International Journal of
Economic Policy
(IJECOP)

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CARI Journals

International Journal of Economic Policy
ISSN: 2788-6352 (Online)
Vol. 3, Issue No. 2, pp 1 - 22, 2023
www.carijournals.org

Forecasting Lending Interest Rates of Commercial Banks in Cameroon with Autoregressive Integrated Moving Average (ARIMA) Model.

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Abstract

Purpose: Lending Interest rate prediction is one of the most relevant aspects in the banking sector and a country's economy. Lending is an important variable within this sector since economic and market conditions vary over time. Efficient methods are needed to describe the trends and characteristics of lending interest rate. The performance of different time series models for analysis of lending interest rates of commercial banks in Cameroon is provided to determine the feasibility of method for the generation of results in the wake of economic decisions.

Methodology: Historical time series of lending interest rates in the banking sector in Cameroon were analysed for the period 1972 to 2023. The Box-Jenkins methodology was used to analyse the time Series data.

Findings: It was revealed that 76.75% of the variation in Lending interest rates in Cameroon is accounted for by the lending interest rates for the past 52 years, the inflation rate for the past 52 years and the GDP for the last 52 years. Therefore, an increase in lending interest rates 52 years ago by one unit will increase lending interest rates today by 0.808 units. Similarly, an in increase in inflation by one unit will reduce lending interest rates by 0.002 units. In addition, an increase in GDP by one unit will reduce lending interest rates by 0.000001 unit. The ARIMAX (1,1,4) demonstrated to be more robust. Therefore, lending interest rates in Cameroon will reduce with time as from the year 2023 to 2027 and above. Investors are encouraged to borrow from the banks and invest within this time frame.

Unique Contribution to Theory Practice and Policy: Long and varying lags of interest rates separate the effects of monetary policy from the economy and has caused a lot of unemployment in any society. The degree to which interest rates rise has pulled down the economy is alarming. This can be seen in businesses, economic projections, and spending. More businesses report that interest rates have reduced their capital and non-capital spending expectations compared to 2022. A further indication that the impact of higher interest rates has yet to be fully felt is evidence that keeping the existing policy course will limit the spending activity of more enterprises. Monetary policy has surpassed all other concerns for finance executives in the past quarter. Survey participants mentioned interest rates in their decision to cut spending. The study provides a unique way of comparing results of interest rates using a traditional time series model to a typical Interest rate model.BEAC should chose an accommodating monetary policy centred on decreasing the already high interest rate and injecting cash into CEMAC savings in response to the economic shock currently existing in Cameroon.

Keywords: *Forecast*, *Lending, Interest Rates, ARIMA, Cameroon.*

1. Introduction

Interest rates in an economy vary. Interest rates for lending can be defined as the compensation customers (or lenders) collect from giving up their excess funds, which has to be paid for borrowing as the amount charged to the individual or organisation for use of the borrowed money. Depending on the transaction, there are intermediaries like banks involved, which are compensated by a fraction of the lending interest rate (LIR). This leads to a difference in the interest rate of the borrower and the lender .The discount rate is another form of interest rate. This is the rate at which commercial banks can borrow money from the central bank, the Bank of Central African States (BEAC). Commercial Banks have to leave an amount of money in reserve with the central Bank. Europe differs in that it uses three interest rates. The rate, at which banks can borrow money from the European Central Bank (ECB) for financing operations uses the deposit facility and the marginal lending facility. London Interbank Offered Rate (LIBOR) is another important interest rates for everyday international trading. The British Bankers Association (BBA) in London sets it. Euro Interbank Offered Rate (EURIBOR) is another form of interest rate which defines the floating index rate of the Euro money market (Chen *et al.*, 2016).

One of BEAC's responsibilities is to use interest rates to conduct monetary policy and to influence the supply of money in the economy. Monetary policy contains three major instruments, beginning with open-market operations. To increase the money supply, BEAC buys bonds from the public. To reduce the supply money in an economy, BEAC sells bonds to the public. The most important instrument concerning this paper is the lending interest rate (Trading Economics, 2022). The lower the lending interest rate, customers willing be more willing to take loans from the banks, which increases money supply in the economy. When BEAC increases money supply, it wants to stimulate the economy, just like what is experienced in Cameroon today. To curb the effects of the recession immediately after the financial crisis of 2008, more investments and increasing productions should be encouraged. The higher the lending rate, customers are become discourage to take loans (Hunt & Kennedy, 2004). This lowers the supply of money in the economy. As a matter of fact, the central bank cannot control the supply of money completely in an economy. A low interest rate level can influence banks to make riskier investments in order to generate higher revenues (Angela & Dominik 2015).

Banks in 2008 were short of liquidity and they wanted to augment their deposits and improve their balance sheets. Consequently, they were hesitant to lend and keen to attract savings. So, they didn't want to cut mortgage rates and lending rates. In effect, they were making it more profitable; they could borrow from the central bank at lower interest rates such as 2.5% but lending at very high interest rates such as 10% (Pettinger 2015).

In sub-Saharan Africa, the gap between lending and deposit rates is more than others in the world. Net interest margins in the average African country were 6.8% by 2017, according to the World Bank. This helped cover expenses that are heavier than those in other regions. This allowed

African banks to generate a 17% return on equity for shareholders. On that measure, Africa's banks are the most profitable in the world and at the same time being the least efficient (Finance & Economics, 2020).

Much literature concentrates on interest rate influence on inflation. Little has been written on negative interest rate. Negative interest rate however occurs when nominal interest rates is less than inflation. Very little literature has addressed the forecast of lending interest rates in Cameroon. As a matter of fact the micro-finance sector in Africa is characterised by high and increasing lending interest rates compared to other underdeveloped countries in the world. Most often micro-credit interest rates are often greater than commercial bank interest rates. Precisely, during the period 2003 to 2015, micro-credit interest rates averaged in the Middle East and North Africa at 28% and 22% in Asia. About 34% in Africa, 30% in Latin America and the Caribbean,. In all these later countries, inflation and commercial bank lending rates averaged 8% and 20%, respectively. Increasingly there have been common policy intervention by Central African Banking Commission **(**COBAC) to curb higher micro-credit interest rates by imposing interest rate ceilings. Interest rate ceilings (or caps) are justified by authorities as a means to protect consumers from usury and exploitation (Chikalipah 2017).

Cameroon is a notable case where micro-credit interest rates exceeded 100% before monetary authorities imposed interest rate ceilings. Cameroon introduced interest rate ceilings in 2013, imposing maximum rates of 25%. It is evident that the majority of African countries impose interest rate ceilings on microfinance institutions (MFIs). Arguments have been made that interest rate ceilings do not necessarily protect the poor borrowers, but rather hurt them because they force MFIs to retreat from the market. The vulnerable poor clients would then revert to the unregulated informal credit markets, which are monopolized by individual moneylenders who charge higher interest rates. For instance, in the early 2000s, the central bank of West Africa, BEAC imposed an interest rate ceiling of about 27% for all nonbank lenders. It resulted to many MFIs scaling back the provision of credit to the poor, and a number of MFIs closed down their rural branch networks. (Chikalipah & Makina, 2019).

Moreover, given the considerable gaps in the economic and social developments across different banks and microfinance institutions of Cameroon and the world, the microfinance and the non-microfinance sectors are jointly analysed to establish a single model that fully captures lending interest rates in Cameroon for the past 52 years and for the next 5 years.

Drawing from these phenomena, this study mainly seeks to predict lending interest rates in Cameroon using ARIMA model. The specific objectives of the paper are:

-To compare the forecasting efficiency of 2 different models using model selection criterion.

-To fit Cameroon's lending interest rates in an ARIMA model and forecast future lending interest rates.

2. Literature Review

2.1. Theories on Interest Rates

Liquidity Management Theory

This theory monitors the distribution of assets considering the aforementioned objectives. Other forms of the liquidity management theories include:

Commercial Loan Theory: The commercial loan or the real bills doctrine theory states that a commercial bank should forward only short-term self-liquidating productive loans to business organisations. These are the loans that will generate interest for the business internally.

Shift-ability Theory: This theory was proposed by H.G. Moulton (Meghana, 2023) who insisted that if the commercial banks continue a substantial amount of assets can be moved to other banks for cash without any loss of material. In case of requirement, there is no need to depend on maturities.

Anticipated Income Theory: This theory was proposed by H.V. Prochanow in 1944 (Meghana, 2023) based on the practice of extending term loans by US commercial banks. This theory states that irrespective of the nature and features of a borrower's business, the bank plans the liquidation of the term loan from the expected income of the borrower.

2.2. Empirical Review

Graham and Harvey (2001) showed that credit ratings have serious influence on debt issuance and capital structure. Making accurate predictions of corporate credit ratings is a crucial issue to both investors and rating agencies. Compared with conventional long-term credit ratings, MIRs can be published with high frequency, incorporating market information into data-intensive rating models, which provide more timely information about credit quality at short and medium term horizons. Hence, this paper uses the literature of ARIMA models as fundamentals to evaluate the predictive performance of all candidate models that capture interest rate changes for the past 52 years. This paper uses the Akaike information Criterion (AIC) to select the best model that fits the data under study.

Sarkar and Sriram (2001) studied the predictive performance of banks' failure provided by the naive Bayes classifier. They found that composite attribute model are comparable. This approach is similar to the prediction provided by decision tree classification algorithm.One of the weakness of decision tree classification is over fitting. This occurs when the model is too complex and fits training data too closely. Consequently, there is a poor performance and prediction accuracy on new data (Pierian Training, 2023). This leads to biased results. Hence this paper does not adopts this approach so as to avoid having biased results.

Schmidt (2016) asserts that after the financial crisis of 2008 the importance of regulations and risk management in the banking sector increased severely. Interest rates now change steadily. The reason for the current low interest rate level is still the financial crisis. During and after the crisis the economy was in a recession.

Tang *et al.* (1991) discussed the results of a comparative study of the performance of neutral networks and conventional methods of forecasting time series. Their work was initially inspired by previously published works that yielded inconsistent results about comparative performance. Experimenting with 3 time series of different complexity using different feed forward, back propagation neural network models and the standard Box-Jenkins (1976) model, they demonstrated that for time series with long memory, both methods produced comparable results. However, for series with short memory, neural networks outperformed the Box-Jenkins (1976) model. They noted that some of the comparable results arose since the neural network and time series model appeared to be functionally similar models. They found that for time series of different complexities, there were optimal neutral network topologies and parameters that enabled them to learn more efficiently. Their initial conclusions were that neutral networks were robust and provided good long term forecasting. Neutral networks represented a promising alternative for forecasting, but there were problems determining the optimal topology and parameters for efficient learning (Ringmu & Oumar 2022).

Li *et al.* (2018) began to examine problems important to loaning scales. By analysing the profit of the enterprise through green innovation, they derived the loaning scale-dependent condition to stimulate green innovation.Their scope is limited only to green loans. This paper seeks to examine lending interest rates irrespective of how the loan will be used. Green loans focus only on the use of money borrowed for projects relating to green production and innovation. This paper seeks to predict lending interest rates in Cameroon.How loans obtained are used is not the interest of this paper. The paper seeks to investigate the trend of lending interest rates and to give advice to policy makers on the effects on customers.

A developed financial sector will enhance productivity and growth. Many authors have carried out studies in this direction. They are found out that financial intermediaries have an indispensable rule promoting economic growth and diverse innovations. These financial intermediaries provided strategic services such as evaluating investment projects, facilitating transactions and access to credit (Emmanuel *et al.* 2015).

China’s health expenditure was modelled with ARIMA models, and in particular, hospital costs for respiratory sicknesses in Shanghai, China. The monthly data from January-December 2012 used in the study at the beginning showed that examining the shocks involved in health expenses demonstrated to be the best approach for forecasting health expenses (Yue *et al.* 2015). Based on lag selection criterion, the approach of modelling shocks in health expenses failed to be the best because other processes combining the shocks and the evolution of health expenses demonstrated to be more robust and effective (Ringmu and Oumar 2022).

Following (Roshaiza & Loganathan, 2008), Cameroon's GDP increased by 3.4% in 2011. It demonstrates that Cameroon's economy is in good shape because administrations can implement programs for the country while also attempting to raise GDP to lower the deficit in the budget.

International Journal of Economic Policy
ISSN: 2788-6352 (Online)
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www.carijournals.org

The GDP measures the final goods and services generated inside a country within a specific period (DiPietro & Anoruo, 2006). GDP is also calculated on an annual or per-year basis. A country's Gross Domestic Product (GDP) includes government spending, consumer spending, net exports, and domestic investment. GDP, based on (Hobijn & Steindel, 2009), is a fundamental measurement for the country's health.

3. Methodology

To predict lending interest rate in Cameroon is to develop acquaintance with past patterns of lending interest rate behaviour in order to recognise situations of likely recurrence (Ababio 2012).The paper uses Box- Jenkins (1972) method, simple linear regression, and multiple linear regressions. In this study, the Box-Jenkins (1973) method is used in forecasting the evolution of lending interest rates in Commercial Banks in Cameroon. Before carrying out any forecasting, it is important to know the relationship between the various time series considered.

Some of the methods that are often used in the selection of models include the Akaike information criterion (AIC), Bayesian information criterion (BIC) and mean squared error (MSE). AIC helps to choose the best model that can fit lending rates in Cameroon. The model with the smallest AIC value is the best because it minimises the negative likelihood caused by the number of parameters (Ababio 2012). BIC helps to choose the model that can fit lending rates appropriately. The model with the smallest BIC value fits the data appropriately. MSE indicates how close a set of points is to a regression line. The smaller MSE is, the closer is the fitted line to the regression line. When a time series is not stationary, the lag operator is applied to acquire a stationary series. The lag operator L is defined for a time series $\{X_t\}$ by the following equations.

$$LX_t = X_{t-1}$$

$$L^2X_t = LLX_t = LX_{t-1} = X_{t-2}$$

$$L^kX_t = X_{t-k}$$

A moving average process of order q is denoted MA (q) process (John 1999).

Suppose $\{Y_t\}$ satisfies the process: $Y_t = \eta_1 Y_{t-1} + \cdots + \eta_p Y_{t-p} + \mu_t + v_1\mu_{t-1} + \cdots + v_q\mu_{t-q}$, $\{z_t\}$ is called an autoregressive moving average series of order (p, q), or an ARIMA (p,q) series. An ARIMA (p,q) series is stationary if the roots of the polynomial: $1 - \eta_1 Z - \cdots - \eta_p Z^p$ lie outside a unit circle. An ARIMA model is given as: $Y_t = \eta_1 Y_{t-1} + \eta_2 Y_{t-2} + \cdots + \eta_p Y_{-p} + \mu_t - v_1\mu_{t-1} - v_2\mu_{t-2} - \cdots - v_q\mu_{t-q}$. Also called an ARIMA (p,d,q), meaning an ARIMA model of order p, d, q.

In order to test the forecasting efficiency of certain models, it is important to study how these models are built. Box-Jenkins (2013) method is used in building an ARIMA model. The identification of the model involves determining the order of the model required in order to capture the salient dynamic features of Cameroon's lending interest rates. Before identification of model, it is important to verify if the model required for prediction is stationary. For a stationary time series, autocorrelation function (ACF) graph cuts off quickly or dies down quickly (Ababio 2012). To make the time series stationary, finite differencing is carried out using the lag operator.

From the correllograms, ACF tails off slowly to zero, partial autocorrelation function (PACF) while the partial autocorrelation function truncates after lag 1. This gives an indication of an AR. The model must be checked for adequacy by considering the properties of the residuals. The residuals from an ARIMA model must have a normal distribution and should be random (Ababio 2012).

For p-value associated with the Q statistic, if the p-value is less than the level of confidence (α) the model is not good. Ljung (1978) test is commonly used in ARIMA modeling applied to residuals of an already fitted ARIMA model. This paper uses AIC, BIC, MSE, RMS, R-squared and adjusted R-squared values for model selection. The analysis of data is performed with the help of STATA Version 15 software and EVIEWS Version 10 software.

Diagnostic Test such as the Durbin Watson test, Augmented Dickey Fuller and the Phillips-Perron test for stationarity will be used to test for stationarity. Once these test are carried out it will be possible to predict future values of lending interest rate in Cameroon.

Data used was collected from the end of year financial reports of BEAC from 1972 to 2023. This gives a sample size of 52 which satisfies the criteria that a time series data should not be less than 30 years now.

In statistical process control, the state of statistical control is identified by a process that generates independent, identically distributed random variables. In practice, it is often difficult to achieve this strict state of statistical control. Autocorrelation and other systematic time series effects are often important. Considering these effects, standard control procedures can be seriously misleading. A proposal and test of the statistical modeling and fitting of time series effects and the application of standard control techniques to the residuals of these fittings is done by using the Ljung Box test to test for the presence of white noise (Layth *et al*., 1988).

4. Data Analysis and Discussion of Results

This section centers on the analysis of lending interest rates and discussion of results gotten from analysing the Cameroon's Lending interest rates. It surveys basic correlation analysis among the variables under study. Time series graphs are used to obtain the required mathematical model describing lending interest rates in Cameroon.

4.1. Testing For Stationarity and Comparing Model Efficiency

Table 1 presents a statistical summary of the lending interest rates in Cameroon. It is observed

International Journal of Economic Policy
ISSN: 2788-6352 (Online)
Vol. 3, Issue No. 2, pp 1 - 22, 2023
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that there is a sample size of 52. In Table 1, the average lending rate in Cameroon between the periods of 1972 to 2023 is 4.14%. The least lending interest rate during this period is 2.45% and the maximum lending interest rate is 5.57%.

Table 1: Statistical Summary of Lending Interest Rates (LIR) in Cameroon from 1972-2023

Variable	Obs	Mean	Std. Dev.	Min	Max
LIR	52	4.14	.853	2.45	5.57

Source: Authors, using STATA Version 15

Table 2 presents the regression results which will help to obtain the variance inflation test for multicollinearity. This table also helps to obtain the Durbin Watson test which will be compared to the value of the R-squared to determine if the lending interest rates under the period of study is stationary or not. The coefficient of the lending interest rate is -11.076. This means that an increase in the lending interest rate in Cameroon over the years by one unit will decrease lending in recent years by 11.076 units. The P-value for the lending interest rate is 0 showing that Cameroon's lending interest rate is statistically significant. Moreover, the absolute value of the t-statistic is greater than 2.58. Hence the lending interest rate is significant at 5% level.

The AIC value is approximately at 408 and the BIC value is approximately 412. This means that a minimum of 412 lags will be required to make the lending interest rates in Cameroon to be stationary. The R-squared stands at 39%. This means that past lending interest rates account for 39% of the variation in the interest rates today.

In Table 2, the R-squared=39% greater than the Durbin-Watson d-statistic of 17%, hence the lending interest rate is not stationary and so regression results are spurious. The outcome of this result cannot be used for hypothesis testing and cannot be used for forecasting. The outcome of a spurious regression is basically useless.

Table 2: Linear regression

Variable	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
LIR	-11.076	1.963	-5.64	0	-15.019	-7.132	***
Constant	2043.358	8.296	246.29	0	2026.694	2060.021	***
Mean dependent var	1997.500		SD dependent var		15.155		
R-squared	0.389		Number of obs		52		
F-test	31.825		Prob > F		0.000		
Akaike crit. (AIC)	407.651		Bayesian crit. (BIC)		411.554		

**** p<.01, ** p<.05, * p<.1*

Source: Authors, using STATA Version 15

Before using the differenced variable, Table 3 shows the Variance inflation factor results. The results confirm that there is no presence of multicollinearity.

Table 3: Variance inflation factor

	VIF	1/VIF
LIR	1	1
Mean VIF	1	.

No multicollineariy

Source: Authors, using STATA Version 15

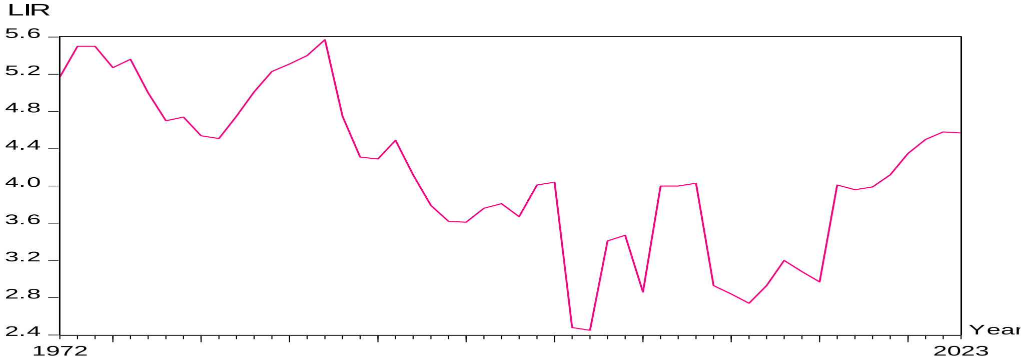
Table 4 presents the Augmented Dickey-Fuller test for unit root. The P-values are not significant at the 1% level. We do not reject the null hypothesis. This tells indeed that the series of the lending interest rate is not stationary after the first difference. One will further test again including the drift. The results in Table 4 shows that the null hypothesis can still not be rejected using the rejection on the 1% critical level hence the lending interest rate is non-stationary. Having confirmed that the sequence is non-stationary, one now uses the differenced variable.

Table 4: Augmented Dickey- Fuller test for unit root With Trend and Fuller test for unit root With Drift

D.LIR	With Trend:MacKinnon approximate p-value for Z(t) = 0.5995				With Drift: MacKinnon approximate p-value for Z(t) = 0.0160		
	L1.	LD.	_trend	_cons	L1.	LD.	_cons
Coef.	-0.207	0.085	-0.004	0.932	-0.162	0.050	0.648
Std.Err.	0.103	0.154	0.006	0.551	0.073	0.142	0.308
t	-2.000	0.550	-0.620	1.690	-2.210	0.350	2.110
P>t	0.051	0.583	0.536	0.098	0.032	0.728	0.041
[95%Conf. Interval]	[-0.415, 0.001]	[-0.224, 0.394]	[-0.016, 0.008]	[-0.177, 2.041]	[-0.309, -0.015]	[-0.236, 0.335]	[0.029,1.267]

Source: Authors, using STATA Version 15

In Figure 1 the graph demonstrates a downward trend. The Time series plot shows that the interest rates were very high in the early 90's and the late 80's. The Figure shows that interest rates have been decreasing as the years increase. The graph does not exhibit any mean reverting as the graph demonstrates a downward trend from 1972 to 2023. Therefore the lending interest rate in Cameroon from 1972 to 2023 is not stationary.



Source: Authors, using EVIEWS Version 10

Figure 1: Time series Plot For Cameroon's Lending Interest Rate

In Table 5 below we have 24 lags. The Autotcorrelation is shown in the column bearing the title AC. The AC values are very big showing that there is the presence of autocorrelation. The Q-Statistic values are big which is not zero. The p-values are all 0 which shows that the variables are not yet stationary. The Null hypothesis for the stationary test is that the variables are stationary. The task of this paper is to make the variable, lending interest rates to be stationary. So the variable lending interest rate has to be converted into first difference so that it becomes stationary. This is shown on Table 6.

Table 5: ACF and PACF

Date: 03/03/23 Time: 12:52
Sample: 1972 2023
Included observations: 52

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.854	0.854	40.191	0.000
		2	0.705	-0.091	68.130	0.000
		3	0.631	0.190	90.917	0.000
		4	0.558	-0.055	109.11	0.000
		5	0.433	-0.184	120.33	0.000
		6	0.382	0.221	129.24	0.000
		7	0.373	0.025	137.91	0.000
		8	0.381	0.163	147.18	0.000
		9	0.360	-0.051	155.67	0.000
		10	0.324	-0.104	162.70	0.000
		11	0.262	-0.115	167.41	0.000
		12	0.236	0.100	171.32	0.000
		13	0.194	-0.050	174.04	0.000
		14	0.081	-0.275	174.53	0.000
		15	-0.019	-0.019	174.56	0.000
		16	-0.079	-0.171	175.05	0.000
		17	-0.139	0.001	176.60	0.000
		18	-0.211	-0.046	180.29	0.000
		19	-0.225	0.084	184.58	0.000
		20	-0.235	-0.140	189.44	0.000
		21	-0.250	-0.010	195.10	0.000
		22	-0.278	-0.070	202.33	0.000
		23	-0.296	-0.011	210.83	0.000
		24	-0.335	0.010	222.11	0.000

Source: Authors, using EVIEWS Version 10

In Table 6, all the variables for the lending interest rates have been converted into second difference with 24 Lags in other to achieve stationary variables. The probabilities are all greater zero meaning that the p-values are all less than 5%. Therefore the variables have all become stationary after the second difference. This means that there are no autocorrelations. The Q-statistics have also reduced compare to those on Table 5. This also adds to the fact that the variables are now stationary.

The correlogram has changed from facing to the right and now to the left. The bars are now much shorter and there is no sharp difference again after the first bar. A difference in the bars occurs after the third bar. Therefore the variables are stationary.

New variables are then created for lending interest rates. These variables will be called differenced lending interest rates.

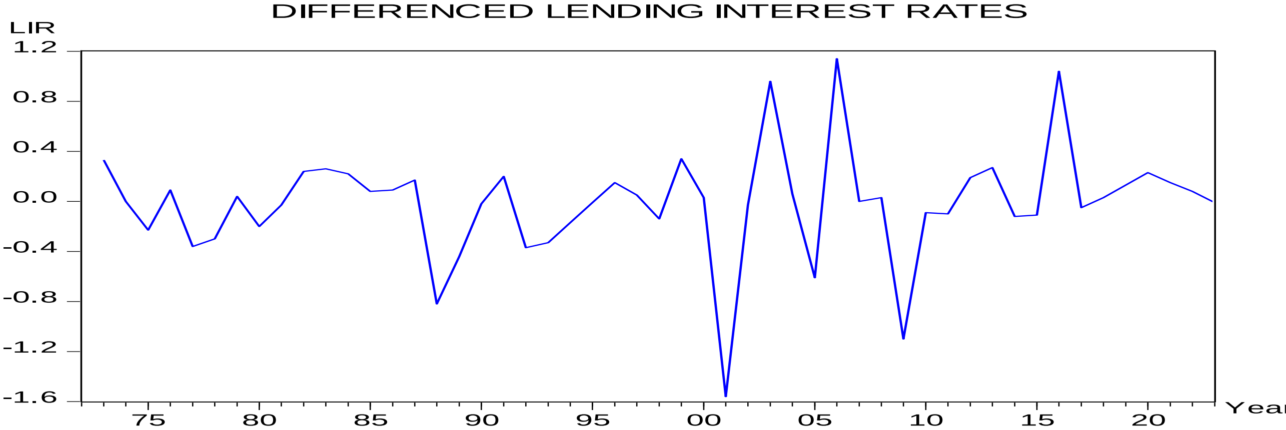
Table 6: ACF and PACF After Second Difference

Date: 03/03/23 Time: 13:01
Sample: 1972 2023
Included observations: 50

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.368	-0.368	7.1965	0.007
		2	-0.277	-0.477	11.352	0.003
		3	0.061	-0.398	11.554	0.009
		4	0.310	0.027	16.980	0.002
		5	-0.271	-0.179	21.213	0.001
		6	0.021	-0.014	21.238	0.002
		7	-0.093	-0.319	21.759	0.003
		8	0.182	-0.185	23.799	0.002
		9	-0.071	-0.188	24.116	0.004
		10	0.117	0.104	25.001	0.005
		11	-0.208	-0.049	27.894	0.003
		12	-0.009	-0.318	27.899	0.006
		13	0.270	0.070	33.024	0.002
		14	-0.084	-0.070	33.537	0.002
		15	-0.216	0.073	37.003	0.001
		16	0.143	0.041	38.570	0.001
		17	0.133	0.084	39.959	0.001
		18	-0.197	-0.085	43.112	0.001
		19	0.010	-0.007	43.120	0.001
		20	0.022	-0.045	43.162	0.002
		21	0.107	0.049	44.188	0.002
		22	-0.095	0.079	45.032	0.003
		23	0.017	-0.071	45.059	0.004
		24	0.032	0.158	45.161	0.006

Source: Authors, using EVIEWS Version 10

Figure 2 is obtained after the graph for the second differenced is carried out. Figure 2 shows that there is mean reversion and the variables are now stationary. After differencing, it is observed that there is a mean reverting about the line of origin. Hence the lending interest rate is now stationary.



Source: Authors, using EVIEWS Version 10

Figure 2: Differenced Time series Plot for Cameroon's Lending Interest Rate

4.2. Forecasting Efficiency of Selected Models

Cameroon's Lending Interest rates are fitted into an ARIMA modelsby observing the ACF and PACF. At the 4th lag there is a sharp cut in the PACF and at the 6th lag there is a sharp cut here too. Hence potential candidates for the selected ARIMA models would be ARIMA (4, 1, 4) and

ARIMA (6, 1, 6). The paper seeks to find the forecasting efficiency of 2 different ARIMA models. The paper goes beyond obtaining forecast values, but tries to find out how to have the most effective and realistic forecast values in fitted ARIMA models. This can only be obtained with the help of the AIC model selection criteria. Table 8 gives values that constitute ARMA model parameters. The coefficients of each variable, constant term that makes up the model and their respective error terms. The table is gotten with the help of STATA version 15. Each coefficient is affixed L, L2, L3, L4, which means the variables use to generate these coefficients, constant terms, variables, are lagged variables. At this level the paper seeks to bring out the various models parameters then with the help of STATA, AIC values are then obtained for appropriate models. This helps in choosing the model which best fits Cameroon's Lending Interest rate. Inputting Cameroon's Lending Interest rate into STATA yields the results obtained in Table 8.

After the first lag the Lending interest rates is significant at 1% level. At the second lag the lending interest rate is significant at 10% level. A the third lag the Lending interest rate is significant at 1% level and finally at the fourth lag the Lending interest rate is significant at 10% level. The AIC value is at 65. This means that a total number of 64 lag were needed to attain stationarity.

The coefficients of the lending interest rates for the AR model decreased from -0.009 to -0.588. This means that as the years increased an increase in the lending interest rates by one unit decreased lending interest rate by 0.09 units in the following year and kept on onto 0.588 units.

The coefficients of the MA model kept fluctuating around1.13%. Meaning that an increase in the shocks in the banking sector by one unit will increase the shocks in the following years to come by 1.13 units. The Chi square value shows that past lending interest rates in Cameroon will effectively affect the lending interest rates in the years to come by 78.895%. This simply demonstrates the goodness of fit.

Table 5: Regression Results for ARIMA (4, 1, 4)

D.LIR	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Constant	-.009	.092	-0.10	.922	-.188	.171	
L	-1.308	.502	-2.60	.009	-2.292	-.323	***
L2	-1.17	.653	-1.79	.073	-2.449	.109	*
L3	-1.255	.445	-2.82	.005	-2.127	-.382	***
L4	-.588	.302	-1.95	.051	-1.18	.004	*
L	1.454	300.465	0.00	.996	-587.446	590.355	
L2	1.126	196.078	0.01	.995	-383.179	385.431	
L3	1.277	137.76	0.01	.993	-268.727	271.281	
L4	.905	290.233	0.00	.998	-567.94	569.751	
Constant	.358	57.372	0.01	.498	0	112.805	

Mean dependent var	-0.012	SD dependent var	0.437
Number of obs	51	Chi-square	78.895
Prob > chi2	.	Akaike crit. (AIC)	65.036

**** p<.01, ** p<.05, * p<.*

Source: Authors, using STATA Version 15

In Table 9, there is a decrease in the standard errors from (0. 092) to (0.446). And later increased to 0.374. The increase in standard error is due to the fact that ARIMA (4, 1, 4) is closer to giving a better forecast than ARIMA (6, 1, 6). Standard error is a measure of the efficacy of forecasting. Very high standard errors indicate certain inconsistencies in the forecasting and it shows how the lending interest rates are related among themselves. The standard error is a measure of dispersion similar to standard deviation. It is an indicator of how reliable an estimate of parameters the sample statistic is. The forecast standard error is larger because it also takes into consideration the errors in estimating the coefficients and the relative extremeness of the values of the independent variables for which the forecast is being computed (Ringmu and Oumar, 2022).The Chi square value has increased from 78.895 to 325.615. This shows that the lending interest rates under ARIMA (4, 1, 4) will effectively affect lending interest rates as the years increase. The AIC value for the ARIMA (4,1,,4) is smaller compared to that of ARIMA(6,1,6). Generally models with smaller AIC values are more preferable. Hence ARIMA (4,1,4) will be more useful in fitting into a known ARIMA model.

Another reasons why the ARIMA (6,1,6) is not preferable for the forecasting of the lending interest rate in Cameroon is because its coefficients were only significant at the third and sixth lags at 1% level. Whereas the ARIMA (4,1,4) was significant at more lags.

Table 6: Regression Results for ARIMA (6, 1, 6)

D.var2	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Constant	-.009	.07	-0.13	.898	-.145	.127	
L	.335	.47	0.71	.475	-.585	1.255	
L2	.097	.374	0.26	.794	-.636	.831	
L3	-.572	.345	-1.66	.097	-1.249	.104	*
L4	.346	.393	0.88	.378	-.425	1.118	
L5	-.211	.248	-0.85	.396	-.697	.276	
L6	-.564	.296	-1.91	.056	-1.143	.015	*
L	-.315	1528.943	-0.00	1	-2996.989	2996.359	
L2	-.466	503.721	-0.00	.999	-987.741	986.808	
L3	.792	919.633	0.00	.999	-1801.657	1803.24	
L4	-.16	157.399	-0.00	.999	-308.657	308.337	
L5	-.332	760.542	-0.00	1	-1490.966	1490.303	
L6	.865	1536.671	0.00	1	-3010.954	3012.685	
Constant	.334	296.46	0.00	.5	0	581.385	
Mean dependent var	-0.012		SD dependent var		0.437		
Number of obs	51		Chi-square		325.615		
Prob > chi2	.		Akaike crit. (AIC)		68.804		

**** p<.01, ** p<.05, * p<.1*

Source: Authors, using STATA Version 15

4.2. Fitting Cameroon's Lending Interest Rates in ARIMA (4,1,4) Model

The theoretical form of the model is given by (1).

International Journal of Economic Policy
ISSN: 2788-6352 (Online)
Vol. 3, Issue No. 2, pp 1 - 22, 2023
www.carijournals.org

$$X_t = \mu_1 X_{t-1} + \mu_2 X_{t-2} + \mu_3 X_{t-3} + \mu_4 X_{t-4} - \vartheta_1 \rho_{t-1} - \vartheta_2 \rho_{t-2} - \vartheta_3 \rho_{t-3} - \vartheta_4 \rho_{t-4} - \tau_t \quad (1)$$

Table 8 displays the parameter estimates of the selected model**.** After the parameters are estimated the model for the lending interest rate over the period under consideration is given in (2).

Equation (2) holds that an increase one year ago an increase in Lending interest rate by one unit will reduce interest today by 1.308 unit. In addition, an increase in lending interest rate by one unit two years ago will reduce lending interest rate today by 1.17 units. Furthermore, an increase in lending interest rate by one unit three years ago will reduce lending interest rate today by 1.255 units. Finally an increase in lending interest rate by one unit four years ago will reduce interest rate today by 0.588 units.

In conclusion an increase in shocks in the banking sector in Cameroon, one, two, three and four years ago will reduce the shock in the banking sector today by 1.454, 1.126, 1.277 and 0.905 units respectively. Therefore, lending interest rates in Cameroon will reduce with time as from the year 2023 to 2027 and above.

$$X_t = -0.009 - 1.308\, X_{t-1} - 1.17 X_{t-2} - 1.255 X_{t-3} - 0.588 X_{t-4} - 1.454 \rho_{t-1} - 1.126 \rho_{t-2} - 1.277 \rho_{t-3} - 0.905 \rho_{t-4} - \tau_t \quad (2)$$

Applying the Lag operator (L) gives a new equation, considering just the AR component so as to have the characteristic polynomial. This is represented in (3).

$$X_t = -1.308 L X_t - 1.17 L^2 X_t - 1.255 L^3 X_t - 0.588 L^4 X_t - \tau_t. \quad (3)$$

The required characteristic is given in (3). The values of π can be gotten by solving the polynomial of degree 4. For absolute values of π greater than 1, the model is stationary and otherwise for absolute values of π less than 1.

$$0.601\pi^4 + 0.536\pi^3 + 0.383\pi^2 + 0.564\pi + 1 = 0 \quad (4)$$

In order to increase the robustness of the ARIMA model in this paper the autoregressive integrated moving average model with explanatory variable (ARIMAX) is adopted. The X added at the end stands for exogenous. In other words, it suggests adding a separate external variable to help measure our endogenous variable. . ARIMAX can be considered a multiple regression model with one or more autoregressive terms (AR) and moving average terms. This method is suitable for forecasting when data is fixed/non-stationary and multivariable with any data model. ARIMAX is related to the ARIMA method, but, while ARIMA is suitable for univariate datasets. ARIMAX provides forecast values of the target variables for user-specified periods to clearly illustrate better results for policy making. This paper adds inflation (INF) and Gross Domestic Product (GDP) as exogenous variables to the ARIMA model selected.

The interest rate represents the expense of retaining, lending, or borrowing money in an economy. Banks give interest on people's savings to entice them to deposit their money. This implies that the bank has access to that money to lend out, which benefits both the bank and people who can invest the extra money profitably. On the other hand, those who use loans to buy consumer items benefit the corporations that sell them; the customer ends up paying more for the item than if he had waited and purchased it interest-free. People are urged to spend rapidly (and borrow if the interest rate is low enough) during periods of high inflation because they fear losing purchasing power in the future (Mcmahon, 2021).

In terms of the relationship between GDP and interest rates, a study conducted by (Saracoglu & Lanyi, 2004) showed a beneficial association between interest rate levels and real GDP. It demonstrates that if interest rates rise, real GDP will also increase. Nonetheless, no research study has found that interest rates are directly linked to the level of inflation. In addition, several studies employed interest rates as an indirect measure Variable. This study was carried out to forecast the lending interest rates in Cameroon. Using the ARIMA model the results of the paper will not be very effective. The relationship between interest rates and GDP will reinforce the ARIMA mode (Anzima *et al*., 2013).

Table 7 shows the results of the ARIMA and ARIMAX results. The choice of te ARIMA models was chosen from the ACF and PACF. The ACF indicates the MA component while the PACF represents the AR component. The PACF demonstrated a sharp drop after the first lag. After differencing the ACF and PACF values lied within the error line. Possible candidates were the ARIMA(1,1,1), ARIMA(1,1,2), ARIMA(1,13) and ARIMA(1,1,4). In order to measure their robustness exogenous variables were added as seen in Table 7. The ARIMAX results were more statistically significant. All the p-values were below 0.05. This shows that the ARIMAX model is far mor effective than the ARIMA model.

Comparing the AIC and SBIC values, ARIMA(1,1,4) has the lowest value. This is our candidate model for forecasting. It's model ir represented by the model below.

The Adjusted R^2 values are smaller than the R^2 values for the ARIMAX. Whereas for the ARIMA models, the do not respect these rules. Because the Adjusted R^2 is always less than or equal to the R^2 values. Moreover the Adjusted R^2 for the ARIMAX increased far better than the Adjusted R^2 for the ARIMA models. If you add a predictor that is useful in predicting Y, the adjusted R^2 will increase because the penalty will be smaller than the R^2 increase. But if you add a predictor that is not useful in predicting Y, the adjusted R^2 will decrease because the penalty will be a bigger negative than the small increase (Martin, 2022).

From Table 7, ARIMA(1,1,4) has R^2 value of 0.7675. This means that 76.75% of the variation in Lending interest rates in Cameroon is accounted for by the lending interest rates for the past 52 years, the inflation rate for the past 52 years and the GDP for the last 52 years. Therefore, an in crease in lending interest rates 52 years ago by one unit will increase lending interest rates today by 0.808 units. Similarly, an in increase in inflation by one unit will reduce lending interest rates by 0.002 units. In addition, an increase in GDP by one unit will reduce lending interest rates by 0.000001 unit.

$$LIR_t = 4.699\text{-}0.002INFL_{t-i} - 0.000001GDP_{t-i} + 0.808LIR_{t-i} + 0.166\varepsilon_{t-i} + \mu_t, \quad (5)$$

Where, $i = 1, \ldots.,2023$.

International Journal of Economic Policy
ISSN: 2788-6352 (Online)
Vol. 3, Issue No. 2, pp 1 - 22, 2023
www.carijournals.org

Table 7: Model Selection Criterions

Model	R^2	Adj R^2	AIC	SBIC	P-value	DWT
ARIMA(1,1,1)	0.0063	0.057193	1.314812	1.466328	0.960545	2.144588
ARIMA(1,1,2)	0.0657	0.006060	1.255001	1.406517	0.357890	1.990573
ARIMA(1,13)	0.0012	0.062517	1.319737	1.471253	0.996289	1.999761
ARIMA(1,1,4)	0.0306	0.031274	1.291556	1.443072	0.687782	1.985105
ARIMAX(1,1,1)	0.7623	0.736509	1.317054	1.542197	0.0000	2.001507
ARIMAX(1,1,2)	0.7666	0.741219	1.301564	1.526707	0.0000	1.886753
ARIMAX(1,13)	0.7603	0.734206	1.326205	1.551348	0.0000	1.789456
ARIMAX(1,1,4)	0.7675	0.742261	1.298154	1.523298	0.0000	1.741511

Source: Author, Eviews version 10

4.2.1. Diagnostic and Forecasting

Now we have our potential candidate model which is ARIMA(1,1,4). We now verify that it satisfy the requirements for a stable univariate process. In order to do this we check that the residuals of the model are whit noise. This done by looking at the Ljung-Box Q statistic. This will help us to conduct the hypothesis. The null hypothesis states that the residuals are white noise. In Table 8 the autocorrelation and partial autocorrelation lie within the error lines. The p-values are bigger 0.05 and that is what we are looking for. Hence we do not reject the null hypothesis and conclude that the residuals are white noise.

Table 8: Ljung-Box Q statistic

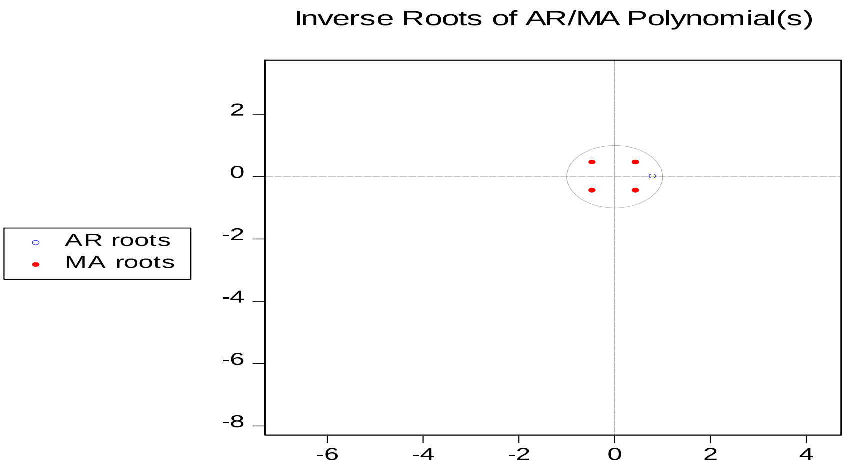
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.122	0.122	0.8255	
		2	-0.127	-0.144	1.7334	
		3	0.066	0.105	1.9814	0.159
		4	0.035	-0.009	2.0522	0.358
		5	-0.211	-0.200	4.7047	0.195
		6	-0.094	-0.037	5.2405	0.263
		7	-0.037	-0.083	5.3257	0.377
		8	0.164	0.210	7.0352	0.318
		9	0.057	0.009	7.2504	0.403
		10	0.107	0.132	8.0178	0.432
		11	-0.083	-0.184	8.4905	0.486
		12	0.009	0.042	8.4963	0.580
		13	0.216	0.259	11.845	0.375
		14	-0.054	-0.103	12.064	0.441
		15	-0.205	-0.046	15.242	0.292
		16	0.019	-0.108	15.272	0.360
		17	-0.024	-0.055	15.318	0.429
		18	-0.197	-0.144	18.521	0.294
		19	-0.050	0.059	18.738	0.344
		20	-0.002	-0.097	18.738	0.408
		21	0.087	0.042	19.428	0.430
		22	-0.019	-0.094	19.462	0.492
		23	-0.006	-0.045	19.465	0.555
		24	0.010	0.077	19.474	0.616

*Probabilities may not be valid for this equation specification.

Source: Author, Eviews version 10

We now check that the estimated ARMAX process is covariance stationary. From figure 3 the AR and MA values lie in the unit circle. Therefore the ARMAX process is covariance stationary.Also the ARMAX process is invertible since all MA roots lie inside the unit circle.



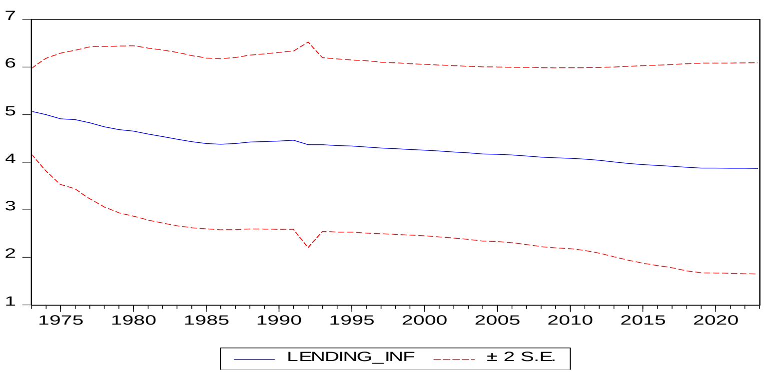
Source: Author, Eviews version 10

Figure 3: Inverse Roots of ARMA Polynomials

Since the model has been checked for diagnostics forecast can now take place. In Figure 4 the forecast values show a downward trend. This means that by 2028 lending interest rates will reduce in Cameroon.

Lower interest rates make credit for business growth and expansion more affordable. Reduced interest rates can lead to an increased volume of customers since consumers have more disposable income. Lower interest rates can boost new loan trustworthiness. Lower interest rates stimulate investment and spending, increasing aggregate demand and economic development. This increase in aggregate demand, however, may result in inflationary pressures.

Forecast of Lending Interest Rates



Forecast: LENDING_INF	
Actual: LENDING_INTEREST_RATES	
Forecast sample: 1972 2028	
Adjusted sample: 1973 2023	
Included observations: 51	
Root Mean Squared Error	0.724254
Mean Absolute Error	0.570405
Mean Abs. Percent Error	16.19881
Theil Inequality Coefficient	0.085045
Bias Proportion	0.061546
Variance Proportion	0.536822
Covariance Proportion	0.401632
Theil U2 Coefficient	1.712428
Symmetric MAPE	14.51742

Source: Author, Eviews version 10

International Journal of Economic Policy
ISSN: 2788-6352 (Online)
Vol. 3, Issue No. 2, pp 1 - 22, 2023
www.carijournals.org

Figure 4: Forecast of Lending Interest Rates in Cameroon

5 . Conclusion, Summary and Recommendation

The paper shows how to choose the best model for Cameroon's lending rates from 1972 to 2023. Referring to the first objective of this study, it is empirically clear that Cameroon's loan rates follows an ARIMA process described in Section 4, based on comparison of standard errors before and after differencing, AIC values. Cameroon's historical adjusted lending rates were used as an exogenous variable in this study. In most cases, high and low linear correlations between lending rates in the tested models gave signals for the corresponding AIC values.

The paper has forecast lending interest rates in Cameroon. The results indicate that these interest rates will increase in the years ahead and remain like that for a while. Instead of focusing on price targeting, BEAC should adopt an inflation-targeting policy. Low inflation (internal stability) and adequate currency coverage (external stability) should be the two critical components of the BEAC's monetary stability mission from the year 2024 up to 2035 when Cameroon will be emerging. The latter relates to price level targeting, distinct from inflation targeting, which enables low, consistent, and predictable price increases. The decision to set a price-level target rather than an inflation target has repercussions for the development of the economy because of the numerous swings in economic activity and their effects on product costs. BEAC should chose an accommodating monetary policy in response to the economic shock brought on Cameroon by the COVID-19 shock, Bokoharam attacks in extreme north of Cameroon and recently the Anglophone crisis in the Northwest and South west regions of Cameroon and to prevent a liquidity crisis in the banking system. BEAC should chose an accommodating monetary policy centred on decreasing the already high interest rate and injecting cash into CEMAC savings in response to the economic shock brought on by the crisis currently plaguing Cameroon and to save the banking system from a liquidity crisis. The central bank should prepare for sudden fluctuations in the price level, so they should chose monetary aggregates as an intermediate aim. Based on our findings for Cameroon, these monetary aggregates continue to contribute very little to output, which is adequate proof that quantity actions cannot effectively affect prices. On net claims Credits, Governments, and Net Foreign Assets Occasionally, has a detrimental impact on the economy of Cameroon. Only when targeting the monetary aggregate has distinct and satisfying characteristics in terms of stability, controllability and information content can it be effective. The consumer price index is directly impacted by changes in commodity prices through pump prices and other energy costs. However, these changes can occasionally be significant and long-lasting due to Cameroon's economy's dependence on trade terms. Due to their short-term impact on inflation, such deviations could be avoided if the central bank credibly pursues an inflation objective. With a price-level objective, the Central Bank must cause price changes in other industries to make up for it. Due to an overall increase in volatility in Cameroon's already vulnerable economy, there are many variations in relative costs. By putting forecasts for inflation and pricing changes, it would be simpler for BEAC to target required banks to enable credit access and induce buyers to spend money while providing assurances regarding the macroeconomic stability. Therefore, the paperl advise bank managers, oversight organisations, and government policymakers to collaborate and address variables that lead to wide interest rate spreads. Instead of blaming one another, better management of the influencing elements will result in a more stable financial system for the nation.

In order to stabilise the banking industry and reduce interest rates, it is essential to learn from Basel III's risk management-related lessons and recommendations. Banks should always conduct themselves with professionalism and integrity. Bank executives should abstain from politics to avoid giving unfair loans to people with ties to the political system. Since the banking industry's growth is intimately related to that of the economy, bank managers should support this growth by managing the banking industry's activities well. Bank executives should encourage this goal of growth. Banks can benefit from economies of scale and technological advancements as their net worth rises over time, allowing them to provide the investing public with reasonably priced financial goods.

Banks should investigate internal and sector-driven initiatives that mitigate or offset the impact of bank and sector specific issues. Diversifying financial goods through tactics is necessary to lessen reliance on interest income and the dangers accompanying it. The Central Bank, during its regulatory job, should ensure adequate research is conducted before setting a policy. Banks should invest in cost-saving and efficient technology to boost their earning capacity. Off course regulation will produce adverse outcomes at the expense of the economy and the broader people. The government and the central bank are in charge of managing the inflation rate. The decision-makers should see that stabilisation measures are implemented to manage the economy. They are operating in a predictable setting. Investors and institutions need to establish correct expectations in nations with high and unstable inflation rates, which prevents the sector from being uniform and encourages the exploitation of some economic players. Government measures that promote and develop competition in the banking sector should be further improved and encouraged. They are promoting the development and reputation of commercial banks to improve their market penetration and undermine the dominance of a select few giant banks.

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