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Application of Correlation Analysis to the Increase in Fuel Prices on Inflation in Indonesia

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Abstract

Fuel Oil (BBM) is one of the tradable products from oil and natural gas natural resources. The increase in fuel prices has caused people's purchasing power to decrease and also greatly affects supply and demand. The purpose of this study is to observe the effect of changes in the price of Fuel Oil (BBM), especially the Pertamax type, on the inflation rate in Indonesia in the period March 2020 to March 2024. Fuel price data comes from Pertamina's report, while inflation rate data is obtained from Bank Indonesia's report. The type of research conducted is quantitative research. The method used is Spearman correlation. The results of the study show that the Spearman correlation analysis between the Inflation and BBM variables in Indonesia during the period March 2020 to March 2024 shows a strong and statistically significant positive relationship between the two. It is concluded that when the price of Pertamax fuel increases, the inflation rate tends to also increase, and vice versa.

Keywords: *Fuel Oil, Inflation Rate, Sperman Correlation*

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1. Introduction

In early April 2022, the public was shocked by the issue of rising fuel oil (BBM) prices, a commodity that plays an important role in economic activities. Indonesia's high fuel consumption, which is mostly covered by imports, makes Indonesia's fuel prices very vulnerable to fluctuations in world fuel prices. In Indonesia itself, fuel is a very important raw material for society, especially for the industrial sector. Changes in fuel prices can affect operational costs in daily activities [1].Based on data from Pertamina, in the last 2 years, fuel prices in Indonesia have fluctuated significantly. In early 2022, the price of Pertamax fuel experienced a striking increase, which rose from Rp9.000 to Rp 12.500 per liter. In fact, the price of Pertamax reached a price of Rp. 14,000 in mid-2022. However, it experienced continuous price changes until Rp. 12.950 per liter in February 2024.

The increase in fuel prices has caused a decrease in people's purchasing power and also greatly affects demand and supply. According to Dila [2], the increase in fuel prices has a significant effect on the inflation rate. Inflation is an increase in the general price level. According to data from Bank Indonesia, the inflation rate from February 2022 to February 2024 fluctuated significantly. Starting from 2.06% in February 2022, it increased gradually until it reached 5.47% in February 2023. However, it continues to decline until it reaches 2.75% in February 2024. Low and stable inflation promotes economic growth. Keeping inflation low and stable can create expected economic growth, expand employment opportunities and provide goods and services that meet public needs.

Based on the results of research Puspopsari [3], partially the price of gasoline has a significant effect on inflation in East Java, but the price of diesel has no significant effect on inflation in East Java. This research needs to be reviewed using monthly data. Therefore, this study examines the effect of changes in fuel prices, especially Pertamax, on the inflation rate in Indonesia by taking data for the period March 2020 - March 2024. This study uses secondary data both data on fuel prices (pertamax) and the inflation rate. The

data analysis technique used is descriptive analysis and correlation analysis to see the relationship between fuel prices and the inflation rate in Indonesia

2. Theoretical Reviews

2.1 Fuel Oil

Fuel is one of the products that can be traded from oil and gas natural resources. Fuel is any material that can be converted into energy. Fuel oil is produced from the distillation process of petroleum (crude oil) from mining into the desired fractions [4]. An increase in the price of fuel oil will have a major impact on the lives of the lower middle class and corporations because an increase in fuel prices will affect the price of commodities circulating in the community.

a) Subsidized Fuels

Subsidized fuel is a type of fuel oil that receives funding from the government through the State Budget (APBN). As a result, subsidized fuel is sold at a low and affordable price. However, this subsidy only applies to low octane fuels such as Pertalite and Biosolar. As shown in the annual state budget and financial appendix, the fuel subsidy is a payment from the government to the owner of the monopoly on fuel distribution in Indonesia, Pertamina, where Pertamina's revenue from fuel delivery is lower than the budget expenditure in providing the fuel [5]. Subsidized fuel in Indonesia by 84 percent can still be enjoyed by the middle class and only 16 percent is enjoyed by the lower class. Fuel subsidies have an impact on consumers because they can get fuel at low prices [6].

b) Non-subsidized Fuels

Non-subsidized fuel is fuel oil that does not receive financial support from the government. The price is set according to the policies of fuel oil and gas companies. Therefore, the price of non-subsidized fuel tends to be higher than subsidized fuel. However, the quality of non-subsidized fuel is better because it has a high octane value, such as Pertamax, Pertamax Turbo, Dexlite, and Pertamina Dex. Usually, these non-subsidized fuels are regulated by private companies, so the government allows them to conduct healthy and efficient competition in the petroleum sector [7].

c) Oil Price Transmission Mechanism

There are 6 channels that can transmit the impact of oil price shocks to economic activity, namely the supplysideshock effect, the supplysideshock effect, the wealth transfer effect, the real balance effect, the inflation effect, the consumption and investment effect, and the sectoral adjustment effect [8].

2.2. Inflation Rate

Inflation is a symptom in which the general price level increases continuously. Inflation is the general increase in commodity prices caused by the unsynchronized commodity procurement program (production, pricing, money printing, etc.) with the level of income owned by the community. In general, inflation causes a number of social costs that must be borne by society. Inflation is important to control because if inflation is high and unstable, it can have a negative impact on economic conditions [9]. High inflation can have an impact on the economy that can disrupt social and political stability, in addition, high inflation also has a broad impact on macro aggregates. Inflation must always be controlled so that it is always below double digits or below 10 percent [10]. Simply to define inflation, Bank Indonesia explains that inflation is a condition of increasing prices in general and takes place continuously, but if the price increase of one or only two goods cannot be said to be inflation, unless the condition of rising prices is widespread and also has an impact on the prices of other goods [11].

a) Causes of Inflation

The occurrence of an increase in the price of goods that takes place in general, continuously, and systematically can result in a decrease in the value of a country's currency [12] states that inflation is not just price fluctuations, but is a price level that is constantly changing, having a uniform impact on individuals, businesses, and governments. In addition, according to [13] inflation is caused by pressures from demand and supply, as well as inflation expectations themselves.

b) Types of Inflation

Based on its nature, inflation can be classified into four types including:

1) Creping inflation, is inflation that occurs below 10% a year.
2) Galloping inflation, is inflation that occurs between 10%-30% a year.
3) High inflation, is inflation that occurs between 30%-100% a year.
4) Hyperinflation, is inflation that occurs above 100%.

c) Sources of Inflation

Modernization and budget deficits both contribute to inflation in Indonesia. Modernization makes it difficult to control the money supply, while deficits financed by printing new money increase the money supply, which results in inflation, especially in the subsistence economy [14]

2.3. Descriptive Analysis

Descriptive statistics is an analysis technique that describes or describes research data using the minimum, maximum, average (mean), standard deviation, total, range, kurtosis, and skewness of the distribution. This study uses the minimum, maximum, mean, and standard deviation values of each variable to provide an overview of the phenomena associated with the research variables.

2.4. Simple Linear Correlation Analysis

Simple correlation is a statistical technique used to measure the strength of the relationship between one variable and another and also to be able to determine the form of the relationship between the 2 variables with quantitative results.

a) Correlation Analysis

Correlation analysis is a statistical method used in determining a quantity that states the existence of a strong relationship between a variable and another variable [15]. From the correlation analysis carried out, a value called the correlation coefficient is obtained. The correlation coefficient can be positive or negative and the correlation coefficient value ranges from -1 to +1. A negative correlation is indicated by a negative correlation coefficient and vice versa a positive correlation is indicated by a positive correlation coefficient. The interpretation of the correlation coefficient is shown in Table 1.

Table 1. Interpretation of the correlation coefficient

Correlation Coefficient (Positive or Negative)	Correlation Coefficient Interpretation
0.00	No correlation
0.01 – 0.20	Very weak correlation
0.21 – 0.40	Weak correlation
0.41 – 0.70	Medium correlation
0.71 – 0.99	Strong correlation
1.00	Perfect Correlation

Source : Sani & Dewi, 2020

To show the magnitude of the relationship between two random variables, each of which has a minimum interval size scale and a bivariate distribution, the correlation coefficient is used, which is formulated as follows:

$$r_{xy} = \frac{n\sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{\sqrt{n\sum_{i=1}^{n} X_i{}^2 - (\sum_{i=1}^{n} X_i)^2}\sqrt{n\sum_{i=1}^{n} Y_i{}^2 - (\sum_{i=1}^{n} Y_i)^2}} \quad (1)$$

Where:

n = number of X and Y data

$\sum_{i=1}^{n} X_i$ = Total number of variables X
$\sum_{i=1}^{n} Y_i$ = Total number of variables Y
$\sum_{i=1}^{n} {X_i}^2$ = Square of the total number of variables X
$\sum_{i=1}^{n} {Y_i}^2$ = Square of the total number of variables Y
$\sum_{i=1}^{n} X_i Y_i$ = The product of the total number of variables X and Y

b) Spearman Correlation Analysis

The simple formula used to measure Spearman rank [16] is as follows:

$$r_s = 1 - \frac{6\sum_{i=1}^{n} b_i^2}{n(n^2-1)} \quad (2)$$

Where:
r_s = spearman rank correlation coefficient
b_i = ranking difference

c) Testing the Correlation Coefficient

- Hypothesis Testing

The hypothesis being tested is
H_0: $\rho_{XY} = 0$ (There is no relationship between X and Y)
H_0: $\rho_{XY} \neq 0$ (There is a relationship between X and Y)

- Test Statistic

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (3)$$

Where:
t = t-value
r = correlation coefficient
n = number of samples

- Test Criteria:

Reject H_0 if $t_{hit} \geq t_{tab}$

Accept H_0 if $-t_{tab} < t_{value} < t_{tab}$
with $t_{tab} = t_{0.5\alpha;df=n-2}$

d) Assumption Test

Before doing a simple correlation analysis, it is necessary to test the assumptions first. This test is carried out to see whether the data in the study is normally distributed or not. The simplest normality test is to make a frequency distribution graph of existing scores. The normal assumption is used to determine whether the residuals are normally distributed [17]. If the normality assumption is not met, OLS estimation cannot be used. Some tests that can be done for normal distribution is Shapiro Wilk test. The Shapiro Wilk Normality Test is a test that is carried out to determine the distribution of random data in a small sample. In 2 seminar papers conducted by Shapiro, Wilk in 1958 and Shapiro, Wilk, Chen 1968, simulations of data of no more than 50 samples were used. Therefore, it is recommended to use the Shapiro Wilk test for data samples of less than 50 samples (N <50). The test rules are as follows:

- If the probability (sig) ≥ 0.05, then the data is normally distributed

- If the probability (sig) < 0.05, then the data is not normally distributed

3. Methods

3.1 Type of Research

This type of research is quantitative research. This study aims to observe the effect of changes in the price of fuel oil (BBM), especially the type of Pertamax, on the inflation rate in Indonesia in the period March 2020 to March 2024.

3.2 Data Source

Fuel price data was sourced from Pertamina reports, while inflation rate data was obtained from Bank Indonesia reports. Analysis was conducted using descriptive techniques and statistical analysis, including hypothesis testing and correlation analysis.

3.3 Research Variable

a. Dependent Variable

The dependent variable is the variable that is influenced as a result of the appearance of the independent variable. The variable used in this study is inflation, The data used is monthly data taken from March 2020 - March 2024 and the fuel price used is monthly data taken from March 2020 - March 2024.

3.4 Procedure Analysis

Analysis procedures include:

a. Input data on fuel prices and inflation rates
b. Perform descriptive data test
c. Conduct a simple correlation analysis test by fulfilling the classical assumption test
d. Interpret the results and conclude about the relationship between fuel prices and inflation rates in Indonesia for the period March 2020-March 2024.

4. Results and Discussion

4.1 Descriptive Analysis

Descriptive analysis is an analysis conducted to assess the characteristics of data. The data collected is processed using descriptive statistical techniques which are presented in the form of frequency distribution, median value, mean, mode, standard deviation, histogram, and polygon. Descriptive statistics show the minimum, maximum, mean, and standard deviation values. The following is the statistical data

Table 2. Descriptive Statistics

Variables	Maximum	Minimum	Mean	Standard Deviation
Fuel Oil	14500	9000	11006.12	2111.17
Inflation	5,95	1,32	2,86	1,42

In this study, two variables were observed, namely the price of fuel oil (BBM) and the inflation rate. The statistical analysis shows that fuel prices range from 9000 to 14500, with an average price of 11006,12 and a standard deviation of 2111,17. This indicates that fuel prices have significant variation, with a sizable price difference between its maximum and minimum values, as well as high dispersion. Meanwhile, for the Inflation variable, the inflation rate ranges from 1,32 to 5,95, with an average of around 2,86 and a standard deviation of 1,42. This shows that the inflation rate tends to be more stable than the fuel price, with lower variation and relatively smaller difference between the maximum and minimum values.

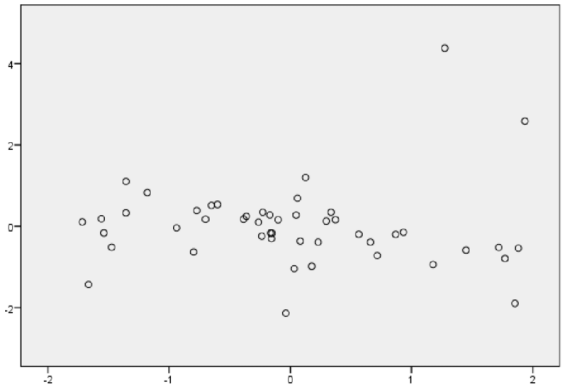

Figure 1. Scatterplot Inflation x Fuel Oil

4.1 Normality Assumption Test

Normality test is carried out to determine whether the data being analyzed is normally distributed or not. The results of the normality test calculation are concluded based on the plot and Shapiro wilk test analysis.

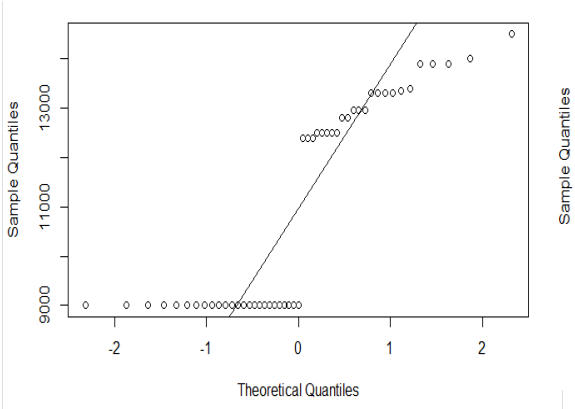

Figure 2. QQ Plot *BBM*

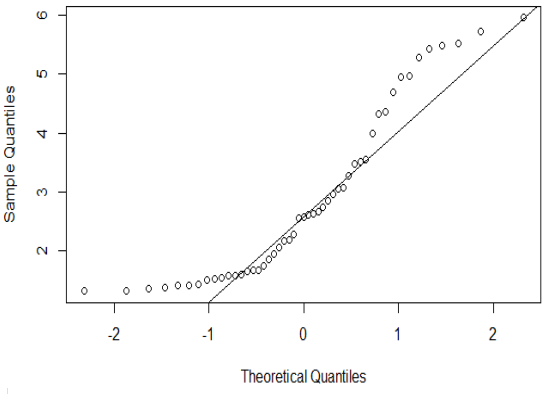

Figure 3. QQ Plot *for Inflation*

Based on the figure above, the QQ plot for fuel data shows that the points spread quite far from the diagonal line. This indicates that the distribution of the fuel data does not follow the standard normal distribution well. More precisely, there is a significant difference between the actual distribution of the fuel data and the distribution that would be expected if the data were normally distributed. This means that there is a possibility that the fuel data has a more extreme or asymmetric distribution pattern, which does not fit the normal distribution. Meanwhile, in the QQ plot for inflation data, the points are spread fairly close but not perfectly on the diagonal line. This suggests that the distribution of the inflation data has a relatively good fit with the standard normal distribution, but there are some deviations that are not significant and indicate inconsistencies in the distribution of the inflation data with the standard normal distribution. Nonetheless, since the points are still quite close to the diagonal line overall, we can still assume that the inflation data has a decent degree of conformity with the standard normal distribution. However, this fit is not perfect as the QQ plot only provides a visual representation and does not provide formal statistical information about the normality of the data. A more robust assessment is needed using statistical tests of normality such as the Shapiro-Wilk test. These statistical tests can provide more information about whether the data distribution is significantly different from a normal distribution.

Table 3. Normality Test

Shapiro-Wilk normality test		
BBM	*W*	0,74569
	p-value	7,52e-05
Inflation	*W*	0,87475
	p-value	9,07e-02

From the normality test results using the Shapiro-Wilk test for both variables, BBM and Inflation, the W statistical value is 0.74569 for BBM and 0.87475 for Inflation. In addition, the p-value is 7,52e-05 for BBM and 9,07e-02 for Inflation. Based on these results, it can be seen that both variables have very low p-values. When the p-value is less than alpha, which in this study is used alpha 0.05, it can be said that there is enough evidence to reject the null hypothesis that the data comes from a normal distribution. Thus, it can be concluded that neither the BBM nor Inflation variables are significantly normally distributed.

4.2 Correlation Test

The correlation test was conducted to evaluate how strong and significant the relationship between the increase in the price of Pertamax fuel and the inflation rate in Indonesia during the period March 2020 to March 2024. In this study, the correlation test was conducted using the Spearman correlation method to evaluate the relationship between the increase in the price of Pertamax fuel and the inflation rate in Indonesia, considering that the data was not normally distributed.

Table 4. Spearman rho Correlation Test

Spearman's rank correlation rho	
Spearman's rho	0,780887
t-value	3,64e-11

The results of the Spearman correlation test between the Inflation and Fuel variables show a strong and statistically significant relationship between the two. The Spearman correlation coefficient (rho) of 0.780887 indicates that there is a strong positive relationship between the increase in the price of Pertamax fuel and the inflation rate in Indonesia during the period March 2020 to March 2024. In addition, the p-value (3.64e-11) is less than alpha (0.05) indicating that the relationship is highly statistically significant. Thus, it can be concluded that when the price of Pertamax fuel increases, the inflation rate tends to also increase, and vice versa.

5. Conclusion

Based on the results of the Spearman correlation test that has been carried out, it can be concluded that there is a strong positive relationship between the Inflation Rate and the Price of Fuel Oil in Indonesia during the period March 2020 to March 2024. This can be proven by the Spearman correlation coefficient (rho) of 0.780887. So, it can be concluded that when the price of Pertamax fuel increases, the inflation rate tends to also increase, and vice versa.

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