Quantitative Analysis of Inflation and Unemployment Rates on Exchange Rate Movement: An Empirical Study Based on Data in the US from 2009 to 2022

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Abstract: The research paper determined the impact of inflation and unemployment rates on the exchange rates in the United States from January 2009 to December 2022, the statistically significant variables among the variables included in this study. The independent variables besides the two used were: - interest rates and bank lending rates. Two regression models were performed, with the first comprising all the variables and the second containing all the independent variables that turned significant in the first regression model. Terms of trade categorized as favorable and unfavorable were used as a control variable on the second regression model with only inflation and unemployment rates. Unemployment rates were negatively related to Exchange in that a percentage increase in this rate would contribute to a reduction in the Exchange rate by 2.63 units. On the other hand, inflation rates increase by a percentage would increase Exchange rates by 0.34 units. Analysis was done in Microsoft Excel and reported at a 95% Confidence Interval. Around 64% of the exchange rates in the United States were explained by these variables used in the study.

Keywords: inflation, unemployment rates, exchange rate, multiple regression analysis

1.   Introduction

Among the vital components of the globe's economy is exchange rates. Therefore, the country's economy must be addressed in business analysis and inspection of the economy. This rate type is generally affected by independent factors, including the political and economic environment. Some of these factors affecting the exchange rate include: - the interest rates, unemployment rate, inflation, government debt, and the lending rate of banks in the country to aid in currency circulation and terms of trade. Each has a different effect and significance rate in the given country's exchange rate. Multiple regression analysis will determine the explanatory variables' importance and impact on the exchange rate in the United States.

   Two regression models will be performed to see the difference and effect of introducing the control variable to the other regression model with the significant variables (inflation and unemployment rates). R-square will be used to see the difference between the two models.

1.1. The Importance of This Study

This study aims to study the impact of explanatory variables like interest rates, inflation, unemployment rate, and the lending rate of banks on exchange rates. Moreover, this study will determine if the relationships between these variables are statistically significant in determining exchange rates. Ultimately, the study will examine the impact of a control variable in the association between significant regressor variables and the answer variable, Exchange rates. They understand the dependency between these variables aided by using multiple regression analysis technique, which reveals information about the variables affecting the exchange rate. Upon noting the dependence, policymakers can make favorable economic judgments if they know how independent variables affect the exchange rate, making this study critical.

2. Literature Review

In this chapter, several scholars on our interest topic will be used to base our argument. The section will be divided according to each independent variable with the dependent variable in this study. The review will be based on similar content but may be different.

2.1. Impact of Inflation on Exchange Rates

The values of a country's currency relative to other currencies change when market inflation fluctuates. A country's currency will appreciate if its inflation rate is lower than another. In contrast to nations with more excellent inflation rates, those with common inflation experience slower increases in the cost of goods and services and frequently have stronger currencies. Conversely, high inflation results in currency depreciation and higher interest rates. By examining the inflation rates in the economy, one may understand how inflation affects the exchange rate [1]. A state interested in regulating the rate of exchange needs to look closely at the inflation rates in the economy.

Among the effects of high inflation on the exchange rate is that it causes the fall of the exchange rates. This is caused by business people's fear of investing in the economy during these times for fear of incurring losses.

2.2. Association Between Interest Rates and Exchange Rates

Exchange rates in the economy are highly affected by the interest rates in the given economy. A direct association is seen between these variables. A study on the impact of interest rates on foreign direct investment revealed that increasing interest rates encourages economic investors to gain more profits. This attraction of investing in the market is also beneficial as foreign business people also feel secure in investing in the economy [2]. The increment of investors due to the rise in interest in the market makes the value of exchange rates appreciate.

The flow of capital in the economy is associated with the interest rates in that when the interest rates are increased, the capital inflow increases in equal proportions. This increase in capital inflow will cause a rise in a country's domestic currency [3]. The increase in capital flow will attract investors into the market, increasing domestic currency value.

2.3. Relationship Between Unemployment Rates and Exchange Rates in the Economy

A percent increase in unemployment causes a 0.11 decrease in the economy's exchange rate when all other factors are constant [4]. The reduction in the exchange rate is caused due to the deduction in money supply hence the decline of the need for foreign currencies. Also, when the employment rate reduces, the number of workers in the economy reduces the demand for exports.

Unemployment, on the other hand, leads to inflation which reduces the purchasing power of buyers reducing the desire for imports purchase and increasing the need for domestic currency, facilitating the exchange rate [5].

2.4. Bank Lending Rates in Association with Exchange Rates in the Business Setting

Exchange rates in the economy are also determined by the willingness of the banks to lend to their members in the state. When banks increase lending rates, the money supply reduces, discouraging foreign investors [6]. This, in turn, increases the demand for the domestic currency making its value rise compared to other countries. Lowering the bank lending rates motivates foreign investors to invest in the country because of the decline of the domestic currency with other nations.

The increment of lending rates by banks is an advantage to the domestic currency as it becomes expensive for inside businesses and industries to take loans; this, in turn, increases the demand to their prompted by the increased saving [7].

2.5. The Link Between Terms of Trade and Exchange Rates

Exchange rates also depend on the terms of trade within a given nation. It directly associates with the rate value of the shared currency. Currency's value appreciates in countries where the given trade terms are better. [8] A state with favorable terms of trade increases its currency demand caused by an increment in export demand, which will, in turn, increase the exchange rates within the country. In severe cases, when the terms of trade are wrong, the exchange rates decrease, devaluing their currency, raising prices of imported goods, and lowering domestic demand, which could lead to recession.

3. Research Methodology

Under research methodology, the research design, data, and data analysis will be tackled in this section. All the processes used in this research study will be explained here.

3.1. Research Design

The research designs utilized in this study were descriptive and regression analysis models. Descriptive statistics give an overview of the available dataset handled. After summarizing the data in question, regression models were adopted to know the association between the answer and the regressor variables in this study. Correlation analysis emerged in the investigation since, for any dataset to be performed in regression analysis, there has to be a relationship between the variables at hand.

3.2. Data Used

Secondary data was used in this study. The data had six variables: Exchange rate, Unemployment rate, interest rates, inflation rates, terms of trade, and bank lending rates. The data was collected and fed monthly from January 2009 to December 2022.

3.3. Research Method

The research method involved data assembling on the factors affecting the exchange rate in the US economy from a secondary source. The exchange rate is affected by factors, including interest rates, inflation rates, bank lending rates, terms of trade, and jobless rates. Multiple regression analysis is a method to know how the independent variables affect the answer variable in any setting. Apart from

knowing the interaction between the explanatory and dependent variables, regression analysis provides a technique for understanding the statistical significance of the independent variables.

Independent variables determine the increment or decrement of the answer variable [9]. The variable of concern in a regression analysis is the dependent variable (whose effect is selected). For our case in this study, interest rates, inflation rates, bank lending rates, and jobless rates form the explanatory variables, whereas the exchange rate is the variable of interest. Terms of trade created the study's control variable, which was maintained constant in the experiment. Business terms were categorized into two classes: favorable and unfavorable trade terms.

The hypotheses were examined through multiple regression analysis using the linear entry approach [10,11]. The data was determined by minimizing the sum of the squares of the vertical deviations between each data point and the fitted line; a point has zero vertical deviation if it perfectly lies on the line. No cancellations exist between positive and negative values since the deviations are squared and added. The statistical program typically computes the least square estimates b0, b1... bn. Regression model assumptions were.

$$y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + e$$

W h e r e $b_0 = intercept, x_1 =$ interest rates, $x_2 =$ inflation rates, $x_3 =$ bank lending rates , $x_4 =$ jobless rates, $e =$ error term.

The degree of confidence in this study was 95% (t-test for confidence interval, significance = 0.05).

3.4. Techniques for Analyzing Data

Microsoft Excel was used for the analyses. The computation of means, frequencies, and standard deviation was done using descriptive statistics. Correlation analysis, one-way Analysis of Variance (ANOVA), and t-tests were utilized as inferential statistics. This study examined each hypothesis at a significance level of Alpha = 0.05.

4. Data Analysis and Presentation

The chapter seeks to answer the objectives in chapter one of this study. The analysis tools will be explored in detail, including the exact analysis guided by the relevant hypothesis. For the output presentation, tables will be used to display the results from the study. Graphs will also be used in representation for quick visualization of the data.

4.1. Descriptive Statistics

The general description of the data gives a quick overview of the data dealt with in the study. For this study in particular, the variables of interest will be analyzed and represented in a table as below: -

Table 1: Descriptive statistics for the variables.

	Exchange Rates	Interest Rates	Inflation Rates	Bank lending Rate	Unemployment rate
Mean	103.83	0.73	243.44	0.60	6.33
Standard Error	1.15	0.06	1.59	0.06	0.18
Median	107.31	0.25	238.03	0.16	5.80

Table 1: (continued).

Mode	#N/A	0.25	224.81	0.09	3.60
Standard Deviation	14.87	0.83	20.64	0.84	2.33
Sample Variance	220.99	0.69	426.15	0.70	5.41
Kurtosis	0.00	2.91	0.38	2.63	-0.23
Skewness	0.05	1.83	0.83	1.78	0.62
Range	70.41	4.02	87.06	4.05	11.20
Minimum	76.64	0.25	211.93	0.05	3.50
Maximum	147.05	4.27	298.99	4.10	14.70
Sum	17443.95	122.44	40897.57	101.18	1063.20
Count	168.00	168.00	168.00	168.00	168.00

An equal sample size of 168 was used for the dataset for every variable studied. For the exchange rates, the average of the sample was 103.83. Its standard error was reported at 1.15, which is very minimum, showing that the sample's mean is not widely deviated from the population's average. Some skewness to the right is sported in the data since the median (107.31) is higher than the listed mean. Based on the data spread in the sample for this variable, the data is widely dispersed since the standard deviation (14.87) is somehow significant. The spread is supported by the range being 70.41.

The first independent (interest rates) is highly skewed to the left since the average is much bigger than the median of the rates. The kurtosis and skewness suggest that the data is not normally distributed. The rates are dispersed with a standard deviation of 0.83%.

Another essential variable considered was the rate of inflation. According to the sample, the inflation rate indicated a slight variation, shown by a small standard error of 1.59. the mean and the median are very close, saying that the data was negligibly skewed. The kurtosis reports that the data is less peaked than the normal distribution. In the period of data collection, the inflation rates were not constant.

The bank rates of lending were not constant in the period of observation. A range of 4.05 was noted during that period. However, the subsequent rates were relatively spread according to the standard deviation. Skewness combined with kurtosis to report that the bank rates were lowly skewed with a moderate peaked distribution.

The mean is relatively higher than the median, indicating a positive skewness. Some values of the unemployment rate are higher in the sampled data. The unemployment rate has been varying throughout the period, with a range of 11.20%.

4.2. Graphical Representation

The line graph for the variables was drawn for easy visualization and noting trends. Three-line charts for (exchange, inflation, and unemployment rates) were removed, as shown.

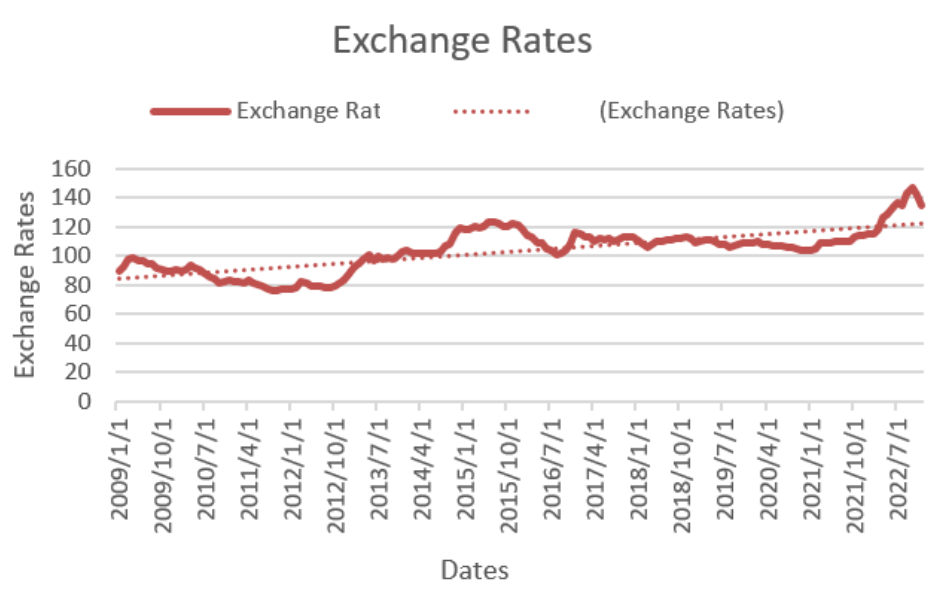### 4.2.1. Line Graph for Exchange Rates Against Time

Figure 1: Line graph for exchange rates against time.

From the line chart in figure 1, exchange rates from January 2009 to December 2009 had a slow growth rate. The linear trend has a positive gradient. This means the exchange will continue increasing when the factors affecting it are constant or change within the same ranges.

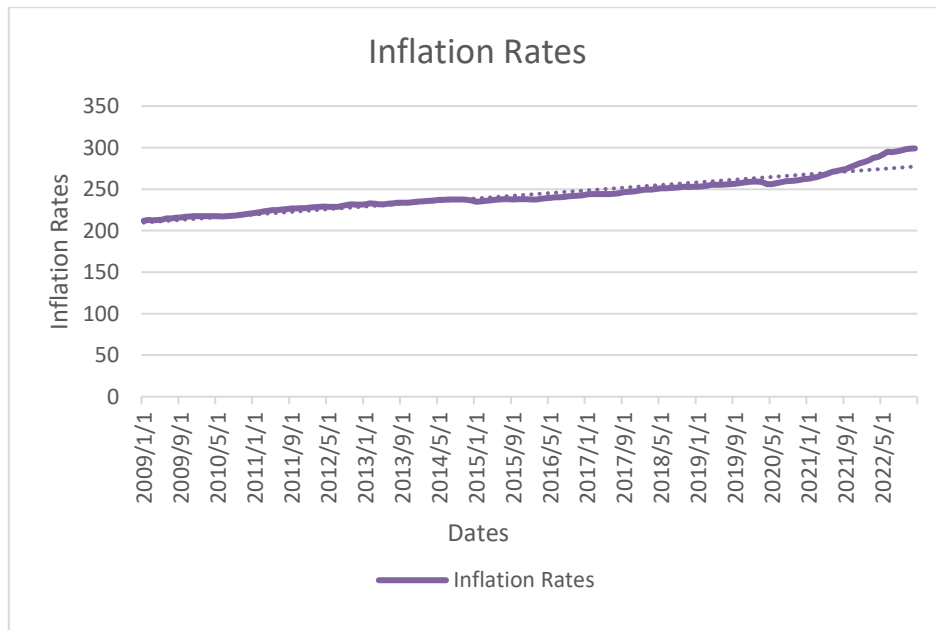### 4.2.2. Line Graph for the Inflation Rates Against Time

Figure 2: Line graph for inflation rates against time

In the period studied, the inflation rates increased from the first date collected to the last day when the data was collected. However, the trend line indicates that the slope is relatively steep. The gradient is minimal, meaning a slow growth rate.

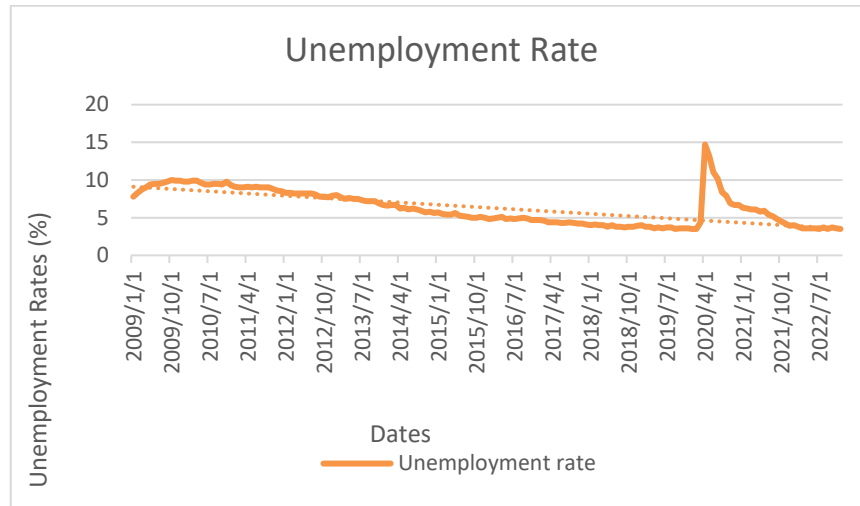### 4.2.3. Line Graph for the Unemployment Rate Against Time

Figure 3: Line graph for unemployment rates against time.

The line graph represents the unemployment rate against time. The trend line plotted in the chart shows that at a low rate, the rate was reducing gradually. This is a robust improvement by the forces put in place as people are absorbed in government, reducing the unemployment rate in the economy.

4.3. Correlation Analysis

Table 2: Correlation analysis between the variables.

	Exchange Rates	Interest Rates	Inflation Rates	Bank lending Rate	Unemploy-ment rate	Terms of Trade
Exchange Rates	1.00					
Interest Rates	0.52	1.00				
Inflation Rates	0.74	0.54	1.00			
Bank lending Rate	0.50	1.00	0.51	1.00		
Unemploy-ment rate	-0.72	-0.62	-0.65	-0.61	1.00	
Terms of Trade	-0.04	-0.12	0.02	-0.12	0.09	1.00

Pearson correlation determined the interaction between the variables. The answer variable (Exchange rate was positively correlated with inflation rates, interest rates, and bank lending rates at 0.74, 0.52, and 0.50, in that order. The other independent variable(unemployment) was negatively related to exchange rates at -0.72. Due to the correlation between these variables, regression analysis can be performed to test their speed of significance.

4.4. Regression Analysis

In this section, regression analysis will be done in two parts. The first part is where all independent variables in this study will be regressed on exchange rates [12]. Then two variables (the most significant variables) will be regressed in the other part of the equation with the introduction of the control variable terms of trade.

The inclusive regression analysis is, thus,

Table 3: Regression coefficients for model 1.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	37.63	13.96	2.69	0.01	10.05	65.20	10.05	65.20
Interest Rates	-3.41	22.69	-0.15	0.88	-48.22	41.40	-48.22	41.40
Inflation Rates	0.34	0.06	5.91	0.00	0.23	0.46	0.23	0.46
Bank lending Rate	3.48	22.22	0.16	0.88	-40.40	47.36	-40.40	47.36
Unemployment rate	-2.63	0.44	-5.96	0.00	-3.50	-1.76	-3.50	-1.76

Taking all other independent variables constant, the exchange rate was at 37.63. A percentage increase in the interest rate would lead to a decrease of 3.41 units of the exchange rate. On the other hand, inflation rates were positively related to the exchange rate with a coefficient of 0.34, showing that increasing the inflation rate at a percent would increase the exchange rate by 0.34 units. Since its probability value of 0.000 is less than the significance level (0.05), the inflation rate is statistically significant in explaining the exchange rates. The unemployment rate was inversely rated with the exchange rate. A unit increase in the unemployment rate would result in a 2.63 unit decrease in the exchange rates like the inflation rates; this has a probability of 0.00, which is less than the significance level signifying statistical significance. 3.48 units of the exchange rate would increase with the unit addition of favorability rates in banks.

4.4.1. Significance of the Coefficients

The following hypothesis was tested.

$$H_0: The\ coefficients\ are\ not\ statistically\ significant$$

$$H_1: The\ coefficients\ are\ statistically\ significant$$

This hypothesis was tested at a 95% confidence interval. From the above analysis, intercept, inflation rate, and the unemployment rate was statistically significant in explaining the rate of exchange. This is concluded since all the probability values against these coefficients are less than the

significance level (0.05). The other coefficients were insignificant since their probability value was more significant than 0.05, giving enough support for the null hypothesis.

4.4.2. Analysis of Variance

Table 4: ANOVA for model 1.

ANOVA					
	df	SS	MS	F	Significance F
Regression	4	23910.16386	5977.540965	74.97576078	6.11855E-36
Residual	163	12995.389	79.72631291		
Total	167	36905.55287			

The analysis of variance tests for the significance of the entire regression model. The significance F is equivalent to the probability value. The p-value on the last column of the ANOVA table is very low, indicating the significance of the model.

4.4.3. Summary of the Inclusive Multiple Regression Model

Table 5: Summary of model 1.

SUMMARY	OUTPUT
Regression Statistics	
Multiple R	0.805
R Square	0.648
Adjusted R Square	0.639
Standard Error	8.929
Observations	168

The R-square and the adjusted R-square measure the variation of the model's answer variable explained by the independent variables. The Adjusted R-Square is, however, more efficient since it accounts for several explanatory variables in the regression analysis. Therefore, 63.9% of the exchange rate variation is explained by the regressor variables, while the other interpretation is defined by variables not captured in the model. Multiple R indicates the association level between all the variables in the regression analysis. Therefore, the association stands at 80.5, implying a robust direct association.

4.5. Second Multiple Linear Regression Model

From the above regression model, independent variables unemployment and inflation rate had a significant interaction effect with the Exchange rates in the economy. These explanatory variables are in another model regressed with exchange rates with the impact of a control variable terms of

trade. The analyses are displayed below in the same table format as tabulated in the first regression analysis with all the explanatory variables in the question.

Table 6: Regression coefficients for model 2.

	Coeffi-cients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	38.292	12.472	3.070	0.003	13.664	62.919	13.664	62.919
Inflation Rates	0.339	0.044	7.685	0.000	0.252	0.426	0.252	0.426
Unemploy-ment rate	-2.650	0.393	-6.746	0.000	-3.426	-1.874	-3.426	-1.874
Terms of Trade	-0.440	1.408	-0.313	0.755	-3.220	2.339	-3.220	2.339

When trade terms are unfavorable, the exchange rates reduce by 44%. Assuming the other independent factors, a unit increase in the unemployment rate would decrease the exchange rate to 2.650 units. This shows an indirect relationship between unemployment and the rate of exchange. When the inflation rates increase at a unit percentage, exchange rates increase at 0.339 units. On the other hand, assuming all other independent variables in the modeling are zero, the exchange rate is 38.292. apart from the terms of trade, all the independent variables, including the intercept, have the probability values against them being less than the significance level, indicating the importance of the coefficients.

4.5.1. Analysis of Variance

Table 7: ANOVA for model 2.

ANOVA					
	df	SS	MS	F	Significance F
Regression	3	23914.681	7971.560	100.635	5.43703E-37
Residual	164	12990.872	79.213		
Total	167	36905.553			

A probability value of 5.43703E-37 is much smaller than the alpha level of significance (0.05). This indicates that at least one of the model's regressor variables is essential in explaining the exchange rates. Therefore, the regression model is statistically acceptable.

4.5.2. Summary of the Regression Model

Table 8: Summary of the regression model.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.805
R Square	0.648
Adjusted R Square	0.642
Standard Error	8.900
Observations	168

An Adjusted R- Square of 0.642 indicates that the regressors explain 64.2% of the variation of the answer variable in this variable. At the same time, the other interpretation is captured by other variables that are not in the model.

Comparing the two regression models, there is a slight change in the levels of variation explained by the answer variable. In the second model with the control variable. The interpretation of the independent variable is presented slightly higher than in the first regression analysis, where some of the regressor variables were insignificant.

5. Conclusion

From the ongoing, exchange rates in the US are affected by different independent factors, with their level of interaction varying. The interest rates, inflation rates, unemployment rates, willingness and rates of bank lending, and the variable control terms of trade were quantitatively analyzed in this study. Inflation and unemployment rates in the US from 2009 to 2022 were statistically significant in explaining the exchange rates in the states.

Under unemployment, this research agreed with previous studies that when the rate increased, the exchange rate would be adversely affected negatively in the states, just like in other countries. Generally, this research study coincided with the previous studies conducted by different researchers.

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