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# Introduction

Regression analysis is a statistical tool used to model the relationship between a dependent variable and one or more independent variables (Koto, 2013). This research aims to estimate the relationship between the Jamaican inflation rate, the Bank of Jamaica’s treasury bill rate, the Bank of Jamaica's policy rate and the JMD/USD monthly average exchange over sample the period of March 2020 to March 2022 using regression analysis. For our analysis, the inflation rate was regressed upon the following variables: the BOJ treasury bill rate, the BOJ policy rate, and the JMD/USD monthly average exchange rate. From this analysis, the researchers want to test whether established principles such as the Fisher effect and the Taylor rule hold for the estimated relationship between some of the variables used in the model and make recommendations. Higher global inflation due to policies implemented in response to COVID-19 by governments around the world and certain geopolitical events served as motivation for this research.

# Literature Review

Inflation refersto a broad rise in the prices of goods and services across the economy over time, eroding purchasing power for both consumers and businesses (McKinsey & Company, 2022).  According to The Economic Times (2022), treasury billsare government bonds or debt securities with a maturity of less than a year. Treasury bills are usually sold at a discount from the bill’s face value. The difference between the discount and the face value determines the yield/rate for the treasury bill. Treasury bills are considered very liquid due to their short period of maturity. Treasury bills sold by reputable governments are considered very safe investments due to the low risk of these governments defaulting on their debt. Numerous governments around the used expansionary monetary policy in the form of stimulus packages, tax cuts, and low-interest rates to offset the effects of COVID-19 and the consequences were far-reaching. Small economies like that of Jamaica are susceptible to exogenous shocks. CFI (2022) highlighted that an increase in inflation would result in a fall in the prices of treasury bills due to a fall in demand and ultimately an increase in the rate (recall how the rate of treasury bills is determined) since they are now less attractive. The treasury bill becomes a less attractive investment if the rate of return is not more than the inflation rate.

The policy rate is the interest rate that central bankscharge deposit‐taking institutions for borrowing or deposits. This is a monetary instrument that is used to achieve inflation objectives. Central banks have the authority to adjust interest rates to ensure that consumers and businesses are protected. In recent times, central banks around the world have increased the policy rate which resulted in investment uncertainties as the cost of borrowing is now more expensive. An increase in the policy rate aims to reduce inflation (Adrian and Natalucci, 2022)*.* Central banks, however, face a certain dilemma. If central banks wanted to set interest rates to achieve low, stable inflation while avoiding large fluctuations in output and employment, how would they do it? (Mankiw, 2013) Considering the tradeoff between high-interest rates and high unemployment employment as explained by the Phillips curve. However, most economists believe that monetary policy should be focused on the control of inflation, and inflation can be reduced by increasing short-term interest rates (Alvarez et al., 2001). The relationship between the nominal interest rates, real interest rates, and inflation is described by the Fisher effect. The Fisher effect says that the nominal interest rate moves one-for-one with expected inflation and that real interest rates fall as inflation increases (Mankiw, 2013). Considering the dilemma earlier mentioned that exists when central bankers are setting interest rates there exists some discord about the effect of monetary policy and its use in the short run (Abel et al., 2011). Classical macroeconomists believe that monetary policy should be essentially automatic. In its control of the money supply, the central bank should be required to follow a set of simple, pre-specified, and publicly announced rules (Abel et al., 2011). The opposite of the rules approach, which has been supported by most (though not all) Keynesian economists, is called discretion (Abel et al., 2011). The idea behind discretion is that the central bank should be free to conduct monetary policy in any way it believes will advance the ultimate objectives of low and stable inflation, high economic growth, and low unemployment. Taylor’s Rule provides a middle ground between the two opposing views because although it is a rule, it allows for the consideration of economic conditions, in other words, it allows for some discretion. Taylor (1993) believes it is practically impossible to follow mechanically any particular algebraic formula that describes the monetary policy rule. The Taylor Rule adjusts the equilibrium rate based on divergence in inflation and real GDP growth from the central bank's targets. The rule prescribes a higher interest rate when inflation is above target, and a lower one if inflation is lagging. Critics argued that the basic Taylor Rule formula doesn't account for the ineffectiveness of negative interest rates or alternative monetary policy tools like asset purchases (Nikolsko‐Rzhevskyy and Papell, 2013).

The exchange rate is the price of one country’s currency in terms of another. As Jamaica is a net importer the exchange is a particularly important macroeconomic variable as a depreciation/appreciation of the local dollar relative to the foreign currencies means that the cost of imports will rise /fall (Seagal, 2021). A byproduct of increasing interest rates is a stronger currency as the money supply is reduced. Small economies such as Jamaica, however, do not benefit from this. The USD appreciates significantly more than the JMD as the demand for the USD is much greater due to its place as a global reserve currency. This rapid appreciation of the USD thus causes the currencies of small economies to depreciate relative to the USD, therefore, likely increasing inflation as imports get more expensive (Pettinger, 2019).

# Variables and Data Used for Regressions



InRate = Jamaican inflation rate (%)

TBRate = Bank of Jamaica treasury bill rate (3-month period) (%)

Prate = Bank of Jamaica Policy Rate (%)

Fxrate =JA/US Average Monthly Foreign Exchange Rate ($)

# Simple Regression of Inflation on the Treasury Bill Rate



# Treasury Bill Rate Line of Best Fit from Simple Regression

# Multiple Regression of Inflation on the BOJ Treasury Bill Rate, BOJ Policy Rate, and JA/US Avg Monthly FX Rates



# Line of Best Fit for each Independent Variable MLR

Shown below are the lines of best fit for each independent variable from the multiple regression.

# Discussion of Findings

**Simple Regression Model**

Shown below is the model estimating the relationship between the Jamaican inflation rate and the BOJ treasury bill rate.

Equation (1) can be interpreted: If the predicted treasury bill rate is zero, TBRate = 0, then the predicted inflation rate is the intercept, 3.8573%. We can also write the predicted change in the inflation rate as a function of the change in the treasury bill rate: . This means that if the treasury bill rate increases by one percentage point, , then the inflation rate is predicted to change by about 1.2%. Because equation (1.0) is a linear equation, this is the estimated change regardless of the initial inflation rate.

, the coefficient of determination tells us that the treasury bill rate explains about 65.5% per cent of the variation in the inflation rate for the sample period of March 2020-2022.

We can also say that TBrate is statistically significant at any conventional significance level since its p-value (0.0000000956) for the t-statistic is less than every conventional significance level.

**Multiple Regression Model**

Shown below is a model estimating the relationship between the Jamaican inflation rate, the BOJ treasury bill rate, the BOJ policy rate and the JA/US average monthly exchange rates.

Equation (2) can be interpreted: If the predicted treasury bill rate, policy rate, and the JA/US exchange rate are zero (i.e., TBRate = 0; Prate =0; Fxrate =0) then the predicted inflation rate is the intercept, 7.9678%. This negative coefficient (-0.1099 or β1) for TBRate tells us that as TBRate increases by one 1 percentage point the inflation rate will decrease by about 0.1 percentage points. The coefficient (1.6441 or β2) tells us that as the policy rate increases by 1 percentage point inflation will increase by about 1.6%. The coefficient (-0.0227 or β3) tells us that as the JMD appreciates in relation to the USD, inflation will decrease by 0.0227.

R2 or otherwise called coefficient of determination indicates the total proportion of the variation of the inflation rate (the dependent variable) that is explained by the independent variables: Treasury bill rate, BOJ policy Rate and JA/US Avg Monthly FX Rates.

The formula for R2 is the Regression Sum of Squares (ESS) divided by the Total Sum of Squares (TSS). For this model, R2 is 82.41880061/105.2289862 which equals 0.7832328675.

78.32% of the variation in the inflation rate is explained by the variation in the treasury bill rate, BOJ policy Rate and JA/US Avg Monthly FX Rates.

The t-tests below indicate that β1 (TBrate) and β3 (Fxrate) are statistically insignificant at any conventional significance level while β2 (Prate) is statistically significant at any conventional significance level.

α=10%; α=5%; α=1%

# Recommendations for the BOJ

The simple regression analysis of the inflation rate on the treasury bill rate tells us that the treasury bill rate has a positive relationship (moves in the same direction over time); accounts for 66% of the variation in the inflation rate; and is statistically significant. The multiple regression, however, provides a contrary to the result of the simple regression. The multiple regression shows that the treasury bill rate has an inverse relationship (moves in the opposite direction) and is a statistically insignificant variable in predicting the rate of inflation. Although the Treasury bill rate has an insignificant effect on inflation in the multiple regression, we base our recommendations for this variable based on the results from the simple regression because of the researchers’ prerequisite knowledge we believe the simple regression provides a more accurate description of the how the variable behaves in relation to the inflation rate. During inflationary periods when the treasury bill becomes an unattractive investment because the inflation may surpass the treasury bill rate netting investors less or negative real return. As such we recommend the BOJ only offer fixed selling price for treasury bills (a selling price not determined via an auction) and ensure that the yield/rate is always higher than the current rate of inflation. Doing this will make the treasury bills more attractive during inflationary periods and help reduce inflation by taking money out of circulation and may help do so at a faster pace.

The researcher recognizes that this multiple regression model with the following independent variables: BOJ Treasury bill Rate, BOJ Policy Rate, and JA/US Avg Monthly FX Rates account for 78% of the variation in inflation. The results of a hypothesis test constructed stated that the researcher would reject the null hypothesis and there is evidence that the BOJ policy rate has a significant effect on inflation. Based on the findings, the research purports that there is a positive relationship between the policy rate and inflation. We recommend that the BOJ conducts a contractionary monetary policy in response to increasing inflation rates. The goal of a contractionary policy is to reduce the money supply within an economy by increasing interest rates. This helps slow increasing interest rates by making credit more expensive, which reduces consumer and business spending.

The multiple regression analysis states that the JA currency to the US currency has an insignificant effect on inflation. It’s also highlighted that there is an inverse relationship between the JA/US monthly exchange rate and inflation. Regardless of the significance of the exchange rate on inflation due to the researchers’ prior knowledge, we recommend that the BOJ engage other regional bodies (Government and Central Banks) in implementing policies that would facilitate greater regional integration in an effort to reduce Jamaica’s import bill. Due to the proximity and cooperation of Caribbean countries, the cost of raw materials would be reduced alongside the exchange rate uncertainties usually associated with trade. Reducing exchange rate uncertainties leads to the stabilization of the inflation rate (Ilzetzki et al, 2020).

# How Could the Research Be Improved?

Based on our findings and post-diagnostic checks the research could be improved in the following ways:

1. The sample size for this research is 25 months and the researchers conclude that increasing the sample size would provide a more accurate representation of the data. This would improve the researchers’ ability to draw more precise conclusions and compare the data in this model to developed countries. A larger sample size can enable the identification of any outliers in the data set, the coefficient of determination would be larger, and a smaller margin of error would allow for less variability in the model.
2. The data set used in this model is time series and the characteristic of time series data is that it is exposed to autocorrelation. represents the degree of similarity between a given time series and a lagged version of itself over successive time intervals. Durbin-Watson Test is used to detect autocorrelation in the model. The researchers used the Durbin-Watson Test, and the results were inconclusive in determining if there was first-order autocorrelation. This research could be improved by testing for higher orders autocorrelation using other statistical tests. Not testing for autocorrelation would also display an inflated error term, The OLS estimators are no longer BLUE and hypothesis testing is no longer valid.
3. This research consisted of 3 independent variables. To improve the regression model, there are other variables that have an impact on inflation. By including additional independent variables, the coefficient of determination would increase and thus increasing the number of expected variables in inflation. However, the addition of too many independent variables can also have a negative impact on the regression model. This has the potential of reducing the credibility and the significance of the model. Our multiple regression model was found to have imperfect multicollinearity as indicated by a Pearson’s correlation coefficient of 0.97 between the treasury bill rate and policy rate and a variance inflation factor (VIF) of 7.1 and 8.5 for the treasury bill rate and the policy rate respectively. We assume the correlation between the treasury bill rate and the policy rate is due to the nature of the data; with time series data you can always expect to have some degree of multicollinearity due to how these variables operate in the real world. Since multicollinearity is detected, the researcher can improve the research by omitting one of the collinear variables or combining the highly correlated variables. We would also recommend transforming the highly correlated variables into a ratio such that over time both variables tend to move in the same direction. Multicollinearity means that the independent variables in the model are correlated. Failure to test for multicollinearity could result in skewed results, low t statistics and large standard errors. Variance inflation factor (VIF) is used to determine the presence of multicollinearity. A VIF greater than 10 is normally the benchmark used to identify multicollinearity.
4. Heteroskedasticity was tested using a Breusch-Pagan test and found not to be in our model.

# Conclusion

Based on the literature the researchers can conclude that our findings are in line with established principles such as the Fisher effect and the Taylor rule. The results of the multiple regression analysis estimate that as the policy rate increases by 1 percentage point inflation will increase by about 1.6%. The model estimates a positive relationship between the policy rate and inflation, in other words, these variables move in the same direction. The relationship between these two variables in our model is the same as the Fisher effect. The Fisher effect says that the nominal interest rate moves one-for-one with expected inflation and that real interest rates fall as inflation increases (Mankiw, 2013). The relationship between them is not one-for-one as stated but they do move in the same direction. This finding also supports the literature that the Taylor rule predicts the behaviour of central banks. The rule prescribes a higher interest rate when inflation is above target, and a lower one if inflation is lagging. The literature also supports the positive relationship between the treasury bill rate and inflation. As inflation and nominal interest rates increase, real rates fall. Treasury bills usually have rates/yields that are not greater than inflation as such investors shy away from this debt instrument as inflation increases because they net less real returns. Lastly, (Segal, 2019) purports that a depreciation in the local exchange rate is likely to cause inflation to increase as the depreciation/appreciation of the local dollar relative to the foreign currencies means that the cost of imports will rise /fall (Seagal, 2021). In this regression model, there is indeed a negative relationship between the exchange rate and inflation. The model estimates that as the JMD appreciates in relation to the USD, we will see inflation will decrease.

# References

Abel, A. B., Bernanke, B. S., & Croushore, D. (2011). *Macroeconomics (7th ed.). Pearson*

Adrian, [Tobias, &](https://www.imf.org/en/Blogs/authors?author=Tobias%20Adrian) [Natalucci](https://www.imf.org/en/Blogs/authors?author=Fabio%20Natalucci), Fabio. (2022, August 10) <https://www.imf.org/en/Blogs/Articles/2022/08/10/central-banks-hike-interest-rates-in-sync-to-tame-inflation-pressures>

Alvarez, F., Lucas, R. E., & Weber, W. E. (2001). Interest rates and inflation. American Economic Review, 91(2), 219-225.

Corporate Finance Institute. (2022). Retrieved from <https://corporatefinanceinstitute.com/resources/fixed-income/treasury-bills-t-bills/>

Ilzetzki, Ethan, Reinhart, M, Carmen, and Rogoff, S. Kenneth. (2020). “Will the Secular Decline in Exchange Rate and Inflation Volatility Survive COVID-19? ” Brookings Papers on Economic Activity, Fall, 279-332.

Investopedia, (2022, March 7). Retrieved from

<https://www.investopedia.com/ask/answers/022415/how-does-inflation-affect-exchange-rate-between-two-nations.asp#:~:text=In%20general%2C%20inflation%20tends%20to,weaken%20relative%20to%20other%20currencies>.

Mankiw, G.N. (2012). Macroeconomics (8th ed.) Worth Publishers

Mckinsey & Company. (2022, August 17). Retrieved from

<https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-inflation>

[Pettinger](https://www.economicshelp.org/blog/author/tejvan/), Tejvan. (2019, July 17). Retrieved from

<https://www.economicshelp.org/blog/1605/economics/higher-inflation-and-exchange-rates/>

Seagal, Troy. (2021 June 4). Retrieved from

<https://www.investopedia.com/articles/forex/080613/effects-currency-fluctuations-economy.asp>

Soto, T. (2013). Regression Analysis. In: Volkmar, F.R. (eds) Encyclopedia of Autism Spectrum Disorders. Springer, New York, NY.

<https://doi.org/10.1007/978-1-4419-1698-3_251>

The Economic Times. (n.d). Retrieved from <https://economictimes.indiatimes.com/definition/treasury-bills>