The influence of food price fluctuation on inflation in Padang Sidempuan City, North Sumatera Province

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Abstract. One contributor to inflation in North Sumatra is food, therefore we need to discuss this topic in North Sumatra Province. This study analyses how the development of the price of food commodities (rice, red chili, cooking oil, broiler chicken eggs, purebred eggs, and corn) in Padang Sidempuan City. The purpose of this study is to identify the effect of fluctuations in the price of food commodities (rice, red chili, cooking oil, broiler chicken, broiler eggs and corn) on inflation in Padang Sidempuan City by using the VAR (Vector Autoregression) method. VAR analysis was conducted to analyse the effect of fluctuations in food commodity prices on inflation in Padang Sidempuan City. In the short term there are only two that are significant at a 5% confidence interval namely D (INF (t-1), D (INF (t-2)), whereas in the long run, there are four of the six significant variables namely D (BRS (t-1), D (MKG (t-1), D (DGA (t-1), D (TAR (t-1), D (JGG (t-1)) These variables are said to have a significant effect on inflation in Padang Sidempuan City because of its absolute value The t-statistic variable is greater than the t-table (1.67065).

1. Introduction
Changes in food commodity prices can be the biggest contributor to the inflation rate because, with a large enough population, the demand for food will be quite high. But sometimes the supply is not enough to meet the demand, so that eventually push the inflation rate [1].

| No. | Expenditures Group                                      | Annual Inflation (%) |
|-----|----------------------------------------------------------|----------------------|
|     |                                                          | 2013  | 2014  | 2015  | 2016  | 2017  |
| 1   | General                                                  | 7.82  | 7.38  | 1.66  | 4.28  | 3.82  |
| 2   | Food material                                            | 10.81 | 8.67  | 0.23  | 8.84  | 2.15  |
| 3   | Prepared Food, Beverages, Cigarettes & Tobacco           | 6.07  | 7.19  | 5.80  | 6.39  | 3.20  |
| 4   | Housing                                                  | 6.32  | 7.23  | 3.14  | 1.48  | 6.97  |
| 5   | Clothing                                                 | 1.85  | 2.52  | 4.62  | 2.90  | 4.59  |
| 6   | Health                                                   | 2.92  | 4.10  | 3.55  | 2.17  | 3.28  |
| 7   | Education, Recreation and Sports                         | 5.71  | 1.43  | 4.19  | 2.19  | -0.29 |
| 8   | Transport, Recreation and Financial Services             | 14.88 | 12.06 | -4.60 | 0.57  | 4.64  |

Source: North Sumatra Central Statistics Agency (BPS), 2017 [2]
2. Data collection methods and data analysis

2.1. Data collection methods
This study uses monthly time series data from January 2013 to December 2017. The data used are secondary in the form of monthly food price developments at the consumer level which is the average price at the Padang Sidempuan City level, the data was obtained from the Centre for Strategic Food Price Information (PIHPS).

2.2. Vector autoregression (VAR)
The method used is vector autoregression (VAR). VAR analysis was conducted to analyse the effect of fluctuations in food commodity prices on inflation in Padang Sidempuan City. Commodities to be analysed are rice, red chili, cooking oil, chicken meat, eggs and corn with the Consumer Price Index (CPI) of Padang Sidempuan City.

The specification of the VAR equation model with the order k. In this study, each variable uses natural logarithms to facilitate calculations.

\[
\begin{align*}
\ln\text{IH}K_t &= A_1 + A_2\ln\text{IH}K_t + A_3\ln\text{BRS}_t + A_4\ln\text{CAM}_t + A_5\ln\text{MKG}_t + A_6\ln\text{DGA}_t + A_7\ln\text{TAR}_t + A_8\ln\text{GG}_t + \epsilon_t \\
\ln\text{BRS}_t &= B_1 + B_2\ln\text{BRS}_t + B_3\ln\text{IH}K_t + B_4\ln\text{CAM}_t + B_5\ln\text{MKG}_t + B_6\ln\text{DGA}_t + B_7\ln\text{TAR}_t + B_8\ln\text{GG}_t + \epsilon_t \\
\ln\text{CAM}_t &= C_1 + C_2\ln\text{CAM}_t + C_3\ln\text{IH}K_t + C_4\ln\text{BRS}_t + C_5\ln\text{MKG}_t + C_6\ln\text{DGA}_t + C_7\ln\text{TAR}_t + C_8\ln\text{GG}_t + \epsilon_t \\
\ln\text{MKG}_t &= D_1 + D_2\ln\text{MKG}_t + D_3\ln\text{IH}K_t + D_4\ln\text{BRS}_t + D_5\ln\text{CAM}_t + D_6\ln\text{DGA}_t + D_7\ln\text{TAR}_t + D_8\ln\text{GG}_t + \epsilon_t \\
\ln\text{DGA}_t &= E_1 + E_2\ln\text{DGA}_t + E_3\ln\text{IH}K_t + E_4\ln\text{BRS}_t + E_5\ln\text{CAM}_t + E_6\ln\text{MKG}_t + E_7\ln\text{TAR}_t + E_8\ln\text{GG}_t + \epsilon_t \\
\ln\text{TAR}_t &= F_1 + F_2\ln\text{TAR}_t + F_3\ln\text{IH}K_t + F_4\ln\text{BRS}_t + F_5\ln\text{CAM}_t + F_6\ln\text{MKG}_t + F_7\ln\text{TAR}_t + F_8\ln\text{GG}_t + \epsilon_t \\
\ln\text{GG}_t &= G_1 + G_2\ln\text{GG}_t + G_3\ln\text{IH}K_t + G_4\ln\text{BRS}_t + G_5\ln\text{CAM}_t + G_6\ln\text{MKG}_t + G_7\ln\text{DGA}_t + G_8\ln\text{TAR}_t + \epsilon_t
\end{align*}
\]

Where:
\[
\begin{align*}
\ln\text{IH}K_t &= \text{Consumer Price Index at time } t \\
\ln\text{BRS}_t &= \text{Price of rice at time } t \\
\ln\text{CAM}_t &= \text{Price of red chili at time } t \\
\ln\text{MKG}_t &= \text{Price of cooking oil at time } t \\
\ln\text{DGA}_t &= \text{Price of chicken meat at time } t \\
\ln\text{TAR}_t &= \text{Price of eggs at time } t \\
\ln\text{GG}_t &= \text{Corn price at time } t \\
A1-A8; B1-B8; C1-C8; D1-D8; E1-E8; F1-F8 &= \text{Estimated parameter} \\
\epsilon_t &= \text{Error term}
\end{align*}
\]

3. Results and discussion
This study uses a vector autoregression (VAR) or vector error correction model (VECM) to analyse the effect of fluctuations in food commodity prices on inflation in the city of Padang Sidempuan. The stages in conducting VAR analysis, namely: 1. Data stationarity test, 2. Determination of optimal lag, 3. VAR model stability test, 4. Cointegration test. Then VECM estimation is performed to carry out IRF and FEVD analysis.
3.1. Data stationarity test

Through testing the degree of integration at the level, it appears that all the data is stationary. In all of these research variables the ADF statistic > MacKinnon critical value or probability value < 0.05. Then all variables are stationary at the same level, namely at the level.

| Variable | ADF Statistic | MacKinnon critical value | Interpretation |
|----------|---------------|--------------------------|----------------|
| Ln(INF)  | -7.247941     | -3.546099 -2.911730 -2.593551 | 0.0000 Stationary |
| Ln(BRS)  | -11.61781     | -3.546099 -2.911730 -2.593551 | 0.0000 Stationary |
| Ln(CAM)  | -7.973528     | -3.546099 -2.911730 -2.593551 | 0.0000 Stationary |
| Ln(MKG)  | -8.052948     | -3.548208 -2.912631 -2.594027 | 0.0000 Stationary |
| Ln(DGA)  | -11.46828     | -3.546099 -2.911730 -2.593551 | 0.0000 Stationary |
| Ln(TAR)  | -10.40699     | -3.546099 2.911730 -2.593551 | 0.0000 Stationary |
| Ln(JGG)  | -11.28588     | -3.546099 2.911730 -2.593551 | 0.0000 Stationary |

3.2. Determination of optimal lag

Determination of the optimal lag is based on the value of Likelihood Ratio (LR), Akaike Information Criteria (AIC), Final Prediction Error (FPE), Hannan-Quinn Information Criteria (HQ) and Schwarz Information Criteria (SC). In this study, based on the results of the optimal lag calculation suggested by all criteria is the 5th lag, so the optimal lag chosen is the 5th lag.

| Lag | LogL   | LR     | FPE    | AIC    | SC     | HQ     |
|-----|--------|--------|--------|--------|--------|--------|
| 0   | -1417.165 | NA     | 1.91e+14 | 52.74683 | 53.00467 | 52.84627 |
| 1   | -1318.186 | 168.6306 | 3.04e+13 | 50.89577 | 52.95842* | 51.69125 |
| 2   | -1255.547 | 90.47779 | 2.01e+13 | 50.39064 | 54.25811 | 51.88217 |
| 3   | -1211.610 | 52.07381 | 3.10e+13 | 50.57815 | 56.25043 | 52.76573 |
| 4   | -1140.652 | 65.70213 | 2.33e+13 | 49.76488 | 57.24198 | 52.64850 |
| 5   | -1001.054 | 93.06504* | 2.33e+12* | 46.40941* | 55.69134 | 49.98909* |

Note: * Recommended optimal lag
LR: sequential modified LR test statistics (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

3.3. VAR Model stability test

Pre-determined optimal lag and then tested for stability. VAR stability testing is done by testing the roots of polynomial functions or the roots of polynomial characteristics. VAR estimates are stable if all of its roots have a modulus of <1 and are in a unit circle. The stability of the VAR model will result in the estimation of The Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) being considered valid. Table 4 shows the results of the stability testing of the VAR model.
Table 4. VAR model stability test results

| Root | Modulus |
|------|---------|
| -0.317234 - 0.763400i | 0.826690 |
| -0.317234 + 0.763400i | 0.826690 |
| -0.584435 - 0.503925i | 0.771690 |
| -0.584435 + 0.503925i | 0.771690 |
| -0.441761 - 0.538964i | 0.696875 |
| -0.441761 + 0.538964i | 0.696875 |
| -0.237648 - 0.593957i | 0.639735 |
| -0.237648 + 0.593957i | 0.639735 |
| -0.479133 - 0.372795i | 0.607079 |
| -0.479133 + 0.372795i | 0.607079 |
| -0.505220 - 0.240505i | 0.559545 |
| -0.505220 + 0.240505i | 0.559545 |
| -0.041883 - 0.550959i | 0.552549 |
| -0.041883 + 0.550959i | 0.552549 |

3.4. Cointegration test
Cointegration test is done to find out whether the variables that are not stationary cointegrate or not. Cointegration test results to determine the existence of long-term relationship information between variables. If there is integration in the model being tested, then the next analysis uses VECM. However, if there is no cointegration, the analysis is continued using VAR [3]. The criteria used in the cointegration test is the Johansen Cointegration Test. A model is stated to have cointegration if the trace statistic value is greater than the critical value.

Table 5. Johansen Test results

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | Critical Value | Prob.** |
|---------------------------|------------|-----------------|----------------|---------|
| At most 1 *               | 0.666796   | 284.3230        | 95.75366       | 0.0000  |
| At most 2 *               | 0.647594   | 222.7791        | 69.81889       | 0.0000  |
| At most 3 *               | 0.591837   | 164.3727        | 47.85613       | 0.0000  |
| At most 4 *               | 0.565951   | 114.1917        | 29.79707       | 0.0000  |
| At most 5 *               | 0.497328   | 67.4542         | 15.49471       | 0.0000  |
| At most 6 *               | 0.403528   | 28.9365         | 3.84147        | 0.0000  |

3.5. Estimated vector correction model (VECM)
Based on Table 6 in the short run there are only two that are significant at a 5% confidence interval namely D (INF (-1)), D (INF (-2)), whereas in the long run, there are four of the six significant variables namely D (BRS (-1)), D (MKG (-1)), D (DGA (-1)), D (TAR (-1)), D (JGG (-1)). These variables are said to have a significant effect on inflation in Padang City Sidempuan because the absolute value of the t-statistic variable is greater than the t-table (1.67065).

Table 6. VECM estimation results

| Variable   | Coefficient | T-Statistical | T-Table (5%) | Information |
|------------|-------------|---------------|--------------|-------------|
| CointEq1   | 0.037677    | [ 1.03899]    | 1.67065      | Not significant |
| D(INF(-1)) | -0.812913   | [-5.39047]    | 1.67065      | Significant  |
| D(INF(-2)) | -0.466132   | [-3.36455]    | 1.67065      | Significant  |
| D(BRS(-1)) | 0.039406    | [ 1.06985]    | 1.67065      | Not significant |
**3.6. Impulse response function analysis (IRF)**

Impulse Response Function (IRF) is used to see the effect of the shock of a standard deviation of a new variable on the current time values and future values of the observed model. In this study, the results of the IRF test will be displayed in the form of a Table that is explained within the next 60 months of the study period. Then it will be seen in three periods namely short term (12 months beginning), medium-term (13th to 36th months) and long term (37th to 60th months).

**Table 7. Analysis of impulse response function (IRF) results**

| No | INF  | BRS  | CAM  | NKG  | DGA  | TAR  | JAG  |
|----|------|------|------|------|------|------|------|
| 1  | 1.422880 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 12 | 0.637288 | -0.016109 | 0.034051 | -0.005964 | 0.043288 | 0.002309 | 0.083081 |
| 13 | 0.661050 | -0.025798 | -0.031616 | 0.058345 | -0.018728 | 0.099043 | 0.086842 |
| 36 | 0.664594 | -0.027770 | 0.024809 | 0.017801 | 0.013774 | 0.049784 | 0.081745 |
| 37 | 0.663413 | -0.027949 | 0.022985 | 0.017587 | 0.014146 | 0.048727 | 0.082559 |
| 60 | 0.663592 | -0.027811 | 0.023155 | 0.018189 | 0.013389 | 0.049702 | 0.082247 |

In the short term, the INF shock will be responded to by the INF itself up to 0.637288. IRF results that provide a large response to inflation (INF) is the difference in chicken meat (DGA). Every time a standard deviation occurs, the shock of chicken meat will be responded to by inflation to rise 0.043288. In the medium-term, every INV standard shock occurs, the INF will be responded to by the CPI itself up to 0.664594. IRF results that provide a great response to inflation (INF) are chicken meat (DGA). Every time a standard deviation occurs, the shock of chicken meat will be responded to by inflation to rise 0.049784. In the long run, every time a standard deviation occurs, the INF shock will be responded to by the CPI itself up to 0.663592. IRF results that provide a large response to inflation (INF), namely chicken meat (DGA) Every time a standard deviation occurs, the shock of red chilies will be responded to by inflation to rise 0.049702.

**3.7. Forecast error variance decomposition (FEVD) analysis**

Forecast Error Variance Decomposition (FEVD) analysis is used to determine the contribution of price shocks to each food commodity studied in explaining the diversity of inflation in Padang Sidempuan.
City in the next 60 periods. In addition, in the FEVD analysis it can be seen which food commodity is the most dominant in influencing inflation in the City of Padang Sidempuan.

Figure 1. Forecast Error Variance Decomposition (FEVD) Results

Based on the results of the FEVD analysis shows that in the first period, the diversity of inflation in Padang Sidempuan City was caused by the shock itself, which was 100%. Furthermore, in the second period other variables began to influence inflation diversity explained by 95.96082 by inflation itself, then began to be explained by rice by 0.142271, red chili by 0.480679, cooking oil by 0.121173, chicken by 0.779167, chicken eggs by 2.118618 and corn by 2.118618 0.397276. At the end of the 60th period the contribution of inflation in the City of Padang Sidempuan in explaining the diversity of inflation decreased by 95.89772, and the results of the analysis, the commodity of rice, red chili, cooking oil, chicken meat, broiler eggs, corn explained the inflation variability of Padang Sidempuan City which tends decreased. And the most dominant commodity affecting inflation in the future is chicken eggs.

4. Conclusions
Based on the results of the research that has been done, the following conclusions are obtained in the short term, there are only two that are significant at a 5% confidence interval. Whereas in the long run, there are four of the six significant variables. The variable is said to have a significant effect on inflation in Padang Sidempuan City because the absolute value of the t-statistic variable is greater than the t-table (1.67065).

In the short term, the INF shock will be responded to by the INF itself up to 0.637288. IRF results that provide a large response to inflation (INF) is the difference in chicken meat (DGA). Every time a standard deviation occurs, the shock of chicken meat will be responded to by inflation to rise 0.043288. In the medium-term, every time a standard deviation occurs, the INF shock will be responded by the INF itself up to 0.664594. IRF results that provide a great response to inflation (INF) are chicken meat (DGA). Every time a standard deviation occurs, the shock of chicken meat will be responded to by inflation until it rises 0.049784. In the long run, every time a standard deviation occurs, the INF shock will be responded to by the CPI itself up to 0.663592. IRF results that provide a large response to inflation (INF), namely chicken meat (DGA) Every time a standard deviation occurs, the shock of red chilies will be responded to by inflation to rise 0.049702.

Based on the results of the FEVD analysis shows that the price of food commodities that have contributed to explaining the diversity of inflation in the city of Padang Sidempuan from the greatest influence to the lowest, namely chicken eggs, corn, red chili, cooking oil, chicken meat and rice.

References
[1] Firdaus M 2009 Manajemen agribisnis [Agribusiness management] (Jakarta: Bumi Aksara)
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