

# Evaluating the Relationship between Consumer Price Index with Gasoline and Hog Prices in Vietnam

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**Abstract** This study examines the link between inflation with fuel prices and hog prices in the Vietnamese context using Error Correction Model (ECM). It reveals that the change in the current gasoline and hog prices will produce a positive effect on Consumer Price Index (CPI) values in the next month. Because of the high speed of adjusting CPI to long-term equilibrium, Vietnam's CPI needs more than a month to reach this equilibrium. Taken together, these findings provide some suggestions for using the fluctuations in petroleum and hog prices as warning indicators for a more accurate CPI forecast in Vietnam. Moreover, it is recommended that other factors, for example, the changes in gasoline prices and hog prices, are added in predicting CPI.

**Keywords:** consumer price index, error correction model, gasoline prices, hog prices, inflation forecasting

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## 1. Introduction

In the context of various events such as COVID-19 pandemics and geopolitical differences, inflation is a major topic that has an impact on both economic and social life in many nations. Consumer Price Index (CPI) is a remarkable measure that reflects household expenditures to maintain their quality of living. Furthermore, the Vietnamese government sets the goal of controlling inflation while ensuring economic growth. Inflation is closely related to other economic factors. To forecast the inflation rate, it is necessary to examine the link between macroeconomic indicators.

In Vietnam, consumer price refers to the money that consumers pay to buy a unit of goods or services to use in their daily life. It also shows the price of products on the market, or the price of services needed to support daily living. Therefore, consumer price is the final price consumers pay for a commodity.

CPI is a relative indicator (measured by %) that reflects change in the price level of a basket of representative goods and services over time. This basket of goods and services is made up of popular goods and services that represent the population's consumption that is revised and updated every five years in order to reflect the population's consumption structure in a certain period.

Weight for CPI compilation is the percentage for each item groups in the total of the household expenditure. This data is collected from results of Viet Nam Household Living Standard Survey (VHLSS) and used in a 5-year period (see Appendix, [Table 8](#)). Vietnam's CPI is

calculated using the Weighted Geometric Mean Laspeyres formula.

CPI is calculated monthly using the following comparative bases such as base year, previous month, same month of the previous year, last December of the previous year, and periodical average for each province or city directly under the central government and the whole country.

Inflation forecasting is a major area of interest within the field of forecasting economic indicators. In both developed and developing countries, many forecasts used numerous models, for instance, univariate and multivariate models. With the introduction of time series models, Autoregressive Integrated Moving Average (ARIMA) model is becoming the most popular and approachable method of forecasting inflation. However, CPI depends on the prices of goods and services in the CPI market basket, so using multivariate models are considered. In this paper, Error Correction Model (ECM) is used to examine the relationship between CPI, gasoline price and hog price.

## 2. Literature Review

Time series forecasting is the making of scientific forecasts based on time-series data. It involves building models through analyzing historical data and using them to make future decisions. An important point in forecasting is that at the time of analysis, future outcomes are completely unavailable and can only be estimated through proven statistical methods and mathematical formulas. Forecast results are not always accurate, and predict performance can vary, especially when dealing

with outliers in time series data as well as factors that we cannot control.

Forecasting methods based on time series are quite popularly used because of its advantages such as simplicity and quick results. However, these methods often encounter a huge obstacle in forecasting the change in direction of that series. Therefore, in order to improve the accuracy of forecasting, researchers have to deeply analyze and understand the fluctuations of the components that have a strong impact and are likely to become leading factors. By analyzing these fluctuations, it is possible to estimate the future volatility of the chain.

Because of its concise approach, the ARIMA model is used in numerous research in Vietnam to predict inflation rates based on forecasting CPI. On the other hand, CPI values are not solely determined by their historical values. It seems that prices of other goods in the market can be used as leading indicators to forecast future CPI values. Thus, the ECM framework is applied to evaluate the influence of gasoline and hog prices on CPIs, both short and long term.

Using monthly data in Zambia, Jere, S. *et al.* [1] compared forecast prediction performance between ARIMA and multi-cointegration framework. They found that in forecasting inflation, ECM was the more accurate predicting model because of its smallest errors.

In their study about the China's economy, Zhang, F. W. *et al.* [2] revealed that the Autoregressive Moving Average (ARMA) models can only predict the inflation rate in the short run. When applying to the long run, the forecast values are underestimated. Because ARMA models requires a stable time series, this model is more suitable for predicting annual CPIs, particularly those for the next one or two periods.

Kim, K. H. [3] investigated the relationship between US producer price index and other economic variables using ECM approach. From its findings, all the variables have an equilibrium relation. In particular, the inflation and money supply are positively related. However, the study used Producer Price Index (PPI) instead of CPI to avoid the impact of non-traded goods. Using CPI, according to the author, also leads to the same conclusion.

### 3. Data and Methodology

#### 3.1. Data

The dataset includes three variables, which are monthly CPI, gasoline price and hog price. The data was gathered between January 2018 and August 2022 (see Appendix, Table 9).

**Table 1. Variables description**

Variable names	Indicator names	Definitions
CPI	Monthly CPI	Monthly Consumer Price Index in Vietnam (compared to the previous month = 100)
GP	Gasoline price	RON-95 selling price that announced each adjustment period (VND/liter)
PP	Hog price	Monthly average hog price in the North and South of Vietnam (VND/kilogram)

The first variable is monthly CPI in Vietnam, published by General Statistics Office [4]. In the current economic management and analysis in Vietnam, monthly CPIs compared to the previous month (previous month = 100) are often used, so the article delves into analyzing and forecasting this CPI. Data on gasoline prices (RON-95) and hog prices are collected by the Institute of Economics and Finance, Academy of Finance.

ECM models are estimated by using natural logarithmic transformations of original values to mitigate the influences of outlier values and high variance in the data series. These variables are transformed to

$$\ln CPI = \log(CPI), \ln GP = \log(GP), \ln(PP) = \log(PP)$$

When CPI, fuel price or hog price will hereafter be mentioned, they are the log-transformed values of initial values.

#### 3.2. Research Model

To evaluate the link between variables, this research applied ECM, which was developed by Engle and Granger. Because ECM does not need stationary time series, the model will keep investing in both short- and long-term impacts.

If all series are connected in the same order and cointegrated, an ECM is sufficiently explained. First, the Augmented Dickey-Fuller (ADF) test is used to find the unit root for each variable. This test is predicated on the null hypothesis that the series has a unit root. The test for the long-run relation between variables is the next stage. The Johansen-Juselius test is used to perform the cointegration test. This test is made up of two: the trace test and the maximum eigenvalue test. The optimal lag length is determined using the Vector Autoregression (VAR) model based on the popular criteria such as Akaike Information Criterion (AIC). The ECM model is used to evaluate the link between variables, then measuring the rate at which the CPI adjusts to return to long-term equilibrium.

### 4. Results

#### 4.1. Test Stationarity

Using ADF test at lag 1, only CPI is stationary. After differencing at lag 2, all the series are stationary. As a result, all variables are stationary at difference 2.

#### 4.2. Test Cointegration

Cointegration tests use Johansen's approach to investigate the link between variables to identify the presence of a long-term relationship.

**Table 2. Cointegration test result using trace test**

Null hypothesis	Test statistic	Critical value (at 5%)
$r \leq 2$	6.75	9.24
$r \leq 1$	15.92	19.96
$r = 0$	57.59	34.91

**Table 3. Cointegration test result using eigenvalue test**

Null hypothesis	Test statistic	Critical value (at 5%)
$r \leq 2$	6.75	9.24
$r \leq 1$	9.17	15.67
$r = 0$	41.67	22.00

For both trace and eigenvalue test, at a 5% significant level, there is 1 cointegration relation.

### 4.3. Optimal Lag

**Table 4. Optimal lag selection result**

AIC	HQ	SC	FPE
1	1	1	1

The optimal lag is defined by the outcomes that satisfy most criteria. As a result, this lag is 1. It indicates that the current values are influenced by the prior month's values.

### 4.4. Estimated Model

**Table 5. ECM estimation result**

	Estimate value	P-value
(intercept)	3.90048	1.25e-09
deltalnGP	0.04204	7.42e-06
deltalnPP	0.01621	0.0072
lnGPLag1	0.00478	0.1593
lnPPLag1	0.00348	0.1211
yLag1	-0.86517	1.72e-09

At a 5% significance level, the coefficients chosen are the short-term changes in gasoline and hog prices and the error correction term.

In the short term, variations in both gasoline and hog price have a positive relationship with CPI. While the change in gasoline price increases by 1 unit, the change in CPI may increase by 0.042 units. Furthermore, if the change of pork price increases by 1 unit, the CPI may increase 0.016 units. The results are presented that these two prices last month have influence to the current CPI value.

At one month lag, the lagged error correction term has a statistically significant negative sign. It implies the existence of a cointegration connection. From the outcome, the speed of adjusting CPI to long-term equilibrium is quite high, about 86.52% per month. Thus, Vietnam's CPI needs more than a month (about 35 days) to reach equilibrium in the long run.

### 4.5. Forecast CPI

Using Vector Error Correction Model (VECM) model, [Table 6](#) presents the forecast values for the next period from September 2022 to December 2022. From this table, inflation is predicted to fluctuate around 0.2-0.3% per month. This result is acceptable in the current volatile economic situation.

**Table 6. Forecast values from VECM.**

	Forecast value
Sep 2022	99.9989
Oct 2022	100.2734
Nov 2022	100.3734
Dec 2022	100.3349

Due to the frequent change in goods prices, it is recommended that this model needs to be updated regularly with new data for the most accurate predicting results.

## 5. Conclusion

According to the findings, it is recommended that both petroleum and hog prices are considered the main elements impacting the price level of other commodities in a short-term period. It is necessary to take some measures to stabilize the prices of these key commodities to maintain the CPI stability.

Like many other countries in the world, in Vietnam's economy, petroleum products play an important role because most production and consumption activities require petroleum (as a fuel for transportation, energy production...). According to the calculation of GSO [5]: gasoline costs account for about 3.52% of the total production costs of the whole economy; spending on petroleum accounts for 1.5% of total final consumption of households; the average CPI in the first 8 months of 2022 increased by 2.58% compared to this of 2021, where gasoline prices increased by 45.33% and contributed to the increase of 1.63 percentage points in CPI (in the first 8 months of 2022, the increase in gasoline prices accounted for 63.18% of Vietnam's CPI increase). Every 10% increase in petrol price will increase CPI by 0.36 percentage points.

Similarly, hog prices have an important impact on CPI. Pork is an essential commodity that people consume in daily life. Moreover, food and food accounted for the largest proportion in the CPI summary table (see Appendix, [Table 8](#)). Thus, changes in commodity prices also have a strong impact on inflation.

Therefore, we recommend using the fluctuations of gasoline and hog prices as warning indicators to forecast the fluctuation of CPI (CPI will fluctuate 1 month later than these two warning indicators). Monthly CPI forecast in Vietnam will need to keep track and analyze the fluctuation of gasoline and hog prices in the previous month. From this analysis, it is possible to give the trend of CPI fluctuations in the forecasted months. By combining with other forecasting models, this will result in higher accuracy of Vietnam's CPI forecasting.

In Vietnam, the government announced inflation targeting annually. The finding suggests how macroeconomic factors affect CPIs and provides forecasts for future inflation rate. Although their long-run influences are questionable, it is still recommended to add other factors, for example, the changes in gasoline prices and hog price, in predicting CPI method. After that, VECM may be used to forecast CPIs to calculate inflation targeting.

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## Appendix

**Table 7. Descriptive statistics**

	CPI	GP	PP	lnCPI	lnGP	lnPP
Minimum	98.46	11,930	30,500	4.590	9.387	10.33
1st quartile	99.97	17,929	46,875	4.605	9.794	10.76
Median	100.19	20,623	54,750	4.607	9.934	10.91
Mean	100.24	20,443	59,134	4.608	9.905	10.95
3rd quartile	100.57	21,492	73,000	4.611	9.975	11.20
Maximum	101.52	32,270	93,750	4.620	10.382	11.45
Standard deviation	0.5146	4,161.65	17,031.54	0.00514	0.2057	0.2924

**Table 8. Weights for CPI compilation for the period 2021-2025**

Goods and services categories	Weights (%)
I. Food and foodstuff	33.56
II. Beverage and cigarette	2.73
III. Garment, hat, footwear	5.7
IV. Housing and construction materials	18.82
V. Household equipment and goods	6.74
VI. Medicine and healthcare services	5.39
VII. Transport	9.67
VIII. Post and communication	3.14
IX. Education	6.17
X. Culture, entertainment, and tourism	4.55
XI. Other consumer goods and services	3.53

**Table 9. Data**

Date	CPI	GP	PP
2018-01	100.51	19,917	32,000
2018-02	100.73	20,247	33,000
2018-03	99.73	19,980	30,500
2018-04	100.08	20,327	38,750
2018-05	100.55	20,973	46,750
2018-06	100.61	21,397	47,250
2018-07	99.91	21,170	50,500
2018-08	100.45	21,170	52,250
2018-09	100.59	21,470	52,750
2018-10	100.33	22,103	49,500
2018-11	99.71	21,077	48,250
2018-12	99.75	18,853	47,000
2019-01	100.10	17,600	49,250
2019-02	100.80	17,600	45,000
2019-03	99.79	17,893	41,000
2019-04	100.31	19,933	41,250
2019-05	100.49	21,670	34,000
2019-06	99.91	20,977	36,250
2019-07	100.18	20,623	35,400
2019-08	100.28	20,693	42,250
2019-09	100.32	20,185	44,475
2019-10	100.59	20,925	54,750
2019-11	100.96	20,615	67,500
2019-12	101.40	20,975	83,500

Date	CPI	GP	PP
2020-01	101.23	20,950	82,500
2020-02	99.83	19,750	79,000
2020-03	99.28	17,965	80,750
2020-04	98.46	12,245	84,500
2020-05	99.97	11,930	93,750
2020-06	100.66	13,600	92,000
2020-07	100.40	14,970	89,250
2020-08	100.07	14,945	84,250
2020-09	100.12	15,023	79,750
2020-10	100.09	15,003	72,250
2020-11	99.99	14,987	70,500
2020-12	100.10	15,940	70,250
2021-01	100.06	16,890	80,500
2021-02	101.52	17,540	78,750
2021-03	99.73	18,667	75,000
2021-04	99.96	19,057	73,750
2021-05	100.16	19,407	69,250
2021-06	100.19	20,200	67,450
2021-07	100.62	21,457	58,425
2021-08	100.25	21,497	53,500
2021-09	99.38	21,487	50,500
2021-10	99.80	23,047	41,413
2021-11	100.32	24,407	46,000
2021-12	99.82	23,330	49,250
2022-01	100.19	23,840	52,438
2022-02	101.00	25,320	56,075
2022-03	100.70	28,613	52,900
2022-04	100.18	27,817	55,000
2022-05	100.38	29,263	55,938
2022-06	100.69	32,270	56,525
2022-07	100.40	29,500	64,025
2022-08	100.01	24,973	65,800



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