

VECTOR AUTOREGRESSIVE (VAR) METHOD IN ANALYZING THE EFFECT OF INFLATION ON FOOD PRICE VOLATILITY (FPV) IN PALOPO CITY, INDONESIA

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received 20 February 2023</p> <p>Accepted 08 May 2023</p>	<p>Purpose: This study aimed to analyze the effect of Inflation on food prices in Palopo City, where the inflation rate is calculated based on index numbers collected from several commodities traded at each price level in the market, namely the Consumer Price Index (CPI).</p>
<p>Keywords:</p> <p>VAR; Inflation; CPI; FPV.</p>	<p>Theoretical framework: The Vector Autoregressive (VAR) method is simultaneous equation modeling that has several endogenous variables simultaneously, but each endogenous variable is explained by lags of its own value and other endogenous variables in the model. Forecasting using the VAR method is in some cases better than complex simultaneous equations.</p>
	<p>Design/methodology/approach: The stationarity test in this study uses the Augmented Dickey-Fuller (ADF) method, followed by determining lag optimal Akaike Information Criteria (AIC) and Schwarz information Criterion (SC) analysis. The stability test of the VAR model was carried out through the Johansen Cointegration Test at a 5% significance level which produced six equations with a trace statistically more significant than the critical value. Then an analysis of Impulse Response Functions (IRF) was carried out to see the dynamic response of the CPI variable to food commodity prices. The data used are time series for January 2018 to December 2020.</p>
	<p>Findings: The inflation response to food price fluctuations in Palopo City resulted in three conditions. The Palopo City CPI responded positively to the price fluctuations of garlic and red chili. In contrast, shallots and chicken meat price fluctuations responded negatively to the Palopo City CPI. The Palopo City CPI did not permanently affect the price fluctuations of cayenne pepper and chicken eggs.</p>
	<p>Research, Practical & Social implications: The practical implication of this research is that food commodity prices still have an influence on inflation movements. Local</p>

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governments should cooperate with city governments in the production of food commodities by implementing cropping patterns on these commodities to overcome excess production, and it is necessary to carry out off-season production to achieve harvest deficits so that prices remain stable. Improvements to the trade system also need to be improved in addition to the production system. This is intended so that the distribution of food commodity products can be more efficient by implementing supply chain management.

Originality/value: Collecting time series data of the Consumer Price Index (CPI) for 6 commodities, namely shallots, garlic, chili peppers, cayenne pepper, broiler meat, and broiler eggs, in a modern model, namely a multivariate time series model with a high level of predictive accuracy of the model among these variables to predict and analyze the effects among these series and estimate the interactions among these series with the latest data is the value of this research, and then provide recommendations for the government in making economic strategies, especially for those related to inflation and food prices.

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MÉTODO VETOR AUTOREGRESSIVO (VAR) NA ANÁLISE DO EFEITO DA INFLAÇÃO SOBRE A VOLATILIDADE DOS PREÇOS DOS ALIMENTOS (FPV) NA CIDADE DE PALOPO, INDONÉSIA

RESUMO

Objetivo: Este estudo teve como objetivo analisar o efeito da inflação nos preços dos alimentos na cidade de Palopo, onde a taxa de inflação é calculada com base em números de índice coletados de várias commodities negociadas em cada nível de preço no mercado, ou seja, o Índice de Preços ao Consumidor (IPC).

Referencial teórico: O método Vector Autoregressivo (VAR) é uma modelagem de equações simultâneas que possui várias variáveis endógenas simultaneamente, mas cada variável endógena é explicada por defasagens de seu próprio valor e outras variáveis endógenas no modelo. A previsão usando o método VAR é, em alguns casos, melhor do que equações simultâneas complexas.

Desenho/metodologia/abordagem: O teste de estacionariedade neste estudo usa o método Augmented Dickey-Fuller (ADF), seguido pela determinação do critério de informação de Akaike ótimo (AIC) e análise do critério de informação de Schwarz (SC). O teste de estabilidade do modelo VAR foi realizado por meio do Teste de Cointegração de Johansen ao nível de significância de 5% que produziu seis equações com traço estatisticamente mais significativo que o valor crítico. Em seguida, foi realizada uma análise das funções de resposta ao impulso (IRF) para ver a resposta dinâmica da variável IPC aos preços das commodities alimentares. Os dados utilizados são séries temporais de janeiro de 2018 a dezembro de 2020.

Resultados: A resposta da inflação às flutuações dos preços dos alimentos na cidade de Palopo resultou em três condições. O CPI da cidade de Palopo respondeu positivamente às flutuações de preço do alho e do pimentão vermelho. Em contraste, as flutuações dos preços da chalota e da carne de frango responderam negativamente ao CPI da cidade de Palopo. O CPI da cidade de Palopo não afetou permanentemente as flutuações de preço da pimenta caiena e dos ovos de galinha.

Pesquisa, implicações práticas e sociais: A implicação prática desta pesquisa é que os preços das commodities alimentares ainda influenciam os movimentos da inflação. Os governos locais devem cooperar com os governos municipais na produção de commodities alimentares, implementando padrões de cultivo dessas commodities para superar o excesso de produção, e é necessário realizar a produção fora de época para atingir déficits de safra para que os preços permaneçam estáveis. Melhorias no sistema de comércio também precisam ser melhoradas, além do sistema de produção. O objetivo é que a distribuição de produtos alimentícios básicos possa ser mais eficiente, implementando o gerenciamento da cadeia de suprimentos.

Originalidade/valor: coleta de dados de séries temporais do Índice de Preços ao Consumidor (CPI) para 6 commodities, ou seja, chalotas, alho, pimenta malagueta, pimenta caiena, carne de frango e ovos de frango, em um modelo moderno, ou seja, um modelo de série temporal multivariada com um alto nível de precisão preditiva do modelo entre essas variáveis para prever e analisar os efeitos entre essas séries e estimar as interações entre essas séries com os dados mais recentes é o valor desta pesquisa e, em seguida, fornecer recomendações para o governo na elaboração de estratégias econômicas, especialmente para aqueles relacionados à inflação e preços de alimentos.

Palavras-chave: VAR, Inflação, IPC, FPV.

MÉTODO VECTORIAL AUTORREGRESIVO (VAR) PARA ANALIZAR EL EFECTO DE LA INFLACIÓN EN LA VOLATILIDAD DEL PRECIO DE LOS ALIMENTOS (FPV) EN LA CIUDAD DE PALOPO, INDONESIA

RESUMEN

Propósito: Este estudio tuvo como objetivo analizar el efecto de la inflación en los precios de los alimentos en la ciudad de Palopo, donde la tasa de inflación se calcula en función de los números índice recopilados de varios productos básicos comercializados en cada nivel de precios en el mercado, a saber, el índice de precios al consumidor (IPC).

Marco teórico: El método Vector Autoregresivo (VAR) es un modelo de ecuaciones simultáneas que tiene varias variables endógenas simultáneamente, pero cada variable endógena se explica por rezagos de su propio valor y otras variables endógenas en el modelo. Pronosticar usando el método VAR es en algunos casos mejor que ecuaciones simultáneas complejas.

Diseño/metodología/enfoque: la prueba de estacionariedad en este estudio utiliza el método Dickey-Fuller aumentado (ADF), seguido de la determinación del criterio de información de Akaike (AIC) óptimo de retraso y el análisis del criterio de información de Schwarz (SC). La prueba de estabilidad del modelo VAR se llevó a cabo a través de la Prueba de Cointegración de Johansen al 5% de nivel de significancia, lo que arrojó seis ecuaciones con una traza estadísticamente más significativa que el valor crítico. Luego se realizó un análisis de Funciones de Impulso Respuesta (IRF) para ver la respuesta dinámica de la variable IPC a los precios de las materias primas alimentarias. Los datos utilizados son series temporales de enero de 2018 a diciembre de 2020.

Hallazgos: La respuesta de la inflación a las fluctuaciones de los precios de los alimentos en la ciudad de Palopo resultó en tres condiciones. El IPC de la ciudad de Palopó respondió positivamente a las fluctuaciones de precios del ajo y el chile rojo. En contraste, las fluctuaciones en los precios de los chalotes y la carne de pollo respondieron negativamente al IPC de la ciudad de Palopo. El IPC de la ciudad de Palopó no afectó permanentemente las fluctuaciones de precios de la pimienta de cayena y los huevos de gallina.

Implicaciones sociales, prácticas y de investigación: La implicación práctica de esta investigación es que los precios de las materias primas alimentarias todavía influyen en los movimientos de la inflación. Los gobiernos locales deben cooperar con los gobiernos de las ciudades en la producción de productos alimenticios mediante la implementación de patrones de cultivo en estos productos básicos para superar el exceso de producción, y es necesario llevar a cabo una producción fuera de temporada para alcanzar los déficits de cosecha para que los precios se mantengan estables. Las mejoras en el sistema de comercio también deben mejorarse además del sistema de producción. Esto tiene por objeto que la distribución de productos básicos alimentarios pueda ser más eficiente mediante la implementación de la gestión de la cadena de suministro.

Originalidad/valor: recopilación de datos de series temporales del índice de precios al consumidor (IPC) de 6 productos básicos, a saber, chalotes, ajo, chiles, pimienta de cayena, carne de pollo y huevos de pollo, en un modelo moderno, a saber, un modelo de serie temporal multivariado con un alto nivel de precisión predictiva del modelo entre estas variables para predecir y analizar los efectos entre estas series y estimar las interacciones entre estas series con los datos más recientes es el valor de esta investigación, y luego proporcionar recomendaciones para el gobierno en la elaboración de estrategias económicas, especialmente para los relacionados con la inflación y los precios de los alimentos.

Palabras clave: VAR, Inflación, IPC, FPV.

INTRODUCTION

Inflation is an increase in the price of goods and services for a certain period in an area. Inflation is related to market mechanisms caused by several factors. (Hoong et al., 2023) explained that Inflation reduces the real value of money, resulting in reduced purchasing power, lower profitability, and decreased real returns on investments, including stocks. As a result, inflation affects the stock market and the economy as a whole. Increased public consumption, time-consuming distribution of goods, and excess liquidity in the market as a trigger for consumption or even speculation are factors causing Inflation. According to (Santi et al., 2021),

Inflation can be caused by three factors: demand, supply, and expectations. Another factor causing Inflation is a combination of these three factors. Economics explains that two variables are always used as requirements in conducting various economic analyses, including analyzing the factors that cause Inflation.

According to (Affandi, 2015) Indonesia's inflation is more than a financial problem. The price inflation element fundamentally shapes the inflation process. Inflation is a universal financial phenomenon that has grown significantly worse for emerging nations. The phenomena of inflation in emerging nations motivate policymakers to investigate these aspects to address internal economic issues, claim (Calvo et al., 2018). Results of research by (A. R. (2020) Farandy, 2010) the food commodity itself, through demand-supply dynamics, is the crucial factor driving Indonesia's food price inflation. Meanwhile, According to (Khan & Gill, 2010) fiscal factors have a more significant impact on the inflation of food prices. In comparison, there is significant disagreement regarding calculating inflation using the money supply. On the other hand, the findings (Sultana & Qayyum, 2018) indicated that the cause of inflation is an increase in the money supply.

According to a report by the , families' well-being is negatively impacted by rising food prices (Ferreira et al., 2013). It is consistent with the viewpoint of (Sultana & Qayyum, 2018) because inflation will lower people's purchasing power and favor the wealthy rather than the poor, many governments attempt to control inflation through monetary reform and wage and price regulation. According to (Ramzan, 2021) stable inflation will lead to an inefficient distribution of resources, which will lower economic productivity. The poor and low-income groups will suffer as a result of this.

According to (Bernanke & Mishkin, 1997), a country's inflation rate is typically targeted at or below two digits because low inflation is thought to stimulate the economy. Low inflation can encourage consumers to purchase goods and services. In Indonesia, inflation is rising year after year. The graph below depicts the evolution of Indonesia's inflation from 2016 to 2020.

Research by (Umaru & Zubairu, 2012) found the impact of inflation on the expansion and development of the Nigerian economy in 2012. They calculated the impact of inflation on economic growth using Unit Root Test and Granger Causality Test. Understanding the price relationship between commodity groups and food commodities in Indonesia is crucial as a basis for inflation control efforts. Research (IRZ et al., 1993) has examined the relationship between food inflation and VECM. Similarly, (Bima, 2017) and (Ramadhan, 2011) found that there is a

statistically significant long-term equilibrium relationship between food prices and agricultural commodities, labor, and energy, based on vector error correction (VEC) estimation.

Furthermore, (Putra, 2022) identified the variables that affect inflation in Indonesia between 2015 and 2020 using the error correction model (ECM) test, in his findings it was conveyed that the increase in the price of goods and services would reduce people's purchasing power and thus reduce national income. While according to (Umaru & Zubairu, 2012) this is in line with what is expressed by (von Braun & Tadesse, 2012) in the findings of his study, an important policy implication is the efforts made by decision-makers to encourage productivity to reduce the price of goods and services (inflation) so as to encourage economic growth. In addition, institutional frameworks and food price volatility around the world need to be addressed through policy (Tirtosuharto & Adiwilaga, 2017).

Price increases have resulted from such demand factors. It is consistent with the assertion assertion (Kornher & Kalkuhl, 2011) that food price inflation is a major concern for global stakeholders, including Indonesia. Consumers are impacted by rising food prices. Furthermore, according to studies (Roache, 2019), food prices have recently fluctuated, causing producers and consumers to become more concerned about food price inflation. Analyze the policy implications for the Indonesian economy using a price adjustment equation (Wimanda et al., 2011). They discover that past and future expectations have a significant impact on the inflation rate. Stock and production (representing the supply side) were heavily influenced by (Kornher & Kalkuhl, 2011).

Measurement of price changes (inflation/deflation) at the consumer level can be done using the Consumer Price Index (CPI). In the study (And & Kalim, 2012) in Pakistan conducted research using CPI data from 1972 to 2008. A long-run association was found using the Johansen cointegration check technique (Sultana & Qayyum, 2018), and the CPI was used in their study as a measure of food inflation. Another interesting study was also presented by (Abdoulaye et al., 2015) which aimed to evaluate the correlation between cereal prices and CPI to emphasize the significant influence of food crops on CPI. According to the findings, there is a long-term relationship between CPI and input factors, including wheat, rice, and corn. Therefore, the CPI is often used as an indicator of inflation and to aid economic policy making.

Referring to these explanations, analyzing the effect of inflation on price volatility is very important to study because the research findings can be a reference and recommendation for the government in taking appropriate actions to maintain food price stability and reduce the

negative impact of inflation on people's living conditions. Thus, this study aims to analyze the effect of Inflation, in this case CPI, on food price volatility.

LITERATURE REVIEW

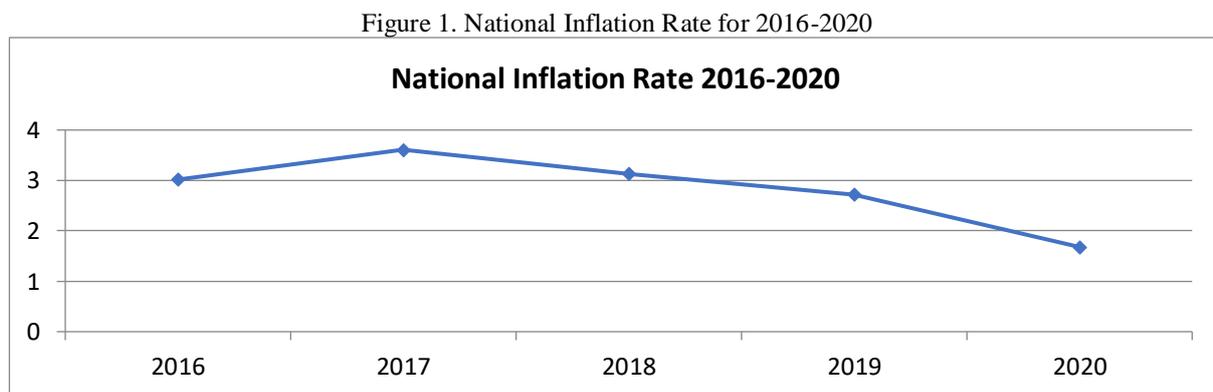
The research related to price inflation and food price volatility has been conducted in several places and produced various results. The multiple linear regression method was used in the research of (Leiley et al., 2020); (Irnawati, 2020); and (Bafadal, 2012) to analyze the effect of inflation and food prices. (Leiley et al., 2020) in analyzing the effect of agricultural commodities on inflation in Manado city showed that the vegetable group, nuts inflation, fruits inflation and seasonings inflation. grains group had no effect on Manado city inflation. Meanwhile, the research of (Irnawati, 2020) to forecast the effect of food commodity prices on inflation in Pangkalpinang City in 2015-2017 showed that variations in food commodity prices were able to influence inflation by 55.3%. In contrast to the inflation factor in Kendari City, (Bafadal, 2012) concluded that the processed food, beverages, cigarettes and tobacco group had a greater influence on inflation than the foodstuff group. In the foodstuff group, the fresh fish sub-group has the largest influence on inflation. The effect of rising rice prices on inflation is not too large.

In addition, research related to inflation and food prices using the Vector Autoregressive (VAR) method was conducted by (Chintia & Destiningsih, 2022); (Rahmanta & Maryunianta, 2020); and (Setiawan & Hadianto, 2019). The research of (Chintia & Destiningsih, 2022) showed that the price of rice and broiler chicken meat have a major influence on inflation in Semarang City in the long term. Meanwhile, inflation that occurs in Medan City based on research (Rahmanta & Maryunianta, 2020) from the biggest influence to the smallest is the price of red chili, shallot price, rice price, cayenne pepper price, and garlic price. Furthermore, (Setiawan & Hadianto, 2019) used the Vector Autoregressive (VAR) model to model fluctuations in food commodity prices and their impact on inflation in Banten Province. The results obtained by shaking the commodity prices of corn, rice, purebred chicken meat, eggs, and curly red chili by one standard deviation will have an impact on increasing inflation in Banten Province.

Inflation Rates

Inflation rate refers to the general rate of increase in the prices of goods and services in a country's economy over a period of time, usually measured in percentage terms. The inflation

rate can be calculated by comparing the consumer price index (CPI) at two different time periods. A low and stable inflation is considered a sign of a healthy economy, while too high inflation can cause economic instability and harm consumers and businesses. Data from the Central Bureau of Statistics in Figure 1 shows that in the last five years, the national inflation rate has decreased since 2017 with inflation of 3.61% and in 2020 it was 1.68%.

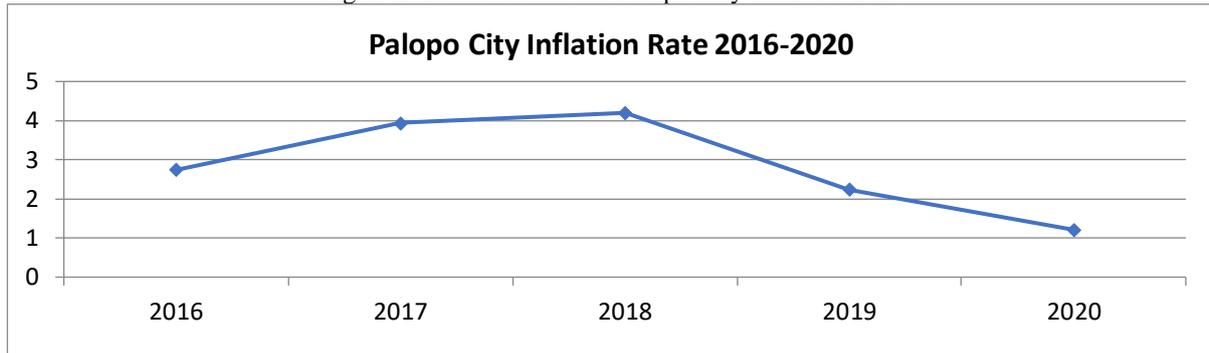


Source: Central Bureau of Statistics of Indonesia

According to the central inflation control team, the low Inflation in 2020 was supported by the relatively minimal pressure on global commodity prices and the limited further impact of Inflation on Volatile Foods and Administered Prices. In addition, the consistency of Bank Indonesia's monetary policy succeeded in anchoring inflation expectations on target and keeping the rupiah exchange rate in line with its fundamental value.

The development of Inflation in South Sulawesi Province is calculated from a combination of five cities, one of which is Palopo City. The inflation rate in Palopo City has never reached 10%, so that inflation in Palopo City is included in the low-moderate inflation category. Inflation in this category can encourage the economy of Palopo City to be better by increasing income and making people excited to work, save and invest. The following is the inflation rate of Palopo City from 2016 to 2020.

Figure 2. Inflation Rate for Palopo City for 2016-2020



Source: Central Statistics Agency for Palopo City

Based on Figure 2 above, it can be seen that the highest inflation rate for the last five years in Palopo City was in 2018 by 4.20%. Based on data from the Central Bureau of Statistics for the City of Palopo in 2018, Inflation in the foodstuffs group was the most significant contributor, at 8.80%. In 2020 Palopo City's Inflation of 1.21% is the lowest in the last five years.

According to CPI data, the spending category of processed food, beverages, and cigarettes is a commodity group that has a significant influence on Palopo City inflation. Food price fluctuations in Palopo City are always accompanied by changes in the CPI of the processed food, beverage, and cigarette expenditure group. Food price changes in Indonesia can be driven by uneven supply and demand values, crop failures owing to climate change, and disruption of distribution channels in various locations, according to (Dicky Zunifar Rizaldy, 2020).

Table 1. The Average Consumer-Level Food Prices in Palopo City Year 2018-2020

Commodity	Price (Rp/kg)		
	2018	2019	2020
Red onion	28.733	33.340	35.706
Garlic	27.899	32.607	30.826
Red chili pepper	33.870	37.282	31.983
Cayenne pepper	30.009	39.133	26.126
Chicken meat	28.882	26.320	25.888
Chicken eggs	23.925	25.807	24.938

Source: Food Security Service of Palopo City after processing

Table 1 showed the average consumer-level food prices in Palopo City in 2018-2020, where red onion is a food ingredient with a significant yearly price increase. While in January and December 2020, the increase in the price of cayenne pepper and chicken meat was the most significant contributor to Inflation. Referring to this explanation, the extent to which the effect

of Inflation, in this case, the CPI, has on food price fluctuations of the six commodities is an exciting matter to study.

MATERIAL AND METHODOLOGY

Data Collection

The method of data collection is the method of documentation. Documentation is one of the methods used to obtain data and information in the form of books, archives, documents, written numbers, and pictures in the form of reports and information that can support research. Documentation is used to collect data and then reviewed.

The documentation used in this study includes archived food price reports in Palopo City, food price reports for South Sulawesi Province, and consumer price statistics obtained from the Food Security Service for Palopo City, the National Strategic Food Price Information Center (PIHPS) and the Central Statistics Agency (BPS) of Palopo.

Data Analysis

To analyze the inflation response to food price fluctuations in Palopo City, the time series for January 2018 to December 2020 and the time series for the general CPI for Palopo City for January 2018 to December 2020, from now on analyzed using VAR (Vector Autoregressive) analysis. VAR analysis analyzes the relationship between the prices of foodstuffs that are the object of research, namely shallots, garlic, red chilies, bird's eye chilies, chicken meat, and chicken eggs, and the general Consumer Price Index (CPI) for Palopo City, with the equation below:

$$INF_t = a_0 + a_1 INF_{tp} + a_2 HBM_{tp} + a_3 FPV_{tp} + a_4 HCM_{tp} + a_5 HCR_{tp} + a_6 HDA_{tp} + a_7 HTA_{tp} + et_1 \dots \dots \dots (1)$$

$$HBM_t = b_0 + b_1 HBM_{tp} + b_2 INF_{tp} + b_3 FPV_{tp} + b_4 HCM_{tp} + b_5 HCR_{tp} + b_6 HDA_{tp} + b_7 HTA_{tp} + et_2 \dots \dots \dots (2)$$

$$FPV_t = c_0 + c_1 FPV_{tp} + c_2 INF_{tp} + c_3 HBM_{tp} + c_4 HCM_{tp} + c_5 HCR_{tp} + c_6 HDA_{tp} + c_7 HTA_{tp} + et_3 \dots \dots \dots (3)$$

$$HCM_t = d_0 + d_1 HCM_{tp} + d_2 INF_{tp} + d_3 HBM_{tp} + d_4 FPV_{tp} + d_5 HCR_{tp} + d_6 HDA_{tp} + d_7 HTA_{tp} + et_4 \dots \dots \dots (4)$$

$$HCR_t = e_0 + e_1 HCR_{tp} + e_2 INF_{tp} + e_3 HBM_{tp} + e_4 FPV_{tp} + e_5 HCM_{tp} + e_6 HDA_{tp} + e_7 HTA_{tp} + et_5 \dots \dots \dots (5)$$

$$HDA_t = f_0 + f_1 HDA_{tp} + f_2 INF_{tp} + f_3 HBM_{tp} + f_4 FPV_{tp} + f_5 HCM_{tp} + f_6 HCR_{tp} + f_7 HTA_{tp} + et_6 \dots \dots \dots (6)$$

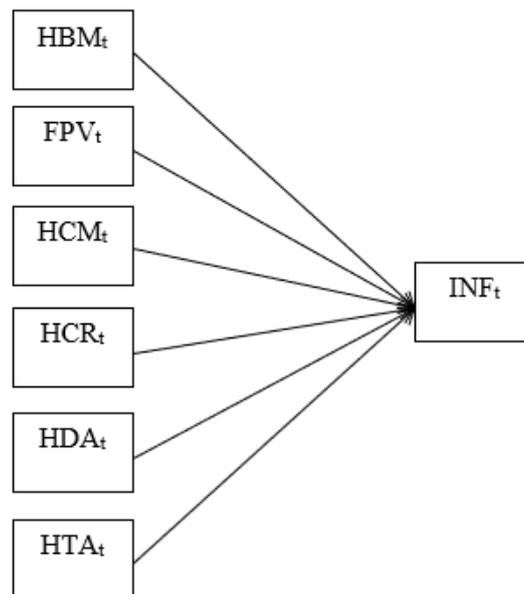
$$HTA_t = g_0 + g_1 HTA_{tp} + g_2 INF_{tp} + g_3 HBM_{tp} + g_4 FPV_{tp} + g_5 HCM_{tp} + g_6 HCR_{tp} + g_7 HDA_{tp} + et_7 \dots \dots \dots (7)$$

Where :

- INF_t = Inflation in the current year
- INF_{tp} = Inflation in the previous year
- HBM_t = The price of shallots in the current year
- HBM_{tp} = Price of shallots in the previous year
- FPV_t = Price of garlic in the current year
- FPV_{tp} = Price of garlic in the previous year
- HCM_t = Price of red chili in the current year
- HCM_{tp} = Price of red chili in the previous year
- HCR_t = Price of cayenne pepper in the current year
- HCR_{tp} = Price of cayenne pepper in the previous year
- HDA_t = Price of chicken meat in the current year
- HDA_{tp} = Price of chicken meat in the previous year
- HTA_t = Price of chicken eggs in the current year
- HTA_{tp} = Price of chicken eggs in the previous year
- $a_0 \dots g_7$ = Constant or intercept
- $a_1 \dots g_7$ = coefficient
- $et_1 \dots et_7$ = term error

The stages of the VAR analysis consist of the stationarity test, where each price variable will be tested through the Augmented Dickey-Fuller (ADF) test to determine whether it is stationary at the level or the first difference. Second, determining lag optimal Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). Third, the stability test uses the AR Roots Table to determine whether the VAR model is stable.

Figure 3. VAR Testing Model



Source: Prepared by the authors (2022)

Fourth, Johansen Cointegration Test (JCT) tests whether the variable is stable at the level. The presence or absence of cointegration is based on the likelihood ratio (LR) test. If cointegration exists in the model to be tested, the following analysis will use the Vector Error Correction Model (VECM). Fifth, the Vector Error Correction Model (VECM) estimation is carried out to determine the effect of each food price on Inflation (CPI) in Palopo City in the short and long term. Sixth, IRF (Impulse Response Function) analysis is conducted to determine the inflation response caused by its impact on Inflation itself and fluctuations in food prices which are the object of research. The analysis results are displayed in graphical form, describing how a variable will restore balance after being influenced by other variables.

RESULTS AND DISCUSSION

Testing the VAR Model

The effect of fluctuations in food prices on Inflation in Palopo City was analyzed using the Vector Autoregression (VAR) model. Based on research conducted by (Mohamed et al., 2023) that before estimating the VAR model, several steps must be carried out, including (1) a data stationarity test, (2) determining lag optimal, (3) a VAR model stability test, and (4) cointegration test.

The decision to determine whether the data is stationary is made by comparing the ADF statistical value with its critical value. Research conducted by (Karim & Ahmed, 2023) explained that the outcome of doing the ADF test at different levels and figuring out stationarity by taking the logarithm of the initial gap between the two series. The unit root structure of the data must be studied because each series utilized for analysis must be stationary in order to create a useful model.

The absolute value of the ADF statistic that is greater than the critical value indicates the observed data is stationary; conversely if the ADF statistic's absolute value is less than the critical value, the data is not stationary. The results of the ADF test (Table 2) show that of the seven variables tested, only six have an absolute ADF value more significant than the MacKinnon. Thus, at this level, there is one variable to be analyzed that is not stationary. So it is necessary to do the first differentiation process (first differencing). The results of the ADF test at the first difference show that the absolute value of ADF for all the variables analyzed is greater than the MacKinnon 5% level. Indicates that all variables are stationary at the first difference, and further testing can be carried out.

Table 2. Stationarity Test

Variable	Level		First Difference	
	Nilai ADF	Nilai Kritis MacKinnon 5%	Nilai ADF	Nilai Kritis MacKinnon 5%
IHK	-0.782818	-2.948404	-5.764100*	-2.951125
Red onion	-3.103416*	-2.948404	-6.425593*	-2.951125
Garlic	-3.193791*	-2.951125	-4.447376*	-2.951125
Red chili pepper	-4.768922*	-2.981038	-6.446949*	-2.951125
Cayenne pepper	-3.185274*	-2.967767	-6.690554*	-2.954021
Chicken meat	-3.087098*	-2.948404	-4.823982*	-2.957110
Chicken eggs	-3.665806*	-2.948404	-5.653770*	-2.954021

Description: * stationary at 5% level
 Source: Prepared by the authors (2022)

After carrying out the stationarity test, the next step is determining lag. According to Ng, S., & Perron, P. (2001) determining lag considers two things: a lag too long will waste degrees of freedom, while a lag too short will result in wrong model specifications. In this study, lag was determined to cover variable dynamics (Table 3) better.

Table 3. Results of Determination of Lag Optimal

Lag	LogL	LR	FPE	AIC	SC	HQ
0	12.07723	NA*	1.72e-09*	-0.317327	0.003303*	-0.211047*
1	46.00300	50.88865	4.75e-09	0.624813	3.189850	1.475050
2	96.32410	53.46617	7.07e-09	0.542244	5.351690	2.136439
3	181.3159	53.11985	3.78e-09	-1.707242*	5.346612	0.630911

Description: * lag Recommended optimally
 Source: Prepared by the authors (2022)

The next step is to test the stability of the VAR model by calculating the roots of the polynomial function, known as the roots of polynomial characteristics. If all the roots of the polynomial function are in the unit circle or if the absolute value is < 1 , then the VAR model is considered stable. Table 4 shows that all the roots of the polynomial function are inside the unit circle or absolute value < 1 so that the VAR model is considered stable. The stability of the VAR model makes IRF and FEVD considered valid. This test shows that the VAR model is stable at its optimal lag, namely lag 2nd.

Tabel 4. VAR Model Test Results

Root	Modulus
-0.517525 – 0.587909i	0.783243
-0.517525 + 0.587909i	0.783243
-0.216707 – 0.743618i	0.774552
-0.216707 + 0.743618i	0.774552
0.682891	0.682891
-0.003931 – 0.613830i	0.613843
-0.003931 + 0.613830i	0.613843
0.276447 – 0.521446i	0.590194
0.276447 + 0.521446i	0.590194
0.454915 – 0.369321i	0.585957

0.454915 + 0.369321i	0.585957
-0.489871 - 0.180718i	0.522142
-0.489871 + 0.180718i	0.522142
-0.059292	0.059292

Source: Prepared by the authors (2022)

After the VAR model is considered stable, determine whether variables are cointegrated in the long-run analysis. If these variables are not cointegrated, then the VAR estimation is carried out. If cointegrated equations are found, the estimation is continued with VECM. The method used in this cointegration test is the Johansen Cointegration Test (JCT). This method concludes that if the trace statistic exceeds the critical value, the equation is cointegrated (Table 5).

Table 5. *Johansen Cointegration Test*

<i>Hypothesized No. of CE(s)</i>	<i>Eigenvalue</i>	<i>Trace Statistic</i>	<i>0.05 Critical Value</i>	<i>Prob**</i>
None*	0.954815	232.2718	111.7805	0.0000
At most 1*	0.740709	133.1683	83.93712	0.0000
At most 2*	0.661445	89.97458	60.06141	0.0000
At most 3*	0.587603	55.31636	40.17493	0.0008
At most 4*	0.330858	26.97172	24.27596	0.0223
At most 5*	0.270896	14.11541	12.32090	0.0248
At most 6	0.117651	4.005379	4.129906	0.0538

Description: * *cointegrated at 5% level*

Source: Prepared by the authors (2022)

The cointegration test results using JCT at the 5% significance level six equations have a trace statistical value more significant than the critical value. The VAR model to be analyzed has six equations cointegrated in the long run. Johansen Cointegration test was also conducted in the study (Mohamed et al., 2023) which showed the existence of long-term equilibrium among the research variables. In the following analysis, the estimation is continued using the VECM (Vector Error Correction Model) model.

Analysis of Inflation Response to Food Price Volatility in Palopo City Through Vector Error Correction Model (VECM) and Impulse Response Function (IRF)

Inflation can affect food price volatility (A. R. Farandy, 2020; Woertz et al., 2014). When inflation occurs, the value of the currency decreases and the prices of goods and services increase. This can lead to higher food prices and may increase food price volatility. In the long term, high inflation can lead to a decline in investment and economic growth, which can reduce people's ability to buy food and lead to more serious food shortages. Another factor that triggers

inflation is the COVID-19 pandemic, which affects inflation through an increase in the price of goods and services, and a decrease in the production and supply of goods and services. This is in line with the findings of (Al-shakrchy et al., 2023) that there is a significant relationship between COVID-19 and inflation in MENA countries.

Table 6. Short-Term VECM Estimation Results

Variabel	Koefisien	T-statistik
CointEq1	-0.073976	[-1.30106]*
D(IHK(-1))	0.106688	[0.39314]
D(IHK(-2))	0.177305	[0.67266]
D(LN_HBM(-1))	-14.51850	[-1.27495]*
D(LN_HBM(-2))	-4.675924	[-0.55453]
D(LN_FPV(-1))	2.365943	[0.12520]
D(LN_FPV(-2))	29.91692	[1.47788]**
D(LN_HCM(-1))	11.09084	[1.01809]*
D(LN_HCM(-2))	8.988592	[0.96994]*
D(LN_HCR(-1))	6.009840	[0.83751]*
D(LN_HCR(-2))	-5.544082	[0.54389]
D(LN_HDA(-1))	-20.60500	[-1.15083]*
D(LN_HDA(-2))	-33.99260	[-1.79794]***
D(LN_HTA(-1))	-7.896580	[-0.39068]
D(LN_HTA(-2))	3.750201	[0.19494]
T-tabel (n = 36; $\alpha = 0.25$) = 0.681		
(n = 36; $\alpha = 0.1$) = 1.305		
(n = 36; $\alpha = 0.05$) = 1.688		

Description: *, **, *** significant at the level of 25%, 10%, 5%

Source: Prepared by the authors (2022)

The VECM model produces two outputs: the long-term balance relationship between variables and the speed at which these variables move toward their long-term balance. According to (Juanda & Junaidi, 2012) the VECM specification limits the long-term behavioral relationship between existing variables, becomes a determinant in cointegrating relationships, and allows short-term dynamic changes. This cointegration term is called error correction because if there is a deviation from the long-term balance, it will be corrected gradually through short-term partial adjustments.

The VECM estimation results (Table 6.) show the effect of food prices on the CPI of Palopo City in the short term, where there is an adjustment mechanism from the short term to the long term indicated by the parameter's significant cointegration error (CointEq1) an error correction model is valid and stable if the parameter values are negative with an absolute value of less than one and significant. The meaning of cointegration is an adjustment from the short term to the long term in the Palopo City CPI, which is corrected every month by 0.073%.

In the short term, there are seven out of fourteen variables that are significant or have a $|T\text{-statistic}|$ value $>$ T-table. The least number of significant variables in the short term occurs

because one variable reacts to another variable takes time (lag). The short-term estimation results (Table 6) show a variable that has a positive coefficient sign meaning that any increase in food commodity prices will cause an increase in the CPI of Palopo City in the short term. Based on the seven significant variables at the three confidence levels, four variables have a positive coefficient sign: the price of garlic on the lag second. The first and second lags, and the price of cayenne pepper on the first lag

The VECM estimation results show that there is a short-term relationship between the prices of shallots, red chilies, bird's eye chilies, and chicken meat in lag the 1st

1. If the price of shallots and chicken meat increased in the previous year by 1 rupiah, it would decrease the CPI by 14.52 and 20.60 rupiahs. Respectively to increase in the price of shallots and chicken meat tended to encourage consumers to delay buying and look for alternative commodity replacements.
2. If there were an increase in the price of red chili and cayenne pepper the previous year by 1 rupiah, it would increase the CPI by 11.09 and 6.00 rupiah, respectively, because consumers would still consume red chili and cayenne pepper even though the price increased. After all, these two commodities are the food industry's primary raw materials.

Furthermore, there is a short-term relationship between the prices of garlic, red chili, and the lag 2nd

1. If there were an increase in the price of garlic and red chili in the previous two years by 1 rupiah, it would increase the CPI by 29.61 and 8.99 rupiahs, respectively, because the increase in the price of garlic and red chili was not able to prevent consumers from continuing to buy them. After all, these two commodities become the primary raw material for various food processing industries.
2. If there were an increase in the price of chicken meat in the previous two years by 1 rupiah, it would decrease the CPI by 33.99 rupiahs. Consumers tend to reduce their consumption of chicken meat when prices increase and look for food substitutes for chicken meat at relatively low prices. A different thing is shown in the results of (Setiawan & Adi Hadiano, 2019) in Banten Province, where the price of chicken meat does not significantly affect the CPI of Banten Province due to the increased demand for chicken meat during the month of Ramadan and holidays in Banten Province.

Table 7. Long-Term VECM Estimation Results

Variabel	Koefisien	T-statistik
LN_HBM (-1)	-311.3551	[-10.6868]***
LN_FPV (-1)	365.1847	[9.58556]***
LN_HCM (-1)	18.50611	[1.10803]*
LN_HCR (-1)	-193.9211	[-11.5452]***
LN_HDA (-1)	-222.2517	[-12.4737]***
LN_HTA (-1)	337.4502	[11.7920]***
T-tabel (n = 36; $\alpha = 0.25$) = 0.681		
(n = 36; $\alpha = 0.1$) = 1.305		
(n = 36; $\alpha = 0.05$) = 1.688		

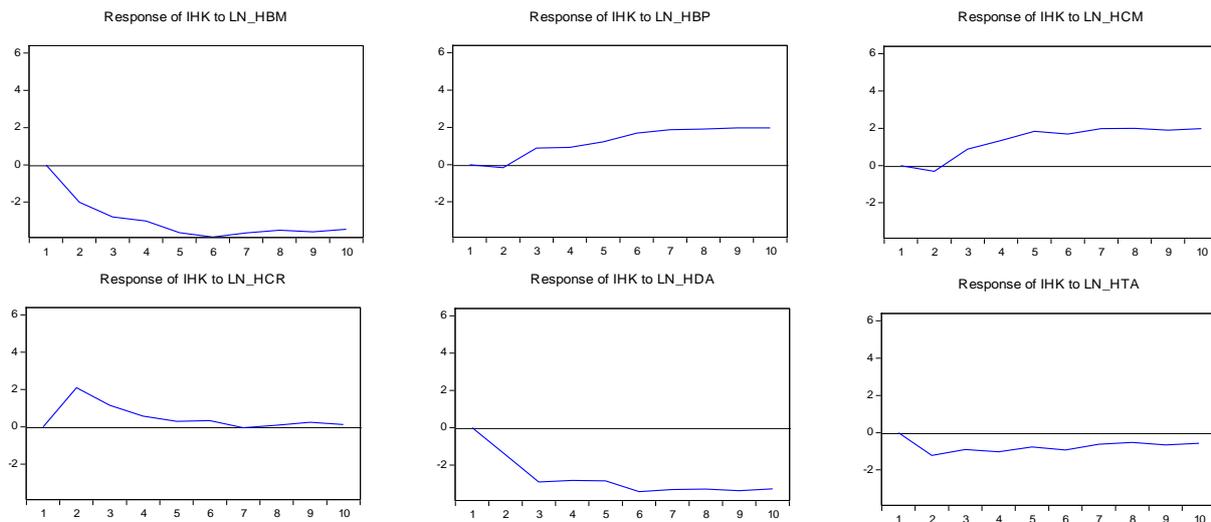
Description: *, **, *** significant at the level of 25%, 10%, 5%

Source: Prepared by the authors (2022)

The long-term VECM estimation results (Table 7) show that all variables have a $|T\text{-statistic}|$ value $>$ T-table with a significance level of 25%, 10%, and 5%, with the following description; at the 5% confidence level, there is a long-term relationship between the prices of shallots, garlic, cayenne pepper, chicken meat, and chicken eggs on the CPI of Palopo City, which means;

1. If there were an increase in the prices of shallots, bird's eye chilies, and chicken meat the previous year by 1 rupiah, this would decrease the CPI by 311.35, 193.92, and 222.25 rupiahs, respectively. The increase in the prices of these three commodities has prompted consumers to delay buying them and replace them with other foods. So wait for a decline in the price of these three commodities in the long run.
2. Conversely, if there were an increase in the price of garlic, red chili, and chicken eggs one year earlier by 1 rupiah, then the CPI would increase by 365.18 rupiahs, 18.51, and 337.45 rupiahs, respectively. The increased prices of garlic, red chili, and chicken eggs did not affect purchasing power because these three commodities are the primary raw materials in various food processing industries. The results of research conducted by (Setiawan & Adi Hadiano, 2019) show that the price of chicken meat and chicken eggs is significant at the 5% level for the long term.

Figure 4. Results of *Impulse Response Functions*
 Response to CholeskyOne S.D. (d.f. adjusted) Innovations



Source: Prepared by the authors (2022)

Analysis The results of the IRF analysis (Figure 4) show the long-term response of CPI to food commodity price shocks in standard deviations, where on the vertical axis, the response of the Palopo City CPI to food price shocks is shown. The horizontal axis shows the period (month) with the following results: The CPI response to the price of shallots and chicken meat shows a negative number until the 10th period, which means that shocks to the price of shallots and chicken meat will have a negative response in terms of its effect on the CPI.

Meanwhile, the CPI's response to garlic and red chili prices showed negative numbers in the second period. However, it moved positively until the 10th period, which means that the prices of garlic and red chilies will respond positively to their influence on the CPI. Finally, the response of the CPI to the prices of cayenne pepper and chicken eggs shows a positive number until the 10th period. It is close to the equilibrium point, which means that shocks to the prices of cayenne pepper and chicken eggs will not permanently impact the CPI. So it will not affect the stability of the CPI.

CONCLUSIONS

Based on the results of the research that has been done, the following conclusions are obtained (1) The results of the VECM estimation show that if there were an increase in the price of shallots and chicken meat in the previous year by 1 rupiah, it would decrease the CPI by 14.52 and 20.60 rupiahs. If there was an increase in the price of red chili and cayenne pepper in the previous year by 1 rupiah, then it will increase the CPI by 11.09 and 6.00 rupiah, respectively. Furthermore, if there were an increase in the price of garlic and red chili in the

previous two years by 1 rupiah, it would increase the CPI by 29.61 and 8.99 rupiahs, respectively, in the food processing industry, and if there were an increase in the price of chicken meat in the previous two years by 1 rupiah, it would lower the CPI by 33.99 rupiah; (2) An increase in the prices of shallots, cayenne pepper, and chicken meat in the previous year by 1 rupiah would lower the CPI by 311.35, respectively, 193.92 and 222.25 rupiahs. Conversely, if there were an increase in the price of garlic, red chili, and chicken eggs one year earlier by 1 rupiah, it would increase the CPI by 365.18 respectively, 18.51, and 337.45 rupiahs; and (3) The inflation response to food price fluctuations in Palopo City resulted in three conditions. The Palopo City CPI responded positively to the price fluctuations of garlic and red chili. In contrast, shallots and chicken meat price fluctuations responded negatively to the Palopo City CPI. The Palopo City CPI did not permanently affect the price fluctuations of cayenne pepper and chicken eggs. For future research, it is recommended to add other types of commodities that are considered to have an effect on inflation to see a more comprehensive relationship between inflation and the consumption price index, especially agricultural commodities.

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