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Determinants of Inflation in Malaysia using Multiple Linear Regression

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Abstract Inflation is one of the most important economic and policy indicators. It refers to the rate at which the general level of prices of goods and services rises in response to currency depreciation. Despite the fact that there have been many studies into the inflation phenomenon, there is still a limited knowledge about the specific macroeconomic factors that have a significant impact on inflation. In this study, we aim to determine how money supply, exchange rate, unemployment rate, gross domestic product (GDP), and gross savings affect inflation rate in Malaysia by applying multiple linear regression analysis. Based on the secondary data used in this study, we found that any increase in GDP and gross savings will significantly increase inflation rate in Malaysia.

Keywords Inflation; money supply; exchange rate; unemployment rate; GDP; gross savings; regression analysis

1 Introduction

Inflation has been one of the most prominent subjects in economics in recent years. It is one of the macroeconomic indicators that measures a country's economic stability. In general, inflation is represented as a steady increase in the general price level of goods and services over a period of time. When high inflation occurs for a lengthy amount of time, the increase in the price levels of goods and services has an effect on production, which in turn may influence on consumption, which leads to a decrease in national income, and has a negative impact on economic stability. As a consequence, inflation is seen as having a long-term negative effect on a country's socioeconomic development.

Malaysia is one of the upper-middle-income countries with low inflation, with an annual average of 2.9% in the history [1, 2]. Since 2010, the consumer price index (CPI) has proxied the inflation rate in Malaysia for a variety of major groups, but food and non-alcoholic beverages, housing and utilities (water, electricity, coal, and other fuels), and transportation have always been the key contributors to the change in inflation in Malaysia. Despite accusing some parties for raising the cost of living for a family, the Malaysian government and citizens should identify what products are driving the high cost of living, which leads to economic instability, and it has now become the primary issue of the country.

According to prior studies, there are some arguments about the precise relationship between inflation and macroeconomic factors in Malaysia. In any nation, including Malaysia, money supply is the primary factor influencing inflation. Cheng and Tan [3] have shown that the

money supply and inflation have a positive relationship in Malaysia. The gross domestic product (GDP) or gross savings is also another economic measure that is closely linked to inflation. Furthermore, numerous researches on the determinants of inflation have been conducted, with an emphasis on independent variables such as exchange rate and unemployment rate. Therefore, this study will be on the Malaysian definition of which macroeconomic variables will have a significant impact on inflation using a multiple linear regression model fitted using the ordinary least squares method. The selected predictor variables are money supply, exchange rate, unemployment rate, GDP, and gross savings.

There are five parts to this article. The introduction is in Section 1, while Section 2 contains a literature review on multiple linear regression model analysis, and the relationship between Malaysian inflation and the selected macroeconomic indicators. Section 3 will further define the methodology and specifies the data used in the estimation model, while Section 4 addresses the findings. Finally, in Section 5, the conclusion of the study will be outlined.

2 Literature Review

According to previous studies, money supply, exchange rate, unemployment rate, gross domestic product (GDP), and gross savings have all been macroeconomic factors that influence Malaysian inflation rates.

2.1 Multiple Linear Regression Model Analysis

In Yolanda's [4] study, he used multiple regression analysis to construct a regression model to investigate the relationship between the level of inflation and the selected independent variables in Indonesia, namely the Indonesian bank rate, money supply, foreign exchange rates, world oil prices, and gold prices. According to his findings, the fitted regression model, with a coefficient of determination of 0.9497, was an appropriate model for this analysis. Similarly, Elsiddig [5] conducted a study in which he developed a multiple linear regression model to investigate the issue of inflation in Sudan. The money supply, GDP, deficit financing, and exchange rate were chosen as independent variables in this study, and the results showed that the regression model is a reliable method for estimating the inflation rate in Sudan.

2.2 Money Supply and Malaysian Inflation

When compared to other ASEAN countries, money supply is the most important factor in explaining inflation in Malaysia [6]. To support this claim, Edward and Ramayah [6] have used ordinary least squares regression method to examine the relationship between money supply (M2) and inflation in Malaysia, showing that M2 is a strong determinant of Malaysian inflation. As for Ridzuan et al. [7], in their study using a vector error correction model, found that money supply has a 0.541 correlation with inflation in Malaysia. In addition, Hashim, Osman, and Elias [8] applied regression analysis to reach the same conclusion as Ridzuan et al. [7] regarding the positive relationship between money supply and inflation rate in Malaysia.

2.3 Exchange Rate and Malaysian Inflation

According to Ibrahim's [9] study, ringgit effective exchange rates have a long-run equilibrium relationship with Malaysian inflation, as determined by Johansen Juselius cointegration analysis and the vector error correction model (VECM). He also used the VECM method to support the

accuracy, and found that the inflation rate has a negative response to exchange rate shocks. Some researchers, however, disagree with the above statement, Yien, Abdullah, and Azam [10] employed several statistical techniques, such as the Johansen cointegration test and exploratory data analysis, to better understand the relationship between exchange rate and inflation in Malaysia. According to their findings, they concluded that the exchange rate has a statistically significant positive effect on Malaysian inflation.

2.4 Unemployment Rate and Malaysian Inflation

In Malaysia, studies of the relationship between unemployment rate and inflation are well-documented, and it is widely accepted that both of these macroeconomic factors have become the most important issue for stifling the country's economic growth and development. According to Kogid et al. [11], they investigated the inflation-unemployment relationship in Malaysia using the autoregressive distributed lag bounds testing method, and discovered that there is a long-run cointegration relationship between Malaysian inflation and unemployment rate with a negative coefficient. Another study in Malaysia conducted from the year 1975 to 2014, using error correction model approach by Furuoka and Munir [12] found that the unemployment rate has a substantial impact on inflation, with a coefficient of -0.427, and confirming the validity of the Philips curve assumption in economic theory in Malaysia.

2.5 Gross Domestic Product (GDP) and Malaysian Inflation

The majority of the studies acknowledge that there is a positive relationship between GDP and inflation in Malaysia. Munir, Mansur, and Furuoka [13] performed an analysis to examine the presence of threshold effects in the relationship between Malaysian inflation and GDP. To fit the data from 1970 to 2005, this paper employs a new endogenous threshold autoregressive model. The study found that the estimated model has indicated that 3.89% is the threshold level at which inflation in Malaysia significantly slows GDP, and there is a statistically significant positive relationship between Malaysian inflation and GDP below the threshold point. Furthermore, using the auto-regressive distributed lag and VAR-differenced model, Ismail and Houssein [14] found that inflation has a one-way short-run casual effect on GDP in Malaysia, with a 0.046% positive shift in GDP for every 1% increase in inflation.

2.6 Gross Savings and Malaysian Inflation

Gross savings is a significant economic measure of economic development, according to Ahmad Khan and Abdullah [15], since it is viewed as an element that funds domestic investment to achieve economic growth. They used a life cycle model to determine the relationship between inflation rate and savings in Malaysia, and discovered that the rate of inflation is a significant determinant of both national and private savings. In Malaysia, Aziz [16] has conducted a study on investigating the effect of inflation on gross savings. For this analysis, data from 1970 to 2014 was chosen. Several methods, including impulse response functions techniques and the ordinary least squares method, were used to formulate the findings in his research. The results showed that gross savings have a positive impact on Malaysian inflation in the short run.

3 Methodology

This study will look into the selected macroeconomic factors that could have a significant impact on Malaysian inflation rate. In this analysis, multiple linear regression will be used as the main statistical techniques for determining the relationship between the response variable and predictor variables. The objective of this study is to construct a multiple linear regression model that could be used to predict the Malaysian inflation rate based on the coefficients of the parameters resulted from the model.

As a consideration, this analysis is based on annual data consisting of 24 observations from 1996 to 2019. The data of inflation rate, money supply, exchange rate, unemployment rate, gross domestic product (GDP), and gross savings in Malaysia were gathered from various sources, including the World Bank Group's Data Bank and Department of Statistics Malaysia, all of which are accessible online. In addition, a unit of measurement for each variable are listed below.

Table 1: Variable Unit Measurements

Variables	**Base Unit**
Inflation Rate	annual % in consumer price index (CPI)
Money Supply	% of GDP
Exchange Rate	local currency unit per United States dollar (USD)
Unemployment Rate	% of total labor force
Gross Domestic Product (GDP)	Malaysian Ringgit (in million)
Gross Savings	% of gross national income (GNI)

3.1 Multiple Linear Regression Model

The multiple linear regression model for this study is specified as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \varepsilon \quad (1)$$

where

y is inflation rate,
x_1 is money supply,
x_2 is exchange rate,
x_3 is unemployment rate,
x_4 is gross domestic product (GDP),
x_5 is gross savings,
β_0 is intercept,
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ are the corresponding coefficients for x_1, x_2, x_3, x_4, x_5 ,
ε is error derived from the collected data

It can also be expressed in matrix form with 24 observations, as follows:

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \quad (2)$$

where

$$\boldsymbol{y} = \begin{bmatrix} y_1 \\ y_2 \\ . \\ . \\ y_{24} \end{bmatrix}, \quad \boldsymbol{X} = \begin{bmatrix} 1 & x_{1,1} & x_{1,2} & \cdots & x_{1,5} \\ 1 & x_{2,1} & x_{2,2} & \cdots & x_{2,5} \\ . & . & . & . & . \\ . & . & . & . & . \\ 1 & x_{24,1} & x_{24,2} & \cdots & x_{24,5} \end{bmatrix}, \quad \boldsymbol{\beta} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ . \\ . \\ \beta_5 \end{bmatrix}, \quad \boldsymbol{\varepsilon} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ . \\ . \\ \varepsilon_{24} \end{bmatrix}$$

According to the above model, the response variable is inflation rate, and the predictor variables are money supply, exchange rate, unemployment rate, GDP, and gross savings. In addition, a conceptual structure is being developed to represent the relationship between the response and predictor variables in this study for better understanding.

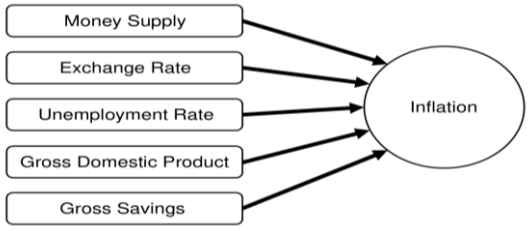

Figure 1: Conceptual Framework of Study

Five alternative hypotheses for testing whether the relationship between the response and predictor variables is significant have also been established based on the aforementioned conceptualization, as follows:

H1: There is a significant relationship between inflation rate and money supply.
H2: There is a significant relationship between inflation rate and exchange rate.
H3: There is a significant relationship between inflation rate and unemployment rate.
H4: There is a significant relationship between inflation rate and GDP.
H5: There is a significant relationship between inflation rate and gross savings.

3.2 Assumptions of Multiple Linear Regression Model

In order to accurately estimate the regression coefficients with the use of ordinary least squares method, the assumptions underlying the multiple linear regression model are stated below.

1. The relationship between the response variable and the predictor variables is linear.
2. The errors are independent without autocorrelation being present.
3. The variance of errors is constant.
4. The errors follow a normal distribution.
5. There is no multicollinearity in the data.

3.3 Residual Analysis of Multiple Linear Regression Model

For evaluating the assumptions of the multiple linear regression model, residual analysis is needed. A multiple linear regression model is said to be unsuitable for determining the relationship between the response variable and the predictor variables if one of the assumptions is violated.

Several types of statistical tests will be considered in this study, which are: Durbin-Watson test, Breusch-Pagan-Godfrey test, Jarque-Bera test, and variance inflation factor (VIF) test. The null hypothesis of each residual test can be written as:

H_0: Residuals are not correlated.

H_0: Residuals are not heteroscedasticity.
H_0: Residuals are normally distributed.
H_0: Residuals are not multicollinear.

According to statistical theory, the null hypothesis is rejected if the p-value is less than the designated significance level.

4 Results and Discussion

4.1 Descriptive Statistics

Table 2: Correlation Coefficient Analysis

Correlation (p-value)	Money Supply	Exchange Rate	Unemployment Rate	GDP	Gross Savings
Money Supply	1				
Exchange Rate	−0.109 (0.614)	1			
Unemployment Rate	0.258 (0.224)	0.690 (0.000)*	1		
GDP	0.017 (0.936)	0.327 (0.119)	0.107 (0.619)	1	
Gross Savings	−0.231 (0.278)	−0.317 (0.131)	−0.110 (0.609)	−0.370 (0.165)	1

*5% significance level

The correlation coefficient indicates how well one variable is studies can be understood by another, and this correlation coefficient has to be between -1.00 and $+1.00$. According to Table 2, there is a statistically significant positive correlation between exchange rate and unemployment rate, with a Pearson correlation coefficient of 0.690 ($r = 0.690$, p-value $= 0$), while other variables have no significant relationship with one another.

4.2 Model Adequacy Checking

Table 3: Residual Analysis Tests

Residuals Test	**Test Statistic**	**p-value**
Durbin-Watson Test	2.531	0.656
Breusch-Pagan-Godfrey Test	7.998	0.156
Jarque-Bera Test	0.414	0.813

According to Table 3, every measure has a p-value greater than 0.05. As a consequence, it is considered that the null hypothesis for each test listed in Table 3 should not be rejected at the 5% significance level.

Table 4: Variance Inflation Factor (VIF) Test

	Collinearity Statistics

Variables	Tolerance	VIF
Money Supply	0.519	1.925
Exchange Rate	0.331	3.019
Unemployment Rate	0.350	2.858
GDP	0.164	6.094
Gross Savings	0.142	7.035

Variance inflation factor (VIF) is a metric for determining how multicollinear the data is. Multicollinearity occurs when two or more predictor variables in a regression model have a linear relationship. If the VIF value is greater than 10, this indicates that the predictor variables are highly collinear, which contradicts one of the assumptions underlying the multiple linear regression model.

The VIF values of all predictor variables are less than 10, as shown in Table 4. As a result, it shows that these variables in the multiple linear regression model have low multicollinearity, indicating the multicollinearity assumption is not violated. Therefore, we can conclude that all the assumptions underlying the multiple linear regression model have been met.

4.3 Regression Analysis

Table 5: Regression Coefficients on Inflation Rate

Response variable: Inflation Rate				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**p-value**
(Constant)	−10.526	9.533	−1.104	0.284
Money Supply	0.001	0.047	0.025	0.980
Exchange Rate	0.464	0.813	0.571	0.575
Unemployment Rate	−1.431	1.137	−1.259	0.224
GDP	3.373	1.284	2.626	0.017
Gross Savings	0.378	0.115	3.288	0.004

R-squared = 0.523
Adjusted R-squared = 0.390
F(5, 18) = 3.943
p-value = 0.014

According to the regression coefficients in Table 5, the model equation is derived as follows:

$$y = -10.526 + 0.001x_1 + 0.464x_2 - 1.431x_3 + 3.373x_4 + 0.378x_5 \quad (3)$$

where

y is inflation rate,
x_1 is money supply,
x_2 is exchange rate,
x_3 is unemployment rate,
x_4 is gross domestic product (GDP),
x_5 is gross savings

The R^2 value of 0.523 indicates that the predictor variables in the model, such as money supply, exchange rate, unemployment rate, gross domestic product (GDP), and gross savings, account for 52.3% of the variance in the response variable (inflation rate) from 1996 to 2019, while the remaining 47.7% is explained by other macroeconomic factors that are not included in this analysis. Furthermore, the F-statistic that is used to determine the overall significance of the regression model has a value of 3.943. We can say that the sample data provides a sufficient evidence to conclude that our model is significant since the p-value of 0.014 is less than 5% significance level.

According to the results shown in Table 5, GDP and gross savings have a statistically significant positive relationship with Malaysian inflation rate, whereas other variables such as money supply, exchange rate, and unemployment rate have no significant impact on the Malaysian inflation rate from the year 1996 to 2019. As a consequence, it is necessary to proceed with the best subset regression model formulation, which only considers the most important predictor variables from the full regression model, namely GDP and gross savings. The coefficients of the parameters and a summary of the best subset regression model are listed below.

Table 6: Regression Coefficients of Best Subset Regression Model

Response variable: Inflation Rate				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**p-value**
(Constant)	−13.342	4.057	−3.288	0.004
GDP	3.417	1.128	3.030	0.006
Gross Savings	0.378	0.094	4.016	0.001

R-squared = 0.455
Adjusted R-squared = 0.403
F(2 , 21) = 8.774
p-value = 0.002

Based on the regression coefficients in Table 6, the model equation is as follows:

$$y = -13.342 + 3.417x_4 + 0.378x_5 \quad (4)$$

where

y is inflation rate,
x_4 is gross domestic product (GDP),
x_5 is gross savings

The model discovered that between the year 1996 to 2019, the two predictor variables, GDP and gross savings, accounted for 45.5% of the variance in the response variable (inflation rate). In addition, the information provided by the predictor variables is significant, as indicated by the p-value of 0.002 from the F-test, which is less than the 5% significance level.

In Malaysia, GDP shows a significant positive relationship with inflation rate. An increase of 1% in GDP triggers the inflation rate to rise by 3.417. This result is in line with Gashe's [17] findings in Ethiopia, which indicate that inflation and economic growth, as measured by real GDP, have a significant and positive relationship. In addition, Gashe [17] has pointed out that there are two dimensions that can be used to explain the existence of a positive effect of inflation on real GDP growth, which are reduced household saving propensities and increased business expenditure propensities, as well as the inflation tax.

Furthermore, based on our results, gross savings shows a strong positive relationship towards inflation rate in Malaysia, with a 1% rise in gross savings increasing inflation by 0.378. This phenomenon is supported by Taye [18] that discovered the inflation has a significant positive long-term effect on Ethiopian gross national savings. This long-term effect can be explained by Mundell and Tobin's neo-classical growth theory. Another researcher, El-Seoud [19], has also discovered that inflation has a statistically significant positive effect on national saving rates in Bahrain in the short and long run. He says, high inflation would raise savings rates by changing income distribution in favor of entrepreneurs, who have a greater proclivity to save than low-income people.

5 Conclusion

The objective of the study was achieved. The findings reveal that each of the predictor variables has a unique relationship with the Malaysian inflation rate. Overall, it can be concluded that gross domestic product (GDP) and gross savings have a significant and positive relationship towards inflation rate, while the other predictor variables, such as money supply, exchange rate, and unemployment rate have a negligible relationship with inflation rate in Malaysia. Based on this analysis, there is an evidence that Malaysian inflation rate has a significant relationship with GDP (H4) and gross savings (H5), but not with money supply (H1), exchange rate (H2) and unemployment rate (H3).

From the previous section, the residual analysis shows the assumptions underlying the multiple linear regression model are met, and no transformations are needed. However, the examination of the regression coefficients of the model reveals that three out of five predictor variables, namely money supply, exchange rate, and unemployment rate, have an insignificant relationship with inflation rate in Malaysia. Besides, the significant positive correlation between the exchange rate and unemployment rate has cast doubt on the model's ability to predict Malaysian inflation rates. Therefore, a multiple linear regression model that only takes into account the predictor variables that have the greatest impact on Malaysian inflation rate, which are GDP and gross savings, should be used to further investigate the behavior of Malaysian inflation rate.

In order to better understand the inflation rates in Malaysia, other macroeconomic factors such as discount rate, government spending, private consumption, and so on should be considered in future research. Finally, policymakers and the government were advised to enact new policies and plans based on the results of this study and the current state of the Malaysian economy in order to sustain low inflation and long-term economic growth and development.

References

[1] World Bank, World Development Indicators. (2020) *Malaysia* [Data file]. Retrieved from https://data.worldbank.org/country/MY.

[2] Bank Negara Malaysia. (2010) 'Determinants of inflation in Malaysia', *Annual Report 2010,* 50 – 53.

[3] Cheng, M. Y. and Tan, H. B. (2002) 'Inflation in Malaysia', *International Journal of Social Economics*, 29(5): 411 – 425. doi: 10.1108/03068290210423532.

[4] Yolanda, Y. (2017) 'Analysis of factors affecting inflation and its impact on human development index and poverty in Indonesia', *European Research Studies Journal*, 20(4): 38 – 46. doi: 10.35808/ersj/873.

[5] Elsiddig, I. M. I. (2015) 'Multiple linear regression model of inflation rate in Sudan', *African Journal of Social Sciences*, 5(1): 81 – 91.
[6] Edward, T. and Ramayah, M. (2016) 'The determinants of inflation: an ASEAN perspective', *Taylor's Business Review: A Contemporary Business Journal*, 6(1): 49 – 72.
[7] Ridzuan, A. R., Maizatul, S., Maimunah, I., Halim, A. and Elsadig, M. A. (2014) 'Monetary instruments and inflation: econometric analysis based on Malaysia economy', *Asian Journal of Agricultural Extension, Economic & Sociology*, 3(6): 473 – 487. doi: 10.9734/ajees/2014/10429.
[8] Hashim, M. J., Osman, I. and Elias, N. L. (2014) 'The determinants of inflation in Malaysia', *3rd International Conference on Accounting, Business and Economics (ICABEC2014)*.
[9] Ibrahim, M. H. (2000) 'Malaysian inflation and the ringgit effective rates: a vector error correction analysis', *Savings and Development*, 24(4): 459 – 478.
[10] Yien, L. C., Abdullah, H. and Azam, M. (2017) 'Granger causality analysis between inflation, debit and exchange rate: evidence from Malaysia', *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 7(1): 189 – 196. doi: 10.6007/ijarafms/v7-i1/2624.
[11] Kogid, M., Asid, R., Mulok, D., Lily, J. and Loganathan, N. (2011) 'Inflation-unemployment trade-off relationship in Malaysia', *Asian Journal of Business and Management Sciences*, 1(1): 100 – 108.
[12] Furuoka, F. and Munir, Q. (2014) 'Unemployment and inflation in Malaysia: evidence from error correction model', *Philippine Journal of Development*, 1(1): 35 – 45.
[13] Munir, Q., Mansur, K. and Furuoka, F. (2009) 'Inflation and economic growth in Malaysia: a threshold regression approach', *ASEAN Economic Bulletin*, 26(2): 180 – 193. doi: 10.1355/ae26-2d.
[14] Ismail, N. A. and Houssein, A. E. M. E. (2020) 'The impact of fiscal policy on GDP per capita: evidence from Malaysia', *International Journal of Politics, Public Policy and Social Works*, 2(5): 14 – 25. doi: 10.35631/ijppsw.25002.
[15] Ahmad Khan, H. H. and Abdullah, H. (2010) 'Saving determinants in Malaysia', *Jurnal Ekonomi Malaysia*, 44(1): 23 – 34.
[16] Aziz, H. T. (2016) The impact of inflation on economic growth: evidence of Malaysia from the period 1970 – 2014. Master's Thesis, Near East University.
[17] Gashe, L. A. (2017) 'Inter-play between saving, inflation and economic growth in Ethiopia: linkage and threshold analysis', *Developing Country Studies*, 7(12): 38 – 44.
[18] Taye, A. Y. (2017) 'The saving-inflation puzzle: explaining their relationship in Ethiopia', *IOSR Journal of Humanities and Social Science*, 22(2): 74 – 81.
[19] El-Seoud, S. A. (2014) 'The effect of interest rate, inflation rate and GDP on national savings rate', *Global Journal of Commerce & Management Perspective*, 3(3): 1 – 7.