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Analytical Study of the Correlation Between Consumer Price Index and Inflation in Malaysia

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Abstract

The measurement of inflation is central to the study and the formulation of any economic policy, and the Consumer Price Index (CPI) has become the primary tool to measure the change in the price levels in Malaysia. This study analyzed the correlation between CPI and inflation in three economic periods such as before the COVID-19 pandemic, during the COVID-19 pandemic and after the COVID-19 pandemic. Time-series analysis is used to analyze monthly CPI and inflation data that are available at the Department of Statistics Malaysia (DOSM). The Augmented Dickey-Fuller (ADF) test is used to test stationarity, correlation and regressions analysis is carried out to determine the direction, strength and explanatory power of the CPI-inflation relationship. The findings indicate that there is a significant positive relationship between CPI and inflation during the COVID-19 pandemic and before the COVID-19 pandemic, but there is no significant linear relationship after the COVID-19 pandemic. These results imply that whilst CPI is useful in monitoring inflation in both stable and crisis times, it is not effective in monitoring inflation during periods of economic recovery, which suggests that CPI-based measure of inflation must be carefully intepreted.

1. Introduction

Inflation is the general increase in prices of goods and services as well as the cost of living over a given period and it is one of the most important indicators of economic stability. High inflation raises production costs, while low inflation may slow economic growth and raise unemployment [1]. In contrast, moderate and stable inflation indicates positive economic activity. Additionally, a steady inflation rate promotes effective resource allocation, investment, consumption and general economic welfare [2]. Since the COVID-19 pandemic disrupted global supply chains and raised the cost of necessities, inflation has become a significant concern in Malaysia. These pressures were further exacerbated by the war between Russia and Ukraine, which boosted the price of grains, oil and fertilizers globally, which increasing inflationary pressures in the country.

Proper inflation measurement is critical because measurement of inflation is what consumers expect to have in the future, which in turn determines their level of spending, saving and financial decisions [3]. Thus, the Consumer Price Index (CPI) is the most widely used measure of inflation and changes in the cost of living. It plays a huge role in wage changes, social benefits, and monetary policy. Even though CPI is a measure of the change in prices of a given set of goods and services that are usually used, it is also limited to possible measurement bias and price shocks of a transitory nature [4]. The CPI may fail to accurately reflect the inflation faced by different income groups in Malaysia particularly those in the Below 40 (B40) households which spend a larger percentage of their income on necessities such as food and transport [5].

The relative price changes and technological advancements can change consumer purchasing behaviour, which could also put a constraint on the accuracy of CPI [6]. Thus, the basket is regularly updated with the current version having 13 major consumption groups and the CPI is compiled by the Department of Statistics Malaysia (DOSM) on a monthly basis, using household expenditure surveys. Despite these efforts, the CPI continues to have problems with its ability to reflect the inflation facing low-income households, rural and consumers facing global price fluctuations.

Another distinction made in the literature on the issue is between headline and core inflation, where the core inflation reflects the long-run trends in inflation by excluding the fluctuations of other items such as food and fuel. It has been found that core inflation can be useful in future predictions [7].

The relationship between CPI and inflation is moderated by regional variations, fluctuations of consumer behaviour and external shocks like changes in the exchange rate and the international oil prices oscillations. The difference in the intensity and timing of the correlation leads to questions concerning the use of CPI to measure inflation and carry out policy decisions despite the positive correlation being largely observed in past studies.

Although the CPI is a commonly used measure of inflation, its weaknesses have been noted especially in developing economies like Malaysia. A researcher expresses concern about the quality and representativeness of the CPI in different socioeconomic and geographic regions and argues that the CPI was originally designed to be on expenditure-weighted cost of living, not an actual measure of inflation [4]. The first critique is that CPI can be inappropriate in the measurement of real consumer behaviour. Substitution of costly products with less costly ones is a common practice among customers, and it tends to create an upward bias and upward inflation [8].

Also, the averages of national CPI can mask considerable regional variations. Malaysia has higher and lower inflation rates between urban and rural areas. For instance, in August 2024, urban inflation reached 1.9% and rural inflation reached 1.7% [9]. Rural B40 households, especially East Malaysian ones, will tend to pay more for food and transportation because of inefficiencies in the distribution, which will additionally limit the representativeness of CPI.

Generally, there is a need to conduct more empirical studies to assess the usefulness of the CPI in different income and geographic groups in Malaysia, although it remains an important indicator of inflation. Since the Malaysia economy is undergoing a transformation and is being digitized, this research re-examines the correlation between CPI and inflation in light of current data and relevant empirical analysis aiming to facilitate a higher quality of inflation projections as well as monetary policy development.

Therefore, this research aims to investigate the relationship between CPI and inflation in Malaysia under varying economic conditions. The main objective of this research is to assess whether CPI is a relevant measure of inflation under normal, crisis and recovery phases. To this objective, the study used the Augmented Dickey-Fuller (ADF) test to determine the stationarity of the data, and correlation as well as simple linear regression analysis to determine the direction, strength and explanatory power. The hypothesis is that there is a positive correlation between CPI and inflation, but the intensity of this correlation may change over time. The expected result of the research is expected to yield empirical data on the effectiveness of CPI as an inflation indicator and that the necessity to improve the methodology to make the inflation measurement more accurate and be able to make informed monetary policy decisions in Malaysia.

2. Methodology

The study relies on secondary data that was collected from data catalogues by Department of Statistics Malaysia (DOSM). The main data set is based on the monthly CPI by division and monthly CPI inflation by division, which can be found on the DOSM. The extracted data involves the CPI and inflation rates, which are reported monthly.

The dataset was divided into three economic periods:

•Before COVID-19: 2008-2019
•During COVID-19: 2020-2022
•After COVID-19: 2023-2024

2.1 Descriptive Statistics

The study starts with descriptive statistical analysis of the inflation and CPI figures such as the mean, median, standard deviation, minimum and maximum values. This initial analysis would assist in detecting anomalies and deciding whether there should be data transformation or preprocessing before a subsequent econometric analysis.

2.2 Stationary Testing

The Augmented Dickey-Fuller (ADF) test is used to measure stationarity, a key assumption in time-series econometrics whereby statistical properties such as the mean and variance remain constant over time, since CPI and inflation are time-series data. Regression and correlation results may be deceptive due to non-stationary data. In order to identify the existence of a unit root and determine whether differencing is needed. If non-stationarity

is identified, the data is appropriately transformed before further analysis [10]. The formula for the ADF test is as follows [11].

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \epsilon_t \quad (1)$$

2.3 Correlation Analysis

Pearson correlation analysis is a widely used statistical method to determine the direction and strength of a linear relationship between two continuous variables. The strength of the relationship between the CPI and inflation is measured by the correlation coefficient, *r*, which has a range of -1 to +1. The formula for Pearson correlation analysis as in [12]. A strong positive correlation occurs when *r* is between 0.5 and 0.8 [13]. This indicates that as CPI increases, inflation also increases in a clear and consistent pattern.

$$r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}} \quad (2)$$

2.4 Simple Linear Regression Analysis

Simple linear regression is a foundational econometric technique used to model the relationship between a single independent variable and a dependent variable. The CPI is the independent variable (X) in this study, while inflation is the dependent variable (Y). The objective is to measure the relationship between changes in CPI and inflation. If the *p*-value is less than the significance level of 5%, meaning that the model is statistically significant. However, if the *p*-value is greater than 5% significance level, it indicates that the model does not have a statistically significant effect. The simple linear regression is given as [14]:

$$Y = \beta_0 + \beta_1 X + \varepsilon \quad (3)$$

3. Results and Discussion

3.1 Augmented Dickey-Fuller (ADF) Test

Table 1 ADF Unit Root Test Results

Variable	Period	*p*-value	Stationary	*p*-value (After 1st differencing)	*p*-value (After 2nd differencing)	Stationary (After 1st and 2nd differencing)
CPI	Before COVID-19	0.2800	No	0.000	-	Yes
CPI	During COVID-19	0.9801	No	0.0087	-	Yes
CPI	After COVID-19	0.7750	No	0.018	-	Yes
Inflation	Before COVID-19	0.0044	Yes	-	-	-
Inflation	During COVID-19	0.3500	No	0.0140	-	Yes
Inflation	After COVID-19	0.0695	No	0.0529	0.0000	Yes

The ADF test was employed during the three economic periods to test for the presence of unit roots for the reliability of the CPI and inflation data series. According to the results, both series were mostly non-stationary at the levels, as the *p*-value exceeds 5% significance level. After applying differencing, all variables become stationary. Thus, the stationary series are used to analyse correlation and regression to ensure reliable and unbiased statistical inference.

3.2 Descriptive Statistics

Table 2 Descriptive Statistics

Variable	Period	Mean	Standard deviation	Minimum	Maximum
CPI	Before COVID-19	0.195	0.5143	-1.5	3.8
CPI	During COVID-19	0.194	0.7870	-3.3	1.5
CPI	After COVID-19	0.170	0.1579	-0.1	0.7
Inflation	Before COVID-19	2.283	1.7744	-2.5	8.5
Inflation	During COVID-19	0.063	0.9428	-2.7	3.0
Inflation	After COVID-19	0.097	0.8574	-2.2	2.2

Before the COVID-19 pandemic, the descriptive statistics show that the mean change in CPI per month was equal to 0.195, which implies that the CPI gained about 0.20 index points every month on average, which was a relatively stable price change before the pandemic. The minimum value of -1.5 and the maximum value of 3.8 further show that fluctuations in prices on a monthly basis were generally low and regular in accordance with Malaysia's stable economic conditions before the pandemic. The standard deviation of 0.5143 supports this claim with high stability being ensured by the minimal the volatility of the change in CPI within this period. Conversely, the inflation rate came to an average of 2.283, which shows an overall positive inflation over the pre-pandemic period. The inflation rate ranged from the lowest of -2.5 to the highest of 8.5 demonstrating a mild deflationary trend and an increase in the inflation rate. The greater standard deviation of 1.7744 than CPI indicates more variability in the rate of change in prices and therefore, the overall price level rose steadily but the variability of the inflation was higher than the variability of the CPI index itself.

During the COVID-19 pandemic, the descriptive statistics revealed that the average change in CPI each month was 0.194 and the average of CPI had a modest growth rate throughout the pandemic. The minimum of -3.3 and the maximum of 1.5, however, indicate that the monthly CPI changes were more dramatic than it was before the pandemic. The higher level of volatility is also supported by a higher standard deviation which is 0.7870 and is evidence of supply chain disruptions, economic uncertainty and restrictions associated with the pandemic. Conversely, the mean change in inflation rate per month was 0.063 which means that the changes in inflation were nearly zero on average in this period. The lowest rate of inflation stood at -2.7 and the highest at 3, which shows that changes in prices were found to be very high. The standard deviation is relatively high, 0.9428, and it is also a sign of a higher degree of instability in the dynamics of inflation that were observed during the pandemic lockdowns, shortages of supplies and sudden changes in consumer demand, which caused the drastic and unstable fluctuations in inflation.

The average change in CPI after the COVID-19 pandemic was 0.170, which showed that the CPI was growing slowly and steadily in the process of economic recovery. The fact that the minimum value of -0.7 is quite close to the maximum value of -0.1 indicates that the changes in the monthly CPI movements are more stable than they were during the pandemic. This stability is also enhanced by a low standard deviation of 0.1579 that indicates the low volatility in changes of CPI in the period of recovery. Meanwhile, the average inflation had a value of 0.097 which means that the average change in inflation fluctuation was more restricted as well, with the range of values between -2.2 and 2.2, which is smaller than that during the COVID-19 pandemic. Though the standard deviation of growth of inflation changes (0.8574) was still higher than CPI, it decreased compared to the pandemic period, which means that the inflation environment is more stable in the post-COVID-19 period as the economic conditions became more normalized.

3.3 Correlation Analysis

Table 3 Correlation analysis

Period	Correlation Coefficient (r)	p-value
Before COVID-19	0.186	0.026
During COVID-19	0.718	<0.001
After COVID-19	0.004	0.985

The value of the correlation coefficient between CPI and inflation before the COVID-19 pandemic is 0.186 and this reflects very weak positive linear relationship as it lies between the range of 0.0 and 0.2. The p-value of 0.026 is a weak value but indicates that the correlation is a statistically significant relationship between CPI changes and

inflation at this period. This finding suggests that fluctuations in the CPI on a monthly basis are positively correlated with the monthly inflation. Nonetheless, the weak correlation value implies that CPI itself cannot adequately capture inflation dynamics and that there are other factors other than CPI that contributed to the inflation process at the time.

During the COVID-19 pandemic, the correlation analysis shows that there is a strong and positive correlation between the CPI and inflation, with a correlation coefficient, r of 0.718. This finding indicates that variation in CPI was strongly related to variation in inflation within the COVID-19 era. The correlation is found to be significant at both 1% and 5% significance levels with a p-value below 0.001. Since the p-value is lower than the significance level, the null hypothesis is rejected, and it is proven that there is a significant relationship between CPI and inflation. The implication of this finding is that monthly CPI changes were closely correlated with growth in inflation during the period of the pandemic.

The correlation analysis after the COVID-19 pandemic shows that there is no significant linear relationship between CPI and inflation. The coefficient correlation is too near to zero (r = 0.004) and the p-value of 0.985 is greater than 5% significance level. Consequently, the null hypothesis fails to be rejected, which results in a finding that the relationship between CPI and inflation is not statistically significant in the given period. This result means that the monthly variations in CPI were practically not related to the inflationary trends in the post-pandemic economy. Thus, the outcomes of the post-pandemic indicate a restoration of economic stability to a greater extent. However, the continuously weak correlation between CPI and inflation suggests that other economic forces influenced the dynamics of inflation in the recovery period but not changes in the CPI.

3.4 Regression Analysis

Table 4 Regression analysis

Period	*R*-square	*t*-statistic	*F*-statistic	*p-value*
Before COVID-19	0.035	2.252	5.069	0.026
During COVID-19	0.515	5.925	35.108	<.001
After COVID-19	1.704×10^{-5}	0.018	1.704×10^{-5}	0.985

The regression analysis conducted before the COVID-19 pandemic suggests that there is a weak explanatory relationship between the CPI and inflation. The value of R-square is 0.035, which implies that CPI variations can only predict 3.5% of the change in inflation meaning that it has limited predictive capability. Nevertheless, the t-statistic of 2.252 of the CPI coefficients is greater than 5% significance level, which means that the CPI is statistically significant in influencing inflation. The F-statistic of 5.069 also support this outcome as it proves the overall regression model to be statistically significant. Despite this significance, the low R-squared means that the inflation dynamics in the pre-pandemic season were driven more by other factors other than CPI movement that include supply terms, fluctuations in demand and policy intervention.

During the COVID-19 pandemic, the regression analysis indicates that the relationship between the changes in CPI and inflation is significantly stronger than in the pre-pandemic period. The R-squared value of 0.515 is quite high and it shows that the level of explanatory power is quite high, as most of the change in inflation can be attributed to the change in CPI. The t-statistic of 5.925 of the coefficients of CPI is much greater than 1% and 5% significance levels and thus it is able to conclude that the effect of CPI on inflation during this period is extremely significant. This is also enhanced by the F-statistic, 35.18, which shows that there is a significant statistical value of the overall regression model. These findings indicate that the CPI motions have been a significant factor in triggering inflation during the pandemic, presumably because of the general supply chain shocks, price spikes and increased sensitivity of consumer prices to economic disturbances.

The regression analysis after the COVID-19 pandemic reveals that the relationship was very weak. The value of R-square is 1.704×10^{-5}, which indicates that the fluctuations in the CPI have practically no effect on the fluctuations in the inflation rates in the post-pandemic period. In line with this finding, the t-statistic of 0.018 is much lower than 5%, which implies that the relationship between CPI and inflation is not significant. The extremely low F-statistics of 1.704×10^{-5} also confirms that the regression model in general does not have explanatory power. These conclusions imply that the dynamics of inflation in the post-pandemic recovery process were predetermined by other macroeconomic variables, including changes in monetary policy, global price normalization and demand recovery, rather than movements in the CPI itself.

3.5 Scatterplot Interpretation

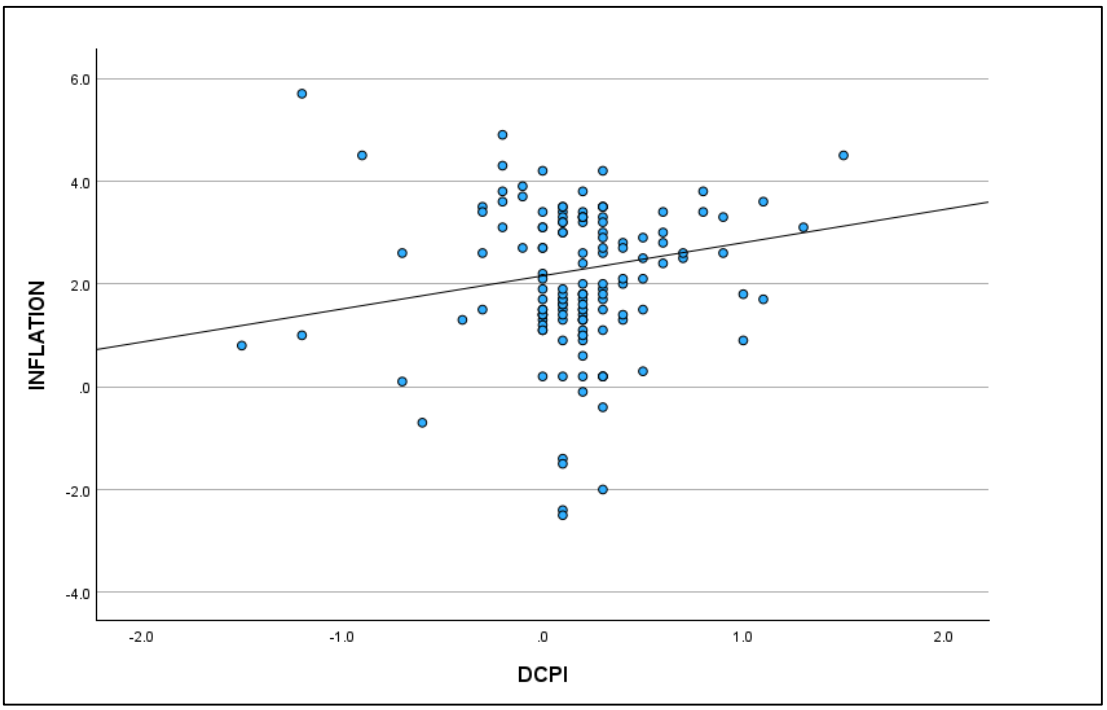

Fig. 1 Scatterplot of CPI and inflation before the COVID-19 pandemic

According to the analysis of the scatterplot, there are apparent differences between the CPI-inflation relationship within the three periods. Based on Fig. 1, the period before the COVID-19 pandemic did not portray an obvious trend and the data were widely scattered. The relationship between CPI and inflation is not as strong as the regression line slopes a little upward. It can be proven by the fact that the value of *R*-square is low (0.035) which is only 3.5%, meaning that the variation in CPI can only explain a small percentage of the change in inflation. It means that in the period before COVID-19, inflation was likely to be affected by another macroeconomic variable such as monetary policy, the changes in the exchange rate and stable economic conditions rather than CPI.

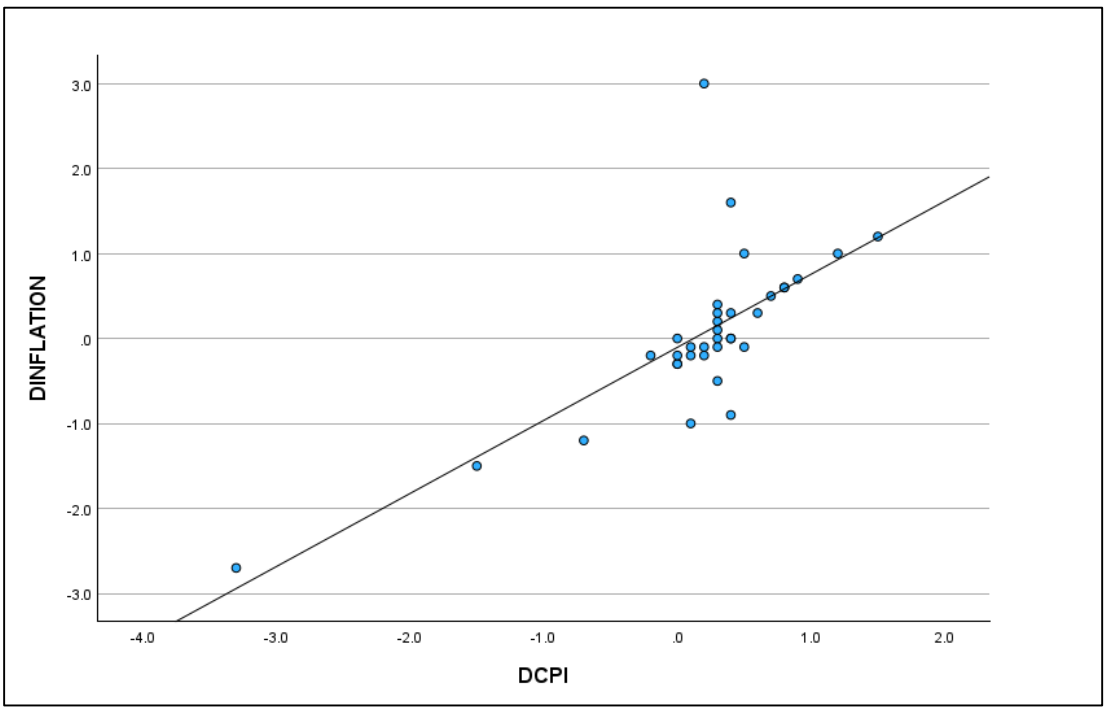

Fig. 2 Scatterplot of CPI and inflation during the COVID-19 pandemic

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The scatterplot during the COVID-19 pandemic as shown in Fig. 2 has a more definite upward trend and has more data points clustering around the regression line. The larger value of *R*-square, 0.515, shows that 51.5% of the variation in inflation could be associated with variations in CPI. The rises in the CPI were closely associated with rises in inflation, which means that the relationship between the CPI and inflation is moderately strong. This enhanced correlation may be due to underproduction, transportation limitations as well as supply chain disruptions due to the pandemic that increased consumer prices and inflation.

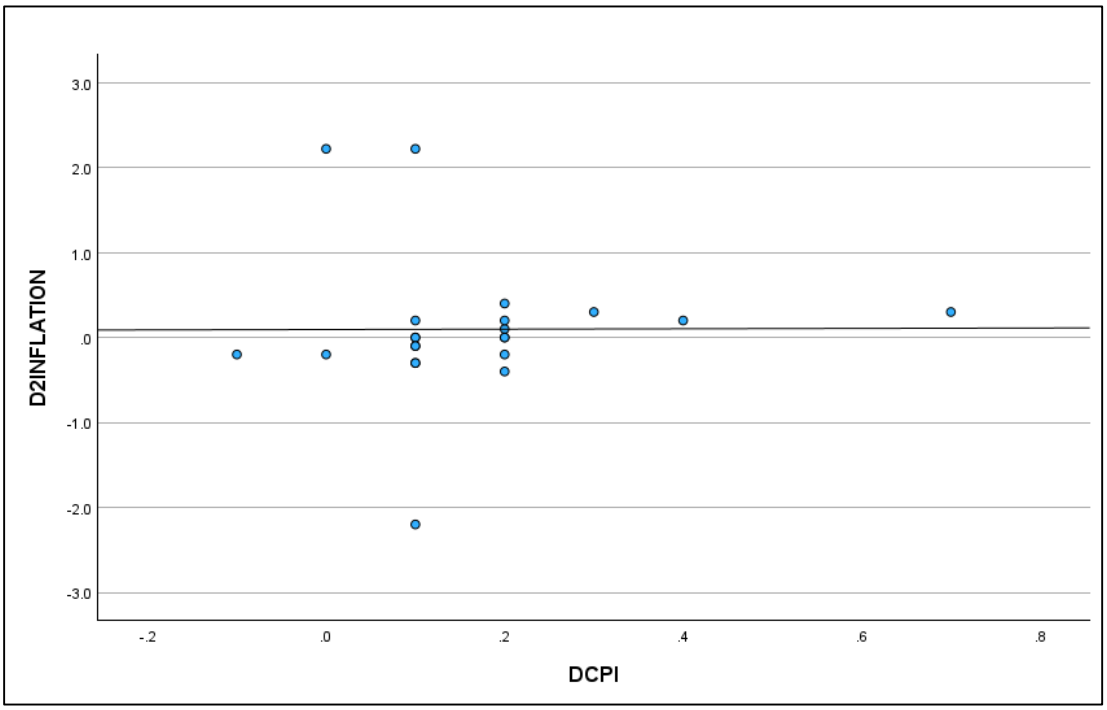

Fig. 3 Scatterplot of CPI and inflation after the COVID-19 pandemic

Fig. 3 shows that after the COVID-19 pandemic, the correlation between CPI and inflation has become significantly weaker. The regression line is almost flat and there is no clear pattern in the scatterplot. There are almost no factors in the variations of inflation which are reflected in the CPI as the *R*-square is 1.704×10^{-5}. This suggests that other factors, including uneven economic recovery, shifted commodity prices in the market, geopolitical issues and government policy reactions influenced more post-pandemic inflation than changes in CPI.

4. Conclusion

The results indicate that the correlation between the CPI and inflation does not remain the same in various economic circumstances. The low *R*-square and weak correlation mean that there was relatively stable inflation prior to the COVID-19 pandemic and that the fluctuation in the CPI has a minor impact on inflation. This implies that inflation during the stable stages was largely influenced by other macroeconomic factors such as monetary policy, general price trends, stable demand and slow adjustments in supply. At this time, CPI played a small role in explaining the movements of inflation.

During the COVID-19 pandemic, the correlation between the CPI and inflation rose considerably. The regression and correlation results indicated that CPI changes accounted for more than half of the change in inflation, indicating that it was a strong and statistically significant relationship. This shift is a consequence of the uncanny circumstances caused by the pandemic, including shifts in consumer behaviour, production downsizing, mobility issues and supply chain disruptions. This strong relationship is further strengthened by the fact that the scatterplot shows more volatility in the prices during the pandemic.

On the other hand, the relationship worsened again after the COVID-19 pandemic. The regression model became statistically insignificant, and there was practically no correlation between CPI and inflation. This implies that the short-run CPI variation and the inflation were no longer strongly correlated in the recovery period. Rather, it appears that inflation has been caused by issues such as the stabilization of world supply chains, stabilization of consumption patterns, central bank policy measures and the revival of international trade. These results suggest that the economic recovery that followed the pandemic was rather structural than caused by shifts in consumer prices.

Overall, the findings suggest that the correlation between the CPI and inflation in Malaysia is dynamic and relies on the economic conditions. CPI is a weak predictor during stable periods, a strong predictor during times

of crisis and a weak predictor during economic recovery. This demonstrates that inflation cannot be explained by a single variable across all economic phases and emphasizes the significance of taking the economic context into account when using the CPI as an indicator of inflation.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Aziera Izzaty Mazlan, Cik Sri Mazzura Muhammad Basri;* ***data collection:*** *Nur Aziera Izzaty Mazlan;* ***analysis and interpretation of results:*** *Nur Aziera Izzaty Mazlan, Cik Sri Mazzura Muhammad Basri;* ***draft manuscript preparation:*** *Nur Aziera Izzaty Mazlan, Cik Sri Mazzura Muhammad Basri. All authors reviewed the results and approved the final version of the manuscript.*

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