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Effectiveness of Interest Rate Policy on The Management of Macroeconomic Stability: Evidence from the United Kingdom

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Abstract: This study examines the dynamic relationship between the London Interbank Offered Rate (LIBOR), the inflation rate, the unemployment rate and economic growth in the context of the UK, for the period 1992: Q1 to 2016: Q4. The study aims to evaluate the impact of the LIBOR on the management of macroeconomic stability in the UK during the period under review. The study employs a vector autoregressive (VAR) model to examine the dynamic relationship between interest rates, unemployment and GDP. A co-integration test evaluates the long-run relationship between these variables, and the VAR Granger-causality tests the direction of causation among the variables.

The Augmented Dickey-Fuller test shows that the co-integration conditions are not satisfied, as they do not confirm the existence of a long-run relationship between the LIBOR and the other variables. However, the VAR model indicates that there does exist a dynamic short-run relationship between the LIBOR and the consumer price index (CPI) as a measure of inflation. In contrast, the model suggests that there no short-run relationship exists between either the LIBOR and unemployment rate or the LIBOR and economic growth. Granger-causality Wald tests suggest that there is a directional causality between the LIBOR and the inflation rate. However, the test does not indicate a directional causality between the LIBOR and the other variables, suggesting that the former does not contribute to employment or economic growth in the UK.

The findings suggest that while the LIBOR is sufficient for controlling inflation, it is not sufficient for improving economic growth and employment in the UK. Additionally, the study supports the likelihood of the Bank of England using monetary policy instruments that are alternatives to the LIBOR to boost economic growth in the UK.

JEL Classification: *E43, E52, E58*
Keywords: *London Interbank Offered Rate, interest rate, monetary policy, macroeconomic goals, UK*

Introduction

Monetary policy is part of overall economic policy as it contributes to macroeconomic policy objectives, which vary according to a country's level of economic development, growth and social progress. Monetary policy objectives have evolved across time and also according to changes in the behavior and performance of different economies. Nevertheless, at present

there is agreement among developed and developing countries that the ultimate objectives of monetary policy, are to stabilize prices, achieve high rates of employment, and promote economic growth, the latter which also includes protecting the respective currency's purchasing power by maintaining relatively stable exchange rates. The question of the effectiveness of monetary policy in achieving these macroeconomic objectives has been widely addressed in the economic literature. However, after the 2008 financial crisis, no consensus existed within economics and political circles.

In the UK, the Monetary Policy Committee's (MPC)[1] main monetary policy objective is to achieve an inflation target rate of 2%. The Committee's secondary monetary policy objective is to support the government's economic objectives, which include achieving high employment and promoting economic growth. The 2008 financial crisis prompted the Bank of England to adopt the types of large-scale non-conventional monetary policies that stimulate demand. These policies involve expanding credit to households and companies, undertaking currency and stock market interventions, providing liquidity in local and foreign currencies, and devising monetary policies that aim for zero interest rates, all to enhance the country's economic activities (Belke, 2016, Kitamura et al., 2016).

The London Interbank Offered Rate (LIBOR) provided one of the biggest warning signs of the 2008 financial crisis. The LIBOR is the rate banks charge other banks for short-term loans for periods of one, three, or six months, or one year. The typical thinking of the day was that an increase in the LIBOR signaled the possibility of financial instability. Here, banks saw lending to their fellow financial institutions as becoming more risky, which meant the need for tighter lending standards and a general unwillingness among banks to take on risk (Martin et al., 2015). The LIBOR spiked to sky-high levels during the 2008 and 2009 financial crisis, as the banks appeared to be approaching collapse (Ivashina and Scharfstein, 2010, Chira, 2014). Banking is clearly an important sector of the economy. Instability can lead to a decrease in lending, consumer credit, and even business loans. Tight credit can translate to slow or even negative economic growth.

In addition, the LIBOR is one of the most important short-term interest rates, worldwide. According to the USA Commodity Futures Trading Commission, the LIBOR is currently used in interest-rate transactions whose total notional value exceeds $500 trillion, including over-the-counter (OTC) swaps, loans and exchange-traded interest-rate futures, and options contracts. Given its role in such a huge amount of transactions, a change in the LIBOR would result in massive increases or decreases in valuations and interest-rate revenues or losses (Harald, 2016).

This paper contributes to the existing literature as it employs a comprehensive list of interactions between the LIBOR and various macroeconomic variables in order to shed light on the question of the effectiveness of a UK monetary policy whose main objective is to reach a target inflation rate of 2%. Moreover, this study examines whether the UK's monetary policy supports its secondary objective of achieving high employment and promoting economic growth. For this purpose, we adopt the use of a vector autoregressive (VAR) model to examine these variables' relationships and dynamic interactions in the short and long-run.

[1] The Monetary Policy Committee (MPC) is a committee of the Bank of England, which meets for three and a half days, eight times a year, to decide the UK's official interest rate (the Bank of England base rate). This committee is made up of nine members; the governor; the three deputy governors for monetary policy, financial stability, and markets and banking; the chief economist, and four external members appointed directly by the governor of the Bank of England. *For more information, see* https://www.bankofengland.co.uk/about/people/monetary-policy-committee

The rest of this paper is organized as follows: the next section presents the literature review; section 3 presents the methodology; section four reports the main empirical results; and section five draws conclusions and some implications.

Literature Review

The impact of monetary policy on macroeconomic outcomes is not a new topic in the economics literature. Multiple studies have employed different theoretical and empirical perspectives and methodologies to analyze the relationship between monetary policy, especially in relation to interest rates and inflation, and its impact on employment and economic growth. This section presents a brief overview of some of these studies.

Inflation and Interest Rates

Although there are multiple definitions of the term 'inflation', there is a consensus that inflation refers to the rate at which the general prices of goods and service rise and the rate at which the purchasing power of the currency falls. Islam et al. (2017) define inflation as a situation wherein the value of money decreases and the prices of goods increase. Studies on the relationship between interest rates and inflation differ in that they use different definitions of the term "interest" (Gul and Ekinci, 2006, Khumalo et al., 2017, Pennacchi, 1991). Some studies focus on the nominal interest rate, the money market rate, or the deposit rate, while others focus on the real interest rate. However, these definitions tend to point out the types of interest rates that are considered in these studies. Fisher (1930) was one of the first to examine the relationship between interest rates and inflation. The author hypothesized that there is a long-run relationship between the nominal interest rate and inflation, in what came to be known as the Fisher effect. According to Fisher, the nominal interest rate consists of the expected inflation rate plus the expected real interest rate. The real interest rate is determined by the return on investment and the preferences of economic agents. These factors are considered to be constant over time. As such, a change in the value of money is associated with a change in the nominal interest rate. Other studies, such as that of Pennacchi (1991), support the conclusion on the relationship between the interest rate and inflation. In his study, Pennacchi employed a model that incorporated data from NBER-ASA survey forecasts of inflation and observations on the maturity of treasury bills for the years 1968 to 1988. The study's findings indicate that the interest rate and the inflation rate are negatively correlated. Gul and Ekinci (2006) employed data on the inflation rate and the nominal interest rate for Turkey, for the years 1984 to 2003, to evaluate the relationship between these two factors. They found that the interest rate had a long-run relationship with the inflation rate for Turkish markets. These authors also used the Granger-Causality test and established that there is a unidirectional relationship between the nominal interest rate and the inflation rate. Using a vector error correction model (VECM), Herwartz and Reimers (2006) analyzed data from 114 economies, over a 45-year period, to determine the relationship between the interest rate and inflation. Their findings suggest that these two variables exhibit a long-run equilibrium relationship for many of the economies examined. However, such a relationship may not exist in economies that are characterized by large reductions in inflation, high interest rates or risk of high inflation.

Booth and Ciner (2001), Diba and Oh (1991) confirmed that there is a long-run relationship between the interest rate and the inflation rate. Nagayasu (2002) found that there is evidence to support the long-term implications of expectations theory. Their study investigated the impact of the interest rate on the evolution of inflation in Japan, for the period 1980 to 2000, and found very strong evidence, especially when using the short-term interest rate. In his study of fifteen developed countries, Kandil (2005) concluded that both the interest rate and the money supply are strongly correlated and are the underlying factors for the formation of price levels.

More recently, Anari and Kolari (2016) argued that there is a dynamic relationship between the interest rate and inflation in the US. The processes of Fisher and Wicksell have been used to investigate this argument. The results show that the Fisher process represents a positive relationship between inflation and the interest rate, where causality runs from inflation to the interest rate; while the Wicksell process represents a negative relationship between the two rates, with causality running from the interest rate to inflation.

Employment and Interest Rates

Similar to the studies on the relationship between interest rate and inflation, studies on the relationship between the interest rate and employment use different methodologies. While these studies focus on equilibrium in the labor market, the dynamics of this equilibrium vary from one model to another. Carruth et al. (1998) tested this relationship using quarterly data for the US for the period 1954 to 1995. Their study focused on the unemployment rate and the rate of interest. Using the Granger-causality test, they found a weak relationship between the real interest rate and unemployment. Doğrul and Soytas (2010) investigated the causality between the unemployment rate and two input prices, namely energy (crude oil) and capital (real interest rate) in Turkey, an emerging market, over the period January 2005 to August 2009. Applying the Toda–Yamamoto procedure, a relatively new technique, they found that the real price of oil and the interest rate improve the forecasts of unemployment in the long-run.

Bierens and Broersma (1993) studied the casual relationship between the unemployment rate and interest rate in the US, Canada, Japan, Germany, the UK, and France. They used the autoregressive moving average (ARMA) modeling approach and found that the casual relationship between unemployment and the interest rate holds. Fitoussi et al. (2000) analyzed data from 19 industrialized countries, for the period 1960 to 1998, to determine the impact of global real interest rates on employment. They deduced that high interest rates in the G7 countries were associated with higher rates of national unemployment. This conclusion was based on their interpretation of the changes in real world interest rates in the 1980s, which were associated with increased costs of capital and consequently falling employment rates. The authors also found that the short-term changes in interest rates between the 1980s and 1990s led to changes in employment rates. Blanchard and Wolfers (2000) used data from 20 industrial nations for the period 1960 to 1996 and found that macroeconomic shocks and labor market institutions were the key determinants of labor dynamics. According to these authors, an increase in the real interest rate can be considered an adverse shock that can lead to an increase in the unemployment rate.

These findings mirror those of Kose, Parsad and Terrones (2003). In their 2003 study, the authors evaluated data from 20 industrial nations for the twenty-year period between 1960 and 1980. A regression analysis of the data indicates that higher real interest rates are associated with higher unemployment rates. Bassanini and Duval (2006) used data from 20 industrial nations for the period 1982 to 2003 and also found that there is a robust relationship between the real interest rate and the unemployment rate. Their study concluded that a rise in the real interest rate has a negative impact on employment. The findings of Scarpetta (1996) support this conclusion. In his study, the author employed data from 17 industrial nations for the period 1983 to 1993. The study focused on the non-employment rate, the long-run unemployment rate, the youth unemployment rate, and the unemployment rate as endogenous variables. Scarpetta found no relationship between these variables and the real interest rate.

Economic Growth and Interest Rates

The role of interest in economic growth has been well documented in multiple studies. Hansen and Seshadri (2014) evaluated this relationship using data from the US and employing growth in productivity as a proxy for economic growth. They found that there is a moderate correlation between the interest rate and economic growth, especially in the long-

run. Specifically, a low interest rate leads to economic growth through an increase in productivity. In another study, Obamuyi (2009) employed secondary time series to evaluate the same relationship in the context of Nigeria, using data for the period 1970 to 2006. He further employed an error correction model (ECM) to capture the causal relationship between the interest rate and economic growth in both the short- and long-run. The findings indicate that there is a long-run relationship between these two variables and the real lending rate affects economic growth in that country.

Di Giovanni and Shambaugh (2008) analyzed data from major industrial nations to evaluate the impact of the interest rate on real output. They found that high foreign interest rates resulted in a contraction of the domestic economy, especially in countries that employ fixed exchange rates. Saymeh and Orabi (2013) evaluated the impact of the interest rate on economic growth in Jordan, using panel data for the period 2000 to 2010. They found that low interest rates in the country are associated with economic growth. More recently, Etale and Ayunku (2016) employed an ECM to evaluate this phenomenon, using econometric data for Nigeria for the years 1985 to 2013. They found that interest rates are inversely related to economic growth.

Additionally, Agalega and Antwi (2013) used principal component analysis and the maximum likelihood method of factor analysis to investigate the effects of macroeconomic variables on the GDP of Pakistan. They found that the interest rate and GDP are inversely related to each other. Bhat and Laskar (2016) examined the effect of changes in the interest rate and the inflation rate on the GDP of India, using yearly data for the period 1998 to 2012. The results show that there is a negative relationship between these two variables.

The majority of the studies discussed in the literature review support the hypotheses that there is a relationship between the interest rate, inflation, employment and economic growth. However, none of the studies examined these hypotheses in the context of the UK. Despite the use of different models and definitions of the aforementioned variables, existing empirical studies support the role of the interest rate in the dynamics of individual economies. The next section presents the methodology, including the model used to evaluate the dynamic relationship between the variables used to evaluate the hypotheses in the context of the UK.

Data and Methodology

Data collection and transformation

The data [(2)] used in this study covers the period 1992:Q1 to 2016:Q4 in the UK. Following in particular the research of Peria et al. (2004)[(3)] and AboElsoud et al. (2020), a theoretical framework of the general macroeconomic model is proposed that takes into consideration the interdependence among selected variables, which consist of the London Interbank Offered Rate (*LIBOR*), the consumer price index (*CPI*), the unemployment rate (*UR*) and the gross domestic product (*GDP*). Only the *GDP* and *CPI* series are expressed in logarithmic form.

Econometric methods

In this study, we analyze the relationship between the *LIBOR* and some of the macroeconomic indicators, namely, *CPI*, *UR* and *GDP,* by examining the case of the UK. For this purpose, we adopt the use of a vector autoregressive (VAR) model in examining the dynamic interaction among the selected variables. Additionally, before estimating the model,

[(2)] The data were retrieved from the Federal Reserve Bank of St. Louis' Database, the World Development Indicators (WDI), and the Bank of England Statistical Interactive Database.

[(3)] Originally, this model was developed by THOMAS, S. & SAUNDERS, A. 1981. The determinants of bank interest margins: theory and empirical evidence. *Journal of Financial and Quantitative analysis,* 16**,** 581-600.; it has been extended by ALLEN, L. 1988. The Determinants of Bank Interest Margins: A Note. *The Journal of Financial and Quantitative Analysis,* 23**,** 231-235. and ANGBAZO, L. 1997. Commercial bank net interest margins, default risk, interest-rate risk, and off-balance sheet banking. *Journal of Banking & Finance,* 21**,** 55-87..

the time-series data is tested for stationarity using the Augmented Dickey-Fuller (ADF) (1979) test and the data set is also tested to determine the existence of a long-run relationship among the variables used in the study. The VAR Granger-causality test is used to test the direction of causation among the variables.

The study further uses the impulse-response function (IRF) to monitor the effect of a one-time shock to one of the innovations of the endogenous variables. In addition, the autoregressive (AR) inverse roots graph is plotted to determine whether the VAR model is stable or stationary and whether the IRFs are reliable. Finally, a diagnostic test is carried out to test for serial correlation and heteroscedasticity in the residuals.

The VAR models adopted to examine the dynamic interaction among the variables used in this study are expressed in equations 1 to 4:

$$LIBOR_t = \beta_0 + \sum_{j=1}^{k} \beta_{1j} LIBOR_{t-j} + \sum_{j=1}^{k} \beta_{2j} lnCPI_{t-j} + \sum_{j=1}^{k} \beta_{3j} UR_{t-j} + \sum_{j=1}^{k} \beta_{4j} lnGDP_{t-j} + U_{1t} \quad (1)$$

$$lnCPI_t = \alpha_0 + \sum_{j=1}^{k} \alpha_{1j} lnCPI_{t-j} + \sum_{j=1}^{k} \alpha_{2j} LIBOR_{t-j} + \sum_{j=1}^{k} \alpha_{3j} UR_{t-j} + \sum_{j=1}^{k} \alpha_{4j} lnGDP_{t-j} + U_{2t} \quad (2)$$

$$UR_t = \gamma_0 + \sum_{j=1}^{k} \gamma_{1j} UR_{t-j} + \sum_{j=1}^{k} \gamma_{2j} LIBOR_{t-j} + \sum_{j=1}^{k} \gamma_{3j} lnCPI_{t-j} + \sum_{j=1}^{k} \gamma_{4j} lnGDP_{t-j} + U_{3t} \quad (3)$$

$$lnGDP_t = \delta_0 + \sum_{j=1}^{k} \delta_{1j} lnGDP_{t-j} + \sum_{j=1}^{k} \delta_{2j} LIBOR_{t-j} + \sum_{j=1}^{k} \delta_{3j} lnCPI_{t-j} + \sum_{j=1}^{k} \delta_{4j} UR_{t-j} + U_{4t} \quad (4)$$

where the *LIBOR* represents the 3-Month London Interbank Offered Rate based on the US. dollar; *lnCPI* is the consumer price index of all items in logarithmic form; *UR* is the registered unemployment rate; and *lnGDP* is the real gross domestic product in logarithmic form. Moreover, *K* denotes the lag length, while the βs, αs, γs, and δs are the coefficients to be estimated; and, finally, the *Us* are the disturbance terms.

Empirical Analysis

Summary Statistics and correlations

Table 1 presents the results of the summary statistics and the correlations. The summary statistics show the distribution properties of the individual variables, while the correlation matrix shows the relationship between these variables in our proposed model.

Table 1. Summary statistics and correlations

	LIBOR	lnCPI	UR	lnGDP
Mean	3.018	4.489	4.555	12.785
Median	3.264	4.459	4.017	12.839
Maximum	6.699	4.728	10.267	13.046
Minimum	0.228	4.243	2.133	12.417
Std.Dev	2.259	0.142	2.268	0.164
Skewness	0.077	0.196	1.166	-0.603
Kurtosis	1.420	1.834	3.193	2.228
Jarque-Bera	10.501	6.307	22.828	8.549
Probability	0.005	0.043	0.000	0.014
Obs.	100	100	100	100
LIBOR	1.000			
lnCPI	-0.754	1.000		
UR	0.308	-0.612	1.000	
lnGDP	-0.619	0.904	-0.852	1.000

- Notes: Variables definition: *lnGDP* is the logarithmic form of the real gross domestic product of the United Kingdom.
- Source: Authors' calculations.

From the correlation matrix in Table 1, we can conclude that there is a strong positive and statistically significance relationship between ln*CPI*, and *lnGDP*. However, there is a strong negative and statistically significance relationship between the *LIBOR* and *lnCPI*, and the

LIBOR and lnGDP. Clearly, all of the correlation signs are consistent with the economic theory. The next step is to test for co-integration.

Co-integration and unit root tests

Testing the co-integration among the variables used in the model requires conducting a previous test for the existence of a unit root for each variable. Unit root tests form one of the essential requirements in time-series econometrics. As emphasized in the literature, working with non-stationary time series would bring on spurious results in empirical studies due to the unstable representation of the data. This is because it is evident that many economic time series exhibit trends that cause the results of the analysis to be artificial. The graphical representation of the respective variables (not reported) in level indicates that we are dealing with a random walk with a drift and trend. Table 2 presents the results of using the ADF test that includes a trend and an intercept.

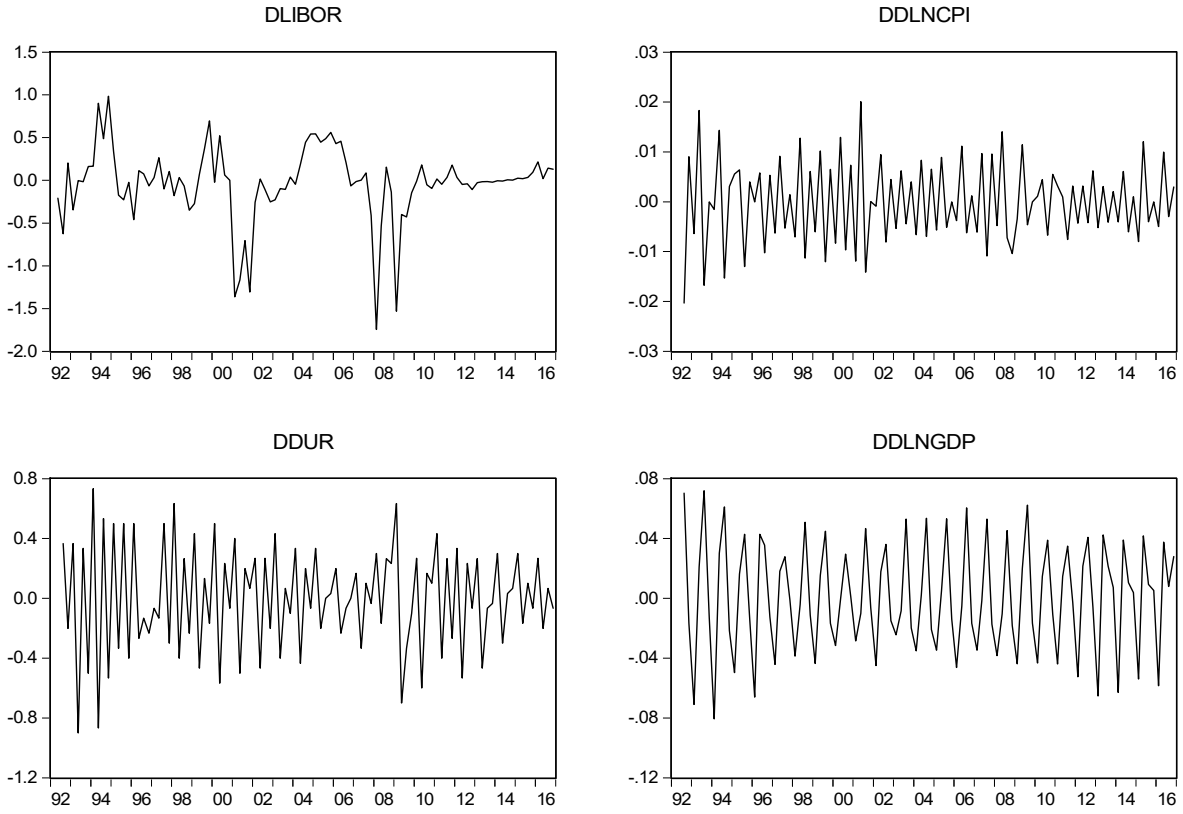
Table 2. Augmented Dickey-Fuller Test

	In Levels		1st differences		2nd differences	
Variable	Lag	Test Statistic ADF	Lag	Test Statistic ADF	Lag	Test Statistic ADF
Include both the constant and trend						
LIBOR	1	-2.791	0	-5.368***	-	-
lnCPI	5	-1.747	4	-3.150	3	-6.905***
UR	8	-3.150	7	-2.511	6	-6.790***
lnGDP	8	-2.283	7	-2.479	6	-6.891***

- MacKinnon (1996) critical value at 1% = -4.04, at 5% = -3.45, and at 10% = -3.15.
- ***, ** and * denote significance at the 99, 95, and 90% confidence levels, respectively.
- The lag orders used in the tests are selected automatically, according to Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC).
- Source: Authors' calculations.

As can be seen from Table 2, the results of the ADF test affirm that all of the variables contain roots. Thus, for some of these variables, the order of integration is *I(1) and* for others it is *I(2)* when a constant and trend are included. That is, the variable *LIBOR* becomes stationary at the 1% significance level after the first-difference *I(1)*, while the variables *lnCPI*, *UR* and *lnGDP* become stationary after the second-difference *I(2)* at the 1% significance level. The aforementioned results indicate that the co-integration conditions are not satisfied. Consequently, no long-run relationship exists between the variables in the study; hence, the co-integration test cannot be performed. Figure 1 presents the log-differences of the respective variables. As can be seen, all of the variables are highly variant over the study period. However, they are stationary and, consequently, their parameters, such as their means and variances, do not change over time.

Figure 1. Log-differences of the variables



- Source: Authors' results.

VAR analysis

As discussed in section 3.2, this study uses a VAR model to examine the relationship between the *LIBOR* and the UK achieving its macroeconomic goals. However, due to the absence of co-integration between the variables, the study estimates the unrestricted VAR to examine the short-run dynamic interactions between the selected variables (differenced).

The lag-length selection for the unrestricted VAR really matters. Using VAR lag-order selection criteria is the most objective and, effective method for determining the lag length, as shown in Table 3.

Table 3. VAR lag-order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	467.970	NA	6.07e-10	-9.871693	-9.763468	-9.827978
1	575.391	203.4142	8.68e-11	-11.81682	-11.27569	-11.59825
2	637.854	112.9651	3.23e-11	-12.80540	-11.83137	-12.41196
3	753.010	198.4608*	3.94e-12*	-14.91510*	-13.50817*	-14.34681*
4	761.786	14.37803	4.64e-12	-14.76141	-12.92158	-14.01825

- * Indicates the lag order selected by the criterion. Each test is at the 95% confidence level.
- Notes: Definitions: LR - sequential modified likelihood ratio; FPE - final prediction error; AIC - Akaike information criterion; SIC - Schwarz information criterion; and HQ - Hannan-Quinn information criterion.
- Source: Authors' calculations.

The results in Table 3 indicate that the LR, FPE, AIC, SC and HQ test statistics selected the optimum lag length of 3 at the 5%level of significance. Hence, a lag length of 3 has been used in estimating the unrestricted VAR model.

As can be seen from the unrestricted VAR results, which are reported in Appendix A, the dynamic short-run relationship between the *LIBOR* and *lnCPI* does exist; the *LIBOR* lags

have significant coefficient values on the *lnCPI* at the 1% and 5% significance levels. Moreover, the *LIBOR's* second lag has a significant coefficient value on the *lnGDP* at the 5% significance level. In contrast, none of the *LIBOR* lags has a significant coefficient value on the *UR* at any significance level. Accordingly, we can conclude that there is no short-run relationship between these two variables.

Additionally, the Granger-causality test is a common diagnostic from a VAR approach. The concept of this test is to investigate the causal relationships between variables. Table 4 depicts the Granger-causality test between the *LIBOR* and the other variables used in the model (differenced).

Table 4. Granger-causality test

Null Hypothesis	F-statistic	*Prob.*
LIBOR does not Granger Cause *lnCPI*	3.720	0.014
LIBOR does not Granger Cause *UR*	0.899	0.444
LIBOR does not Granger Cause *lnGDP*	1.681	0.177

- Note: See Appendix B for more information.
- Source: Authors' calculations.

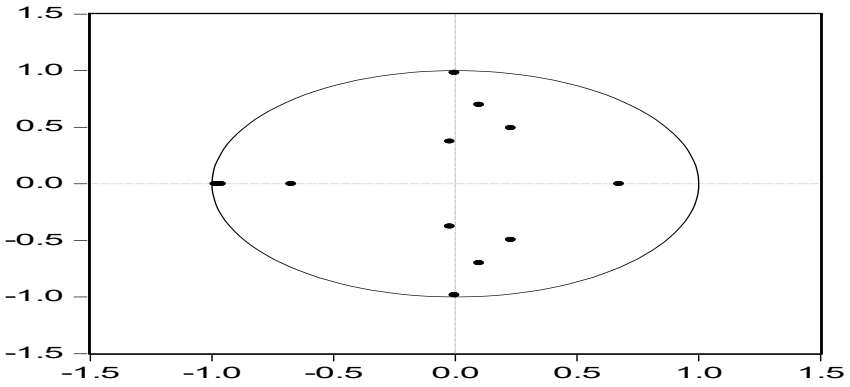
Table 4 presents the outcome of the Granger-causality Wald tests; they show that the null hypothesis of *LIBOR-lnCPI* cannot be accepted. Therefore, there is a directional causality between the *LIBOR* and *lnCPI.* In contrast, and as can be seen from the results, the null hypothesis of *LIBOR-UR* and *LIBOR-lnGDP* cannot be rejected. Hence, there is no directional causality between the *LIBOR* and *UR or between* the *LIBOR and lnGDP,* in their difference form, at the 5% significance level. This implies that the *LIBOR* does not contribute to high employment in the UK nor does it promote economic growth. For more robustness, we check whether or not the stability conditions of the unrestricted VAR model are satisfied. The necessary and sufficient condition for stability is that all of the polynomial roots of the VAR model must lie outside of the unit circle. This can be tested by using both the eigenvalue stability condition test, as presented in Table 5, and the graph of the AR inverse root of the VAR, which is presented in Figure 2.

Table 5. Eigenvalue stability condition test

Root	Modulus
-0.985352	0.985352
-0.003046 - 0.981718i	0.981723
-0.003046 + 0.981718i	0.981723
-0.962786	0.962786
0.098309 - 0.698408i	0.705293
0.098309 + 0.698408i	0.705293
-0.673464	0.673464
0.672818	0.672818
0.229030 - 0.494176i	0.544669
0.229030 + 0.494176i	0.544669
-0.022404 - 0.375845i	0.376512
-0.022404 + 0.375845i	0.376512

- Source: Authors' calculations.

Figure 2. Inverse roots of AR Characteristics Polynomial



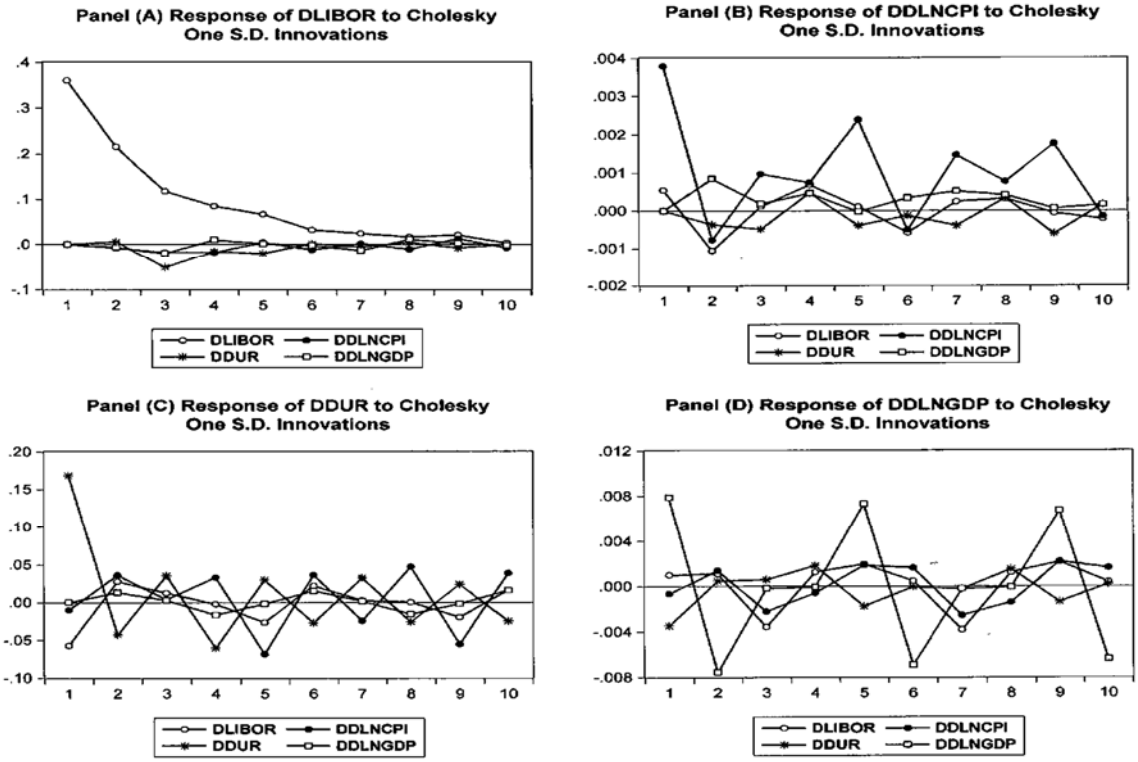
Source: Authors' results.

The outcomes from Table 5 and Figure 2 indicate that all of the inverse roots are smaller than one and that they lie inside the unit circle. This implies that the unrestricted VAR model satisfies the stability condition. Consequently, the IRFs are reliable and can be estimated.

As the estimated unrestricted VAR model appears to be stable, we can now produce the IRFs. Naturally, the impulse-response function illustrates the effect of one standard deviation (SD), as a one-time shock, on all of the endogenous variables taken in the model.

In Figure 3, one SD in the model is calculated according to its percentage. For each variable, the horizontal axis of the IRFs shows the number of periods that have passed after the impulse has been given, while the vertical axis measures the responses of the variables. Moreover, each panel in Figure 3 shows the change that occurs in one variable as a response to a one-time shock in the change of all of the variables used in the model.

Figure 3. IRFs graph



- Source: Authors' results.

As alluded to above, the aim of this study is to analyze the effectiveness of the *LIBOR* in the UK's achieving its macroeconomic goals. Therefore, we focus on the interpretation of panels B, C and D. These panels show how *lnCPI, UR and lnGDP* respond to a one-time shock in a change in the *LIBOR*, in their difference form. As can be seen from panel B, a shock in a change in the *LIBOR* produced high positive fluctuations to *lnCPI* during the period under study. Accordingly, we can conclude that the *LIBOR* is sufficient to achieving the inflation-target objective. However, it is observed from panels C and D that a shock in a change in the *LIBOR* produced positive responses to the *UR* and *lnGDP*, as well as equivalent negative responses during the period under study. These eliminate each other, leaving no contribution to either high employment or economic growth.

Last but not least, Table 6 depicts the diagnostic test that comprises the unrestricted VAR residual serial correlation LM test and the VAR residual heteroscedasticity test. The outcomes of these tests indicate that the model is well specified and there is no existence of serial correlation or heteroscedasticity. As can be seen from Table 6, the null hypothesis of no serial correlation and no heteroscedasticity cannot be rejected.

Table 6. Diagnostic tests

Test	Test Statistic	*p*-vlaue
VAR Residual Serial Correlation LM Test (Lags 1to 3)	LM = 13.046	0.669
	LM = 21.924	0.146
	LM = 9.892	0.872
VAR Residual heteroscedasticity Test	χ^2 = 929.081	0.244

- Source: Authors' calculations.

Conclusion and Policy Implications

This empirical analysis examined the dynamic relationship between the LIBOR, the inflation rate, the unemployment rate and economic growth, in the UK. A correlation analysis of the data indicates that there is a strong negative and statically significant relationship between the LIBOR and the consumer price index, while there is a moderate negative relationship between the LIBOR and GDP in the UK, and there is a weak positive relationship between the LIBOR and the unemployment rate. Despite the fact that all of the correlation signs are consistent with the economic theory, the co-integration test indicates that there is no long-run relationship between the variables used in the study.

The results of the VAR model suggest that there exist a dynamic short-run relationship between the LIBOR and the consumer price index as a measure of inflation. In contrast, however, the model shows that there is no short-run relationship between either LIBOR and the unemployment rate or the LIBOR and economic growth. Alternatively, the Granger-causality Wald tests suggest that there is a directional causality between the LIBOR and the inflation rate. Nevertheless, the test does not indicate any directional causality between the LIBOR and the other variables examined in the study. This suggests that the LIBOR does not contribute to employment or economic growth in the UK.

Consequently, it can be said that the LIBOR is sufficient to achieving the main objective of reaching an inflation target rate of 2%. However, the LIBOR is not sufficient to boost the economy and achieve the secondary monetary policy objective of supporting the government's economic objectives of achieving high employment and promoting economic growth. Therefore, it is understandable that the Bank of England would be likely to use alternative instruments of monetary policy to boost the UK's economic growth. Accordingly, this explains why the UK's Monetary Policy Committee (MPC) has already carried out supportive tools and policies, such as quantitative easing.[(4)] However, the question of the

[(4)] For more information about "quantitative easing", see https://www.bankofengland.co.uk/monetary-policy/quantitative-easing

efficiency of these tools in supporting the government's economic objectives remains an empirical question for future research.

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Appendices

Appendix A: Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 11/29/19 Time: 11:37
Sample (adjusted): 1993Q2 2016Q4
Included observations: 95 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DLIBOR	DDLNCPI	DDUR	DDLNGDP
DLIBOR(-1)	0.606911	-0.002003	0.021447	0.002845
	(0.11522)	(0.00105)	(0.05685)	(0.00278)
	[5.26751]	[-1.90124]	[0.37728]	[1.02499]
DLIBOR(-2)	-0.083047	-1.05E-05	0.074063	-0.006522
	(0.13466)	(0.00123)	(0.06644)	(0.00324)
	[-0.61673]	[-0.00854]	[1.11479]	[-2.01047]
DLIBOR(-3)	0.097186	0.002511	-0.088646	0.004345
	(0.11326)	(0.00104)	(0.05588)	(0.00273)
	[0.85805]	[2.42509]	[-1.58631]	[1.59250]
DDLNCPI(-1)	-2.626304	-0.770987	10.87603	0.186883
	(10.4439)	(0.09548)	(5.15277)	(0.25159)
	[-0.25147]	[-8.07494]	[2.11072]	[0.74280]
DDLNCPI(-2)	-7.643095	-0.513855	12.48632	-0.158560
	(12.4302)	(0.11364)	(6.13277)	(0.29944)
	[-0.61488]	[-4.52186]	[2.03600]	[-0.52951]
DDLNCPI(-3)	-3.076728	-0.537080	16.58863	-0.535353
	(10.4033)	(0.09511)	(5.13278)	(0.25062)
	[-0.29574]	[-5.64701]	[3.23190]	[-2.13613]

DDUR(-1)	0.016255	-0.000696	-0.219304	-0.016974
	(0.22370)	(0.00205)	(0.11037)	(0.00539)
	[0.07266]	[-0.34052]	[-1.98703]	[-3.14973]
DDUR(-2)	-0.380054	-0.003824	0.206707	-0.016887
	(0.23587)	(0.00216)	(0.11637)	(0.00568)
	[-1.61131]	[-1.77343]	[1.77627]	[-2.97208]
DDUR(-3)	-0.001021	0.000209	-0.222610	-0.000247
	(0.22718)	(0.00208)	(0.11209)	(0.00547)
	[-0.00449]	[0.10073]	[-1.98608]	[-0.04513]
DDLNGDP(-1)	-0.882442	-0.032616	1.699722	-0.961628
	(2.13220)	(0.01949)	(1.05198)	(0.05136)
	[-0.41386]	[-1.67323]	[1.61573]	[-18.7215]
DDLNGDP(-2)	-2.992688	-0.007594	2.756272	-0.910500
	(1.83126)	(0.01674)	(0.90350)	(0.04412)
	[-1.63422]	[-0.45360]	[3.05065]	[-20.6391]
DDLNGDP(-3)	0.328067	0.012102	0.298357	-0.881293
	(2.18249)	(0.01995)	(1.07679)	(0.05258)
	[0.15032]	[0.60654]	[0.27708]	[-16.7621]
C	-0.009019	-2.62E-05	-0.001792	-3.12E-05
	(0.03729)	(0.00034)	(0.01840)	(0.00090)
	[-0.24186]	[-0.07679]	[-0.09738]	[-0.03468]
R-squared	0.399236	0.849280	0.777486	0.947593
Adj. R-squared	0.311320	0.827223	0.744923	0.939924
Sum sq. resids	10.67941	0.000893	2.599602	0.006198
S.E. equation	0.360883	0.003299	0.178052	0.008694
F-statistic	4.541076	38.50448	23.87630	123.5562
Log likelihood	-30.98511	415.0268	36.13046	322.9806
Akaike AIC	0.926002	-8.463723	-0.486957	-6.525906
Schwarz SC	1.275480	-8.114245	-0.137479	-6.176428
Mean dependent	-0.024818	6.70E-05	-0.006667	0.000842
S.D. dependent	0.434868	0.007937	0.352542	0.035469

Determinant resid covariance (dof adj.)	2.42E-12
Determinant resid covariance	1.35E-12
Log likelihood	759.1764
Akaike information criterion	-14.88792
Schwarz criterion	-13.49001

Appendix B: Granger Causality tests

Pairwise Granger Causality Tests
Date: 11/29/19 Time: 09:45
Sample: 1992Q1 2016Q4
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DDLNCPI does not Granger Cause DLIBOR	95	2.22881	0.0904
DLIBOR does not Granger Cause DDLNCPI		3.71989	0.0143
DDUR does not Granger Cause DLIBOR	95	1.84254	0.1453
DLIBOR does not Granger Cause DDUR		0.89988	0.4447

DDLNGDP does not Granger Cause DLIBOR	95	1.34667	0.2645
DLIBOR does not Granger Cause DDLNGDP		1.68075	0.1769
DDUR does not Granger Cause DDLNCPI	95	1.96951	0.1244
DDLNCPI does not Granger Cause DDUR		11.9456	1.E-06
DDLNGDP does not Granger Cause DDLNCPI	95	3.15952	0.0286
DDLNCPI does not Granger Cause DDLNGDP		4.18693	0.0081
DDLNGDP does not Granger Cause DDUR	95	11.2171	3.E-06
DDUR does not Granger Cause DDLNGDP		6.63935	0.0004