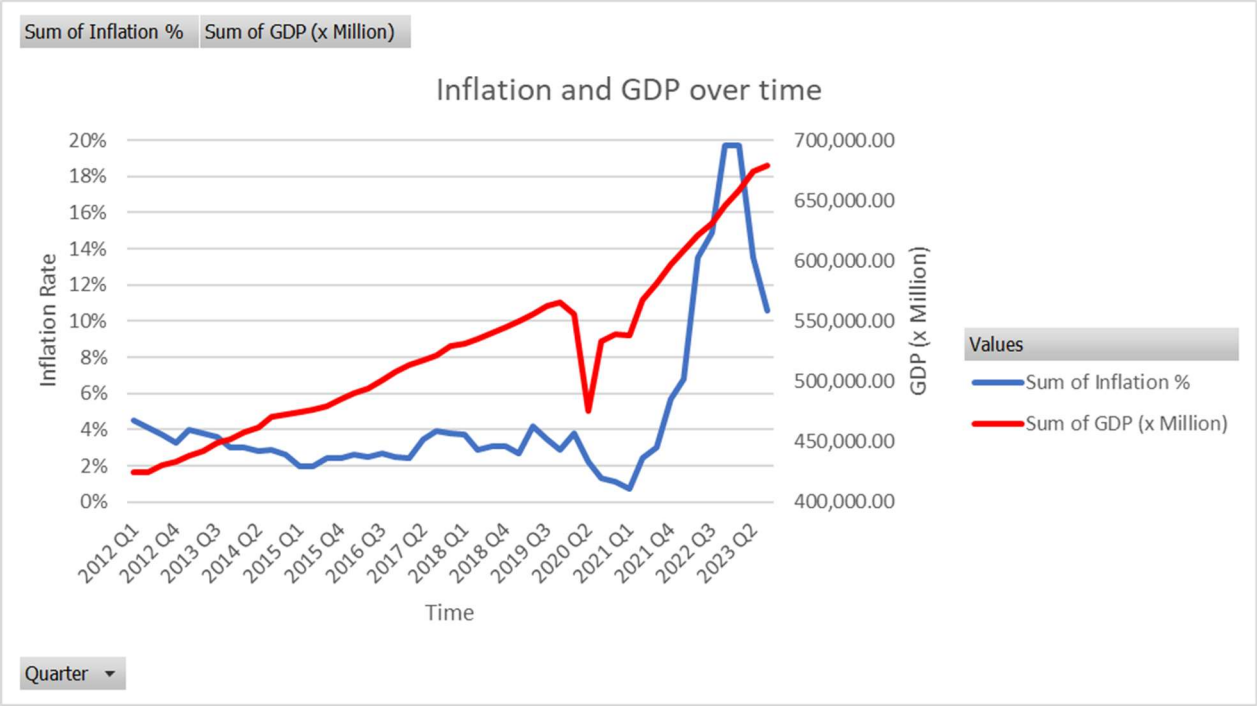

Figure 1: GDP and Inflation Graph

The inflation rate starts around 4.5% and fluctuates around the value of 3%, until it starts to follow a downward trend at the first quarter of 2020. GDP on the other hand, begins at 424,704 and increases constantly and significantly until the first quarter of 2020. After the first quarter of 2020, both factors decrease significantly. GDP's fall lasts for just one period and ends in the second quarter of 2020, but the fall is more significant. On the contrary,

inflation follows a less steep decrease trend, but it lasts for around one year, starts increasing in the second quarter of 2021. After those decreasing periods, both indicators rise drastically. The rise of GDP lasts until the third quarter of 2023, which is the end of our observation period. Inflation on the other hand, rises dramatically and reaches its peak at 2022 Q4 and 2023 Q1, with 19.7% in each of them. It later follows a large decline in the last two periods and decreases down to the value of 10.6%. While it is hard to come to any conclusion with the first part of the graph, both indicators follows mostly an increasing trend after the first quarter of 2021.

4.2 Results of Regression

After modifying the model, the regression is made through STATA which have presented results. According to those results (Table-1), the coefficient of inflation is positive and the causal relationship between the inflation rate and ln(GDP) is significant, per the t-value of inflation.

Table 1: First Estimation

Variable	**Coefficient**	**t-value**	**P-value**
inflation	0.808	3.42	0.001
interest	0.682	0.76	0.449
trade_gdp	1.818	3.44	0.001
capital	$1.09 * 10^{-5}$	14.88	0.000
β0	12.118		

However, it is evidenced that this estimation is not viable, since a autocorrelation problem was observed during the robustness test (Table X).

Table 2: Newey West HAC Estimation

Variable	**Coefficient**	**t-value**	**P-value**
inflation	0.808	2.94	0.005

interest	0.682	0.57	0.572
trade_gdp	1.818	3.65	0.001
capital	$1.09 * 10^{-5}$	10.64	0.000
β0	12.118		

In order to prevent the errors that are caused by autocorrelation, the model was regressed again, with the method of Newey-West HAC (Table 2). The difference between the estimations are not crucial, since the effect of inflation is still significant at 1% level. The adjusted R^2 value is 90.35%, which indicates that 90.35% of the variation of the dependent variable (ln(GDP)) is explained by the independent variables.The coefficient of inflation is equal to 0.808, which means that an increase of 1% in the inflation rate results in an increase of ln(GDP) by 0.808. It can be observed that there is no significant causal relationship between GDP growth and the interest rate, since the t-value of the $inter_t$ variable is 0.57, and therefore the variable is not significant in 95% level. The p-value of inflation is 0.005, which further confirms the significance of the effect that inflation has on GDP growth.

Here is the estimation of the final model:

$$\ln(gdp_t) = \underset{}{12.118} + \underset{(0.0761)}{0.808} * inf_t + \underset{(0.275)}{0.682} * inter_t + \underset{(1.197)}{1.818} * \frac{trade_t}{gdp_t} + \underset{(0.498)}{1.09 * 10^{-5}} * cap_t \quad (1.02*10^{-6})$$

4.3 Test Results

4.3.1 Test for Multicollinearity

The Variance Inflation Factors (VIF) Test was applied to the model, to measure whether the independent variables are not correlated with each other or not.

Table 3: VIF TEST		
Variable	**VIF**	**1/VIF**
inflation	3.19	0.313

interest	2.80	0.357
capital	1.41	0.710
trade_gdp	1.32	0.760
Mean VIF	2.18	

According to the results of the VIF Test (Table 3), there is no multicollinearity present, since none of the variables have VIF values above 10, which is the threshold value.

4.3.2 Test for Omitted Variable Bias

The Ramsey RESET Test was conducted to analyse the validity of the functional form specification of the model. This test is particularly useful for detecting potential misspecifications such as omitted variables or nonlinear relationships between the dependent and independent variables.

Table 4: Ramsey REST Test
F(3, 39) = 1.68
Prob > F = 0.1878

According to the result of the Ramsey REST Test (Table 4), the probability (0.1878) is greater than the 95% significance level and we fail to reject the null hypothesis, which is that the regression model is correctly specified. Thus, it can be said that there is no evidence to suggest that the model is misspecified.

4.3.3 Test for Outliers

Added variable plots are used, to detect the possible outliers in the dataset.

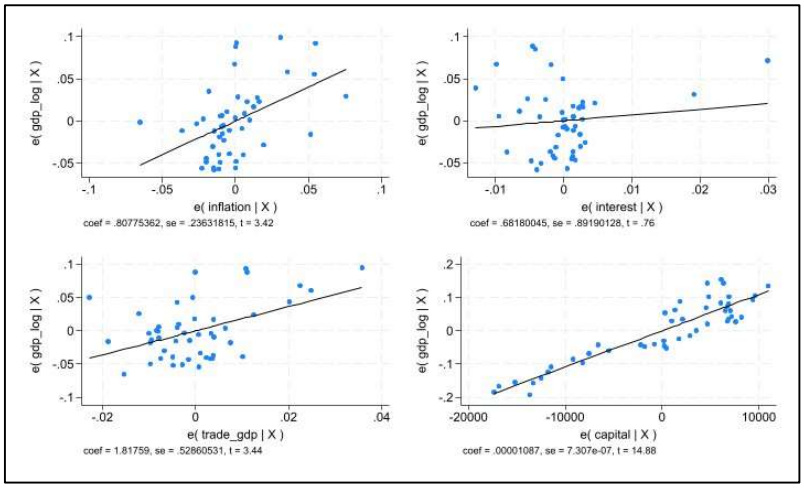

Figure 2: Added Variable Plots

According to the visual inspection of the plots in Figure 2, there are no outliers in the dataset.

4.3.4 Test for Heteroskedasticity

The Breush-Pagan Test is conducted to determine whether the model has heteroskedasticity or not.

Table 5: Breush-Pagan Test
chi2(1) = 2.86
Prob > chi2 = 0.0908

According to the p-value obtained by the test, (Table 5) we fail to reject the null hypothesis of homoskedasticity. Therefore the estimated model does not have a problem of heteroskedasticity.

4.3.5 Test for Autocorrelation

The Breush-Godfrey LM test is conducted on the model, to see whether the model has autocorrelation or not.

Table 6: Breush-Godfrey LM Test

lags(p)	chi2	df	Prob > chi2
1	29.097	1	0.0000

The null hypothesis in Breush-Godfrey LM Test is that there is no serial correlation in the model. Since the p-value is below the value corresponding to the 95% significance level, we reject the null hypothesis (Table 6).

In order to remedy the problem of autocorrelation, the Newey-West HAC method is employed to estimate the model once again. The results are shown in Table 2.

4.3.6 Test for Normality

In order to observe whether the residuals follow a normal distribution, Kernel Density Plots were graphed.

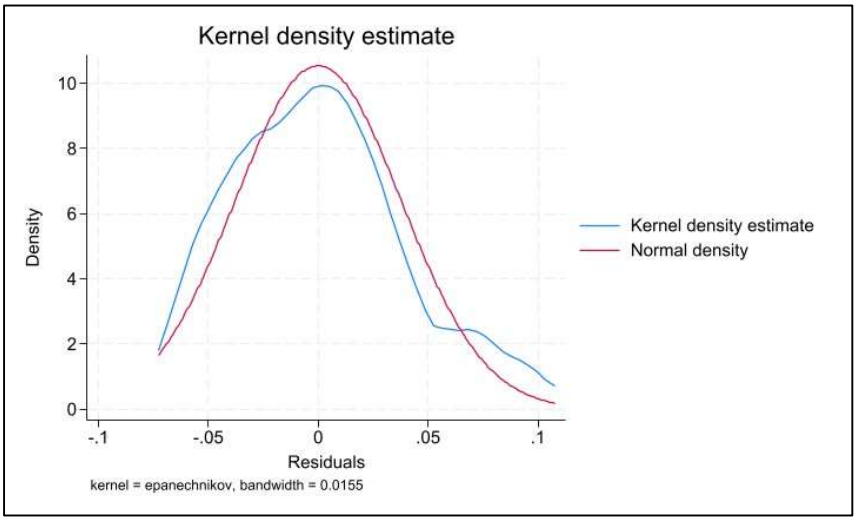

Figure 3: Kernel Density Plots of Residuals

The distribution of the residuals follow a similar bell-shaped curve (Figure 3), ensuring a normal distribution.

4.4 Discussion

The findings of this study provide valuable information about the relationship between GDP growth and inflation rate, in the selected time period in the UK.

Starting with the descriptive analysis, the study observed fluctuations in both inflation rate and GDP over time. Notably, both indicators displayed an increasing trend after the first quarter of 2021. This observation aligns with theories suggesting a potential causal relationship between inflation and GDP growth, such as the Quantity Theory of Money of Friedman (1956). However, it should be noted that another seminal work of the field by Barro (1996) claimed that an increase in the inflation rate causes a decrease in the GDP per capita, and the findings of this research contradicts with that.

Moreover, in to the regression analysis, the results indicated a significant positive relationship between inflation and GDP growth. The coefficient of inflation was found to be 0.808, suggesting that a 1% increase in the inflation rate corresponds to a 0.808 increase in the natural logarithm of GDP. This supports the hypothesis that the inflation rate can trigger economic activity. Nonetheless, it's crucial to note that the model faced an autocorrelation issue, which was remedied by employing the Newey-West HAC method for estimation. On the other hand, the study did not find a significant causal relationship between GDP growth and the interest rate, claiming that the interest rate is the only variable in the model that did not have any significant impact on the dependent variable.

Furthermore, several robustness tests were conducted to assess the validity of the regression model. These tests included inspections for multicollinearity, omitted variable bias, outliers, heteroskedasticity, autocorrelation, and normality. The results of the robustness tests indicated that the model was well-specified, with no evidence of multicollinearity, omitted variable bias, outliers, heteroskedasticity, or a non-normal distribution.

The findings of this study can contribute to the literature on the relationship between inflation and GDP growth. However, it is important to acknowledge the limitations of the study. Firstly, the analysis is based on a specific time period that includes post Covid-19 economic struggles and possible major economic changes because of the extreme economic conditions of the time. Additionally, the study is just based on UK, which makes the findings unsuitable to interpret for the other countries. Sarel (1996) argues that there is a threshold value of inflation that changes the type of relationship between the two factors, but the dataset investigated in the study is insufficient to fully examine the claim.

On the other hand, findings of this research complies with several researches from the literature as well, such as Koulakiotis et al. (2011). Koulakiotis et al.'s study also claimed a positive and significant relationship between the two indicators. However, it should be acknowledged that both studies were solely focused on Europe and therefore have similar limitations.

A longitudinal study including several countries for a similar time period can help evaluate the relationship in a universal way and develop more certain conclusions. An analysis that includes the economic differences between business sectors can also be conducted, with the

variables of sector specific GDP and Gross Fixed Capital Formation. That way, the impact of inflation on the growth of each sector can be found and suggestions for policies can be improved.

Since the research further backs up the claims of the positive impact inflation rate has on GDP growth, central banks should consider the effect of inflation targets on the economic growth.

5. CONCLUSION

5.1 Summary

This research aimed to investigate the relationship between inflation and GDP growth in the UK with a multiple linear regression model. Through a regression model using the data spanning from 2012 to 2023, several findings were found. These results showed a positive relationship between the inflation rate and GDP growth in the UK. Specifically, a 1% increase in the inflation rate corresponded to a 0.808 increase in the natural logarithm of GDP. This result contradicts some earlier studies, such as Barro's (1995) seminal work, which suggested a negative impact of inflation on GDP growth. However, it aligns with theories like the Quantity Theory of Money, suggesting a potential stimulatory effect of inflation on economic activity.

Several robustness tests were conducted on the regression model. Those tests aimed to detext potential problems such as multicollinearity, omitted variable bias, outliers, heteroskedasticity, autocorrelation, and normality There are limitations of the research that needs to be acknowledged. Firstly, the data set only contains a specific time period, including the post COVID-19 economic challenges, which might affect the observed relationship. Moreover, the research focuses solely on the UK, which restricts the universality of the findings results.

5.2 Policy Recommendations and Further Research

Future research can remedy these limitations by conducting longitudinal studies across multiple countries, containing sector-specific analyses to observe the impacts of inflation in more detail.

In view of the findings of the research, policymakers should consider the potential positive impact of inflation on GDP growth, while formulating monetary policies. Adjusting inflation targets accordingly can contribute economic growth. Furthermore, constant evaluation of the inflation dynamics is essential for policies regarding GDP targets.

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7. APPENDICES

Log File

LOG FILE

```
. *opening log file

. log using project.log, replace

-------------------------------------------------------------------------------------------------------------------
-------------------------

      name:  <unnamed>

       log:  C:\Users\ceyci\OneDrive\Masaüstü\project.log

  log type:  text

 opened on:   3 Mar 2024, 14:22:54



.

.

.

. *opening our dataset

. *the data is obtained quarterly by Office of National Statistics

. use "C:\Users\ceyci\OneDrive\Masaüstü\Study\STATA
docs\project_variables_clean_01.03.dta"



.

.

.
```

```
. *seasonally adjusted quarterly gdp is used for gdp values
. *https://fred.stlouisfed.org
. sum gdp

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
         gdp |         47    524271.6    68235.51     424704     679198

.
.
. *RPI values are used for inflation rates
. *https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/doge/mm23
. sum inflation

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
   inflation |         47    .0465957      .04417       .007       .197

.
.
. *For quarterly interest rates, the average of 3 monthly interest rates are used
. *https://www.bankofengland.co.uk/monetary-policy/the-interest-rate-bank-rate
. sum interest

    Variable |        Obs        Mean    Std. dev.       Min        Max
```

```
-------------+---------------------------------------------------------

    interest |        47     .007961    .0109694       .001    .0516667


.

.

. *obtained by Office of National Statistics

.
*https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/unemployment/timeseries/mgsx/lms

. sum unemp


    Variable |        Obs        Mean    Std. dev.       Min        Max

-------------+---------------------------------------------------------

       unemp |        47    .0511489    .0141513       .036       .082


.

.

. *quarterly trade balance is calcualted by substracting the imports by the exports

. *units are seasonally adjusted and in £ million

.
*https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/datasets/uktradegoodsandservicespublicationtables

. sum trade


    Variable |        Obs        Mean    Std. dev.       Min        Max

-------------+---------------------------------------------------------

       trade |        47   -6943.191    7309.254     -26245      13790
```

.

.

. *Gross fixed capital formation is used, £ million

.
*https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/grossfixedcapitalformationbysectorandasset

. sum capital

Variable	Obs	Mean	Std. dev.	Min	Max
capital	47	94216.7	9495.778	75936	109290

.

.

. *numeric value for each quarter to define the data as time series

. sum time

Variable	Obs	Mean	Std. dev.	Min	Max
time	47	24	13.71131	1	47

.

.

. *checking if there are any missing values

. codebook gdp inflation interest unemp trade capital

---

gdp GDP

Type: Numeric (long)

Range: [424704,679198] Units: 1

Unique values: 47 Missing .: 0/47

Mean: 524272

Std. dev.: 68235.5

Percentiles: 10% 25% 50% 75% 90%

438103 472452 521219 562790 630575

---

inflation RPI

Type: Numeric (float)

Range: [.007,.197] Units: .001

Unique values: 29 Missing .: 0/47

Mean: .046596

Std. dev.: .04417

Percentiles: 10% 25% 50% 75% 90%

.02 .025 .031 .04 .135

---

interest Interest Rate

Type: Numeric (float)

Range: [.001,.0516667] Units: 1.000e-07

Unique values: 14 Missing .: 0/47

Mean: .007961

Std. dev.: .010969

Percentiles: 10% 25% 50% 75% 90%

.001 .004167 .005 .006667 .0175

---

unemp
Unemployment Rate

Type: Numeric (float)

Range: [.036,.082] Units: .001

Unique values: 29 Missing .: 0/47

Mean: .051149

Std. dev.: .014151

Percentiles:	10%	25%	50%	75%	90%
	.038	.04	.047	.057	.078

---

trade Trade
Balance

Type: Numeric (int)

Range: [-26245,13790] Units: 1

Unique values: 47 Missing .: 0/47

Mean: -6943.19

Std. dev.: 7309.25

Percentiles: 10% 25% 50% 75% 90%

-16622 -8725 -7259 -3966 1158

---

capital Gross Fixed Capital Formatioin

Type: Numeric (long)

Range: [75936,109290] Units: 1

Unique values: 47 Missing .: 0/47

Mean: 94216.7

Std. dev.: 9495.78

Percentiles: 10% 25% 50% 75% 90%

78655 85844 97427 100943 106086

.

.

.

.

.

. *generating the explanained variable ln(gdp)

. *It is appropriate for this model, to use a logarithm for gdp; it normalizes the data, helps interpreting the coefficient in terms of pe

> rcentage which is suitable for observing the changes in the data

. gen gdp_log = log(gdp)

.

.

.

.

. *generating trade balance as a percentage of gdp, to use as a explanatory variable; a standard way of the measure, provides a relative m

> easure of the importance of the trade balance to the economy, it is also the appropriate way of use for policy making.

. gen trade_gdp = trade/gdp

.

.

.

. *Labelling new variables

. label variable gdp_log "ln(GDP)"

. label variable trade_gdp "Trade Balance / GDP"

.

.

.

.

. *having a look to the inflation and gdp values graphically, to generate a basic idea

. graph twoway lowess inflation gdp_log

.

.

.

.

. *Doing the regression

.

. *ln(gdp) = B0 + B1*inflation_rate + B2*interest_rate + B3*unemployment_rate + B4*trade_balance/gdp + B5*gross_fixed_capital_formation

.

. *The chosen model is consistent with the literature on economic growth, and variable relevance

. regress gdp_log inflation interest unemp trade_gdp capital

```
      Source |       SS           df       MS      Number of obs   =        47
-------------+----------------------------------   F(5, 41)        =     95.01
       Model |  .688840366         5  .137768073   Prob > F        =    0.0000
    Residual |  .059454073        41  .001450099   R-squared       =    0.9205
-------------+----------------------------------   Adj R-squared   =    0.9109
       Total |  .748294439        46   .01626727   Root MSE        =    .03808
```

```
------------------------------------------------------------------------------
     gdp_log | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
   inflation |   .7539516   .2285277     3.30   0.002     .2924306    1.215473
    interest |   1.403362   .9225095     1.52   0.136     -.459684    3.266407
       unemp |  -2.377291   1.123723    -2.12   0.041    -4.646696   -.1078859
   trade_gdp |   1.232197   .5784777     2.13   0.039     .0639376    2.400456
     capital |   7.16e-06   1.89e-06     3.78   0.000     3.34e-06     .000011
       _cons |   12.57862   .2267259    55.48   0.000     12.12074    13.03651
------------------------------------------------------------------------------

.

.
. *Checking for multicollinearity with a VIF test
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
     capital |     10.23    0.097707
       unemp |      8.02    0.124660
    interest |      3.25    0.307846
   inflation |      3.23    0.309392
   trade_gdp |      1.72    0.582210
-------------+----------------------
    Mean VIF |      5.29
```

. *Since the VIF value is bigger than 10 for capital, there is multicollinearity present

.

.

. *Checking multicollinearity again with the correlation matrix, to see the problem more clearly

. pwcorr inflation unemp interest trade_gdp capital, sig

```
             | inflat~n    unemp interest trade_~p  capital
-------------+------------------------------------------------
   inflation |   1.0000
             |
             |
       unemp |  -0.3081    1.0000
             |   0.0351
             |
    interest |   0.7855  -0.2562    1.0000
             |   0.0000   0.0821
             |
   trade_gdp |  -0.4236   0.1223  -0.2257    1.0000
             |   0.0030   0.4128   0.1271
             |
     capital |   0.4920  -0.8971   0.4634  -0.3498    1.0000
             |   0.0004   0.0000   0.0010   0.0160
             |
```

```
. *As we can see from a(5,2) = -0.8971, there is evidence of multicollinearity between
unemployment rate and gross fixed capital formation

> .

.

. *Since they are both capital variables, we should eliminate one to prevent multicollinearity.

.

. *Doing the regression without unemployment

. regress gdp_log inflation interest trade_gdp capital


      Source |       SS           df       MS      Number of obs   =        47
-------------+----------------------------------   F(4, 42)        =    108.65
       Model |   .68235038         4  .170587595   Prob > F        =    0.0000
    Residual |  .065944059        42  .001570097   R-squared       =    0.9119
-------------+----------------------------------   Adj R-squared   =    0.9035
       Total |  .748294439        46   .01626727   Root MSE        =    .03962


------------------------------------------------------------------------------
     gdp_log | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
   inflation |   .8077536   .2363181     3.42   0.001     .3308443    1.284663
    interest |   .6818005   .8919013     0.76   0.449    -1.118129     2.48173
   trade_gdp |    1.81759   .5286053     3.44   0.001     .7508213    2.884359
     capital |   .0000109   7.31e-07    14.88   0.000     9.40e-06    .0000123
       _cons |    12.1177   .0652752   185.64   0.000     11.98597    12.24943
------------------------------------------------------------------------------
```

.

. *Our new model is:

. *ln(gdp) = B0 + B1*inflation_rate + B2*interest_rate + B3*trade_balance/gdp + B4*gross_fixed_capital_formation

.

. *Since the p-value is smaller than 0.05, we can state that the model is statistically significant at 5% significance level

. *The adjusted R-squared value is 0.9035, so we can state that the model explains approximately 90.35% of the variability in the dependen

> t variable

. *We can also claim that the causal relation between interest rate and GDP growth is insignificant at 5% significance level, since the t-

> value for interest is 0.57 which is lower than 1.96

. *For the rest of the explanatory variables (inflation rate, trade balance, gross fixed capital formation), the the relationship is signi

> ficant at 5%, according to each t-value.

.

.

. vif

Variable	VIF	1/VIF
inflation	3.19	0.313271
interest	2.80	0.356590
capital	1.41	0.708950
trade_gdp	1.32	0.754951
Mean VIF	2.18	

. *There is no multicollinearity in the new model, according to the VIF test

.

.

.

. *Using Ramsey REST Test to test for omitted-variable bias

. ovtest

Ramsey RESET test for omitted variables

Omitted: Powers of fitted values of gdp_log

H0: Model has no omitted variables

F(3, 39) = 1.68

Prob > F = 0.1878

. *Based on the Ramsey REST Test, we do not have sufficient evidence to conclude that the model has omitted variables in 95% confidence in

> terval, since the p-value is greater than the associated F-value

.

.

. *Using Added Variable plots to check for outliers

. avplots

. *There are no outliers spotted on the avplots

.

.

. *Checking for Heteroskedasticity with a Breush-Pagan Test. Breush-Pagan is predominantly used in the literaure for heteroskedasticity te

> sting.

. estat hettest

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms

Variable: Fitted values of gdp_log

H0: Constant variance

chi2(1) = 2.86

Prob > chi2 = 0.0908

. *We cannot reject homoskedasticity since the p-value is greater than 0.05, therefore there is no heteroskedasticity problem in the model

> .

.

.

. *time variable is set for Breush-Godfrey Test

. tsset time

Time variable: time, 1 to 47

Delta: 1 unit

```
.
. *Testing for serial correlation with Breush-Godfrey Test
. estat bgodfrey, lags(1)

Breusch–Godfrey LM test for autocorrelation
------------------------------------------------------------------------------
   lags(p) |        chi2              df              Prob > chi2
-------------+----------------------------------------------------------------
      1    |      29.097              1                0.0000
------------------------------------------------------------------------------
                    H0: no serial correlation

.
. *there is serial correlation present, since the p-value is smaller than 0.05
.
.
.
. *Using the Newey-West HAC method to fix serial correlation
. newey gdp_log inflation interest trade_gdp capital, lag(12)

Regression with Newey–West standard errors      Number of obs    =        47
Maximum lag = 12                                F(  4,      42) =    564.14
                                                Prob > F         =    0.0000

------------------------------------------------------------------------------
```

```
             |              Newey–West
    gdp_log | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
   inflation |   .8077536   .2745029     2.94   0.005     .2537844    1.361723
    interest |   .6818005   1.196608     0.57   0.572    -1.733053    3.096654
   trade_gdp |    1.81759   .4977237     3.65   0.001     .8131429    2.822037
     capital |   .0000109   1.02e-06    10.64   0.000     8.81e-06    .0000129
       _cons |    12.1177   .0761225   159.19   0.000     11.96408    12.27132
------------------------------------------------------------------------------

. *Inflation is still statistically significant at 95% confidence interval

.

.

. *Creating a residuals variable to check the normality of residuals

. predict e, residuals

.

.

. *Checking for normality with kernel density plot

. kdensity e, normal

(n() set to 47)

. *The distribution shows that the assumptions of normality of the residuals is reasonably met

.

.
```

.

.

.

.

. log close

      name: <unnamed>

       log: C:\Users\ceyci\OneDrive\Masaüstü\project.log

  log type: text

 closed on: 3 Mar 2024, 14:22:58

.

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