DIESEL PRICES AND FOOD INFLATION ON NON-FOOD INFLATION RATE: A VECTOR AUTOREGRESSIVE ANALYSIS

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Abstract

With the recent enactment of the tax reform for acceleration and inclusion law or TRAIN law, an expansion on value-added tax and an increase in excise tax of sweetened beverages, petroleum products, and automobiles has been implemented. Specifically, increases in diesel prices and food items are having a large impact on the people. Thus, this study aims to explore how diesel prices and food inflation will affect prices of non-food items to provide foundation for future policies and deliver auxiliary information for studying effects of the TRAIN law in the Philippines. Using monthly data and the vector autoregressive (VAR) model, results show that a one-time shock to diesel prices will have a significant contemporaneous effect on non-food inflation. The lasting effect between the two variables indicates that an increase in diesel prices can lead to increase in non-food inflation that is found to last up to the succeeding month. Findings also indicate that a one-time increase in food inflation rate will have significant effects on non-food inflation rate contemporaneously, plus a lingering effect for the two following months. Aside from these effects, the shock on food inflation also has an effect on the eleventh until the fourteenth succeeding months which is found to be a negative effect, indicating that an increase in food inflation can lead to a decrease in non-food inflation in the said months. Lastly, results also show that shocks to diesel price and food inflation explain about 23 percent of the future forecast error variance of non-food inflation rate, making the two variables important determinants of non-food inflation rate.

Keywords: *diesel, food inflation, non-food inflation, vector autoregressive*

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1 Introduction

The tax reform for acceleration and inclusion law or TRAIN law is the comprehensive tax reform program's first component as envisioned by the current administration of President Rodrigo Duterte. This package includes: a) lowering the personal income tax; b) simplifying estate and donor's tax; c) expanding value-added tax base; d) increasing excise tax of petroleum products and automobiles; and, e) adding excise tax on sweetened beverages. Its goal is to provide a simpler and more efficient way of tax collection, wherein the rich will be required to pay bigger taxes to the government, for the poor to benefit more from their programs and services (Department of Finance, 2018).

However, contrary to the government's expectation for this law to be for the benefit of the people, especially the poor, Mapa (2018) reported that the inflation experienced by the poorest 30% of the population, both upon and after implementation of the first wave of TRAIN law, is higher than the headline inflation. He noted that much of these inflations can be attributed to the increase in price of diesel. As per Bobai (2012), an increase in the prices of petroleum products may result to inflation, high cost of living, and unequal distribution of income. A study by Xuan and Chin (2015) on oil price changes showed that there is an existing long run relationship between oil price change and price indices, e.g. aggregate consumer price index, non-food and beverage price index and energy price index. They also found that the short run relationship for the impacts of oil prices on inflation is significant in all sectors of goods.

The study by Mapa (2018) focused on the effects of changes in diesel price on prices of food items, specifically on the price of rice. From there, the effects of shocks on food inflation to non-food inflation will be looked at. The direct effects of changes in diesel price to non-food inflation will be considered as well. For this study, the focus is on how these two variables (i.e. diesel price and food inflation) will affect prices of non-food items. The non-food items considered in this study include: clothing and footwear; housing needs, such as water, electricity, gas and other fuels; household equipment and maintenance; health needs; transport; communication; research and culture; education; and, miscellaneous goods and services. Many of these non-food items are common, if not basic, needs of every individual, poor and non-poor, which is why it is still of interest. The inflation measure from these will be that of all households.

The researchers wish to provide auxiliary information for studies concerning effects of changes in price of diesel and for studying effects of the TRAIN law in the Philippines. Also, the researchers aim to establish a foundation for future policies that will take into account the status of inflation.

1.1 Diesel Price

Diesel is a petroleum product that is a widely used fuel for automobiles and other vehicles. It is generally preferred over gasoline because of its pricing advantage brought about by the fewer steps it undergoes in the refining process (Encyclopedia Britannica, Inc., 2018). On the basis of taxation, efficient pricing of petroleum products are analyzed in relation to prevalent international prices, which are assumed to be competitively determined, and thus efficient (Anand, 2012).

In the Philippines, majority of the petroleum products for consumption came from imports (Alleman, 2009). The country uses diesel mainly for transportation and in industry (Sathaye & Meyers, 1986). Since the efficient pricing of goods in a domestic economy is influenced by the exchange rate of the domestic currency (Anand, 2012), it is known that changes in diesel prices in the country are highly relative to international prices.

Before, the government have had efforts to reduce the dependence of the country to oil supply from the world market through fuel substitution and energy conservation (Sathaye & Meyers, 1986). Sathaye and Meyers (1986) noted that one of the government's strategies was to reduce cost from use of gasoline for transportation by shifting to diesel and implementing price policies (e.g. selling it at a price far lower than the price of gasoline) supplemented by mandatory regulations. However, they further noted that the government's decision on the pricing of diesel worsened the ability of the refining industry of the country to meet the demand of the product, so the government was pushed to the option of removing the differential in pricing.

The aforementioned shows the control of the government on the pricing of diesel— that, apart from the consideration of international prices, price policies by the government also has something to do with the price of the product in the market. Recently, the current administration implemented the TRAIN law, and part of the first package of TRAIN is the increasing of excise tax on petroleum products (Department of Finance, 2018). As per the Bureau of Internal Revenue (2018) and Mapa (2018), the proposed additional excise tax on some petroleum products is shown in Table 1.

Table 1. Proposed Additional Excise Tax on Petroleum Products

Product Type	Existing Tax Rate	Tax Rate per Liter		
	2017	January 2018	January 2019	January 2020
Diesel Fuel	0.00	Php 2.50	Php 4.50	Php 6.00
Kerosene	0.00	Php 3.00	Php 5.00	Php 6.00
Auto LPG	0.00	Php 2.50	Php 4.50	Php 6.00

The values are without consideration of the value-added tax.
Source: Bureau of Internal Revenue

Since diesel is a widely-used product in the country, changes in its pricing would significantly affect the people (Mapa, 2018). According to Sobrevinas (2009), the effects of increased fuel prices can be categorized into two: a) direct effect of the increased prices of petroleum products consumed by the household; and, b) indirect effect on prices of other goods and services (i.e. goods and services that uses petroleum products as intermediate input) consumed by the households. This is the reason why, as aforementioned, increases in prices of petroleum products also result to high cost of living (Bobai, 2012). Moreover, looking at a macroeconomic point of view, according to James and the Economics and Research Department Asian Development Bank (2008), increases in food and energy prices can lead to: a) higher domestic prices of goods; b) downsized private consumption; c) higher interest rates, which could lead to a decrease in fixed investments; d) a significant decline in the gross domestic product because of the decrease in the demand of consumption and investment. In general, it is expected to positively affect price indices used as inflation measures as, per Tang, Wu, and Zhang (2010), oil price shocks positively affect inflation rates.

1.2 Inflation

Inflation refers to the rate of upward change of prices of goods and services in the market. It is believed that moderate and stable inflation rates elevates the process of development of countries and leads to economic growth (Ahmed & Mortaza, 2010). Accurately measuring inflation is essential in almost all economic issue and is endemic in every field of economics (Boskin et al., 1998).

1.3 Consumer Price Index

A popular aggregate price index used to measure inflation is the consumer price index (CPI) (Bryan & Cecchetti, 1993). According to Boskin et al. (1998), CPI is an index that focuses on people's expenditures on goods and services out of their disposable income. They noted that it does not include non-market activity, broader issues on quality of life, costs and benefits of government programs, and "finance future consumption" (i.e. savings).

If the percentage change in the CPI, i.e. the inflation measured, is around 3 percent, the true change in the cost of living is about 2 percent (Boskin et al., 1998). Although CPI is a common measure related to both inflation and cost of living, Boskin et al. (1998) noted that, albeit improvements in the index, the change in CPI has been overstating the actual rate of inflation, and it is likely to overstate forecasts of the change in the cost of living as well. This bias of the index may be due to: a) its failure to account for substitutions that occur when consumers shift from a good that has become more expensive to one that is relatively less expensive; b) its obliviousness to introduction of new goods; c) its lack of mindfulness on quality changes in existing goods; and, d) its ignoring of the drift in shopping patterns towards lower-priced stores (Hausman, 2003). There is also a bias between the trend of price indices and inflation, and the existence of these biases implies that any price index with fixed weights will be an "imperfect long-run target for a policy aimed at aggregate price stability" (Bryan & Cecchetti, 1993). With its bias known, CPI remains to be a popular measure of inflation but viewed using different approaches to address its biases.

It is then of interest to know what this index covers. The CPI price collection has a pyramidal process. At the top is the all-item CPI, which serves as the overall summary measure of the change in consumer prices, followed by a number of broad commodity groups (e.g., housing, food, clothing, transportation, medical care, and entertainment), which will be further divided into categories that will have subcategories as well. Thus, the price data on actual commodities purchased in different places are aggregated to get group indices, and these indices may also be aggregated to form other higher-level indices (Boskin et al., 1998).

The coverage of the CPI may be divided into two: food items and non-food items. Inflation on food items are usually excluded by policy makers studying inflation because of its transitory nature. However, in lower-income countries, it shows that food inflation is not only more volatile but also higher in average compared to non-food inflation. It is said that a policy that focuses on a measure that excludes food inflation may give higher inflationary expectations, an underestimate of forecasts of future inflation, and lags in policy responses (Walsh, 2011). To measure inflation on food items, the weighted average of the prices of items included in the category are computed. These food items include the following:

- Bread and cereals
- Fish
- Oils and fats
- Vegetables
- Fruit
- Meat
- Milk, cheese and eggs
- Sugar, confectionery and ice cream
- Other food products and non-alcoholic beverages

To measure inflation on non-food items, on the other hand, a common technique is through the use of CPI excluding food and energy items (Bryan & Cecchetti, 1994). It is usually referred to as the core inflation. Walsh (2011) noted that policy makers derived core inflation measures in addressing the challenge of setting policies of medium-term goals, with data measure only for current developments— to veer away from highly volatile data, which may be reflective of transitory shocks. The list of non-food items considered is as follows:

- Clothing and footwear
- Furnishing, household equipment, routine maintenance of house
- Transport
- Recreation and culture
- Restaurants and miscellaneous goods and services
- Health
- Housing, water, electricity, gas, and other fuels
- Communication
- Education

1.4 Relationship between Diesel Price, CPI, and Inflation Rates

Diesel price and CPI may be associated by the production chain. Results of the study by Akcay (2011) support the supply side approach in looking at relationships of different price indices. In a supply side approach, the relationships can be summarized as follows: as the producer prices for crude materials increase, the prices for products used as intermediate inputs increase, so the producer prices for finished goods increase, leading to an increase in consumer prices as well. In the case where diesel is considered as the crude material, as diesel price increases, prices of products using diesel as intermediate input increase, so the producer prices for these finished goods increase, and the consumer prices increase as well.

As aforementioned, the coverage of CPI may be divided into two, food and non-food. It has been established in Mapa's (2018) report that changes in diesel price significantly affects prices of food items. In addition to this, Walsh (2011) has noted that an increase in commodity prices, including prices of food, may have an effect on non-food prices. A study on inflation dynamics by Cecchetti and Moessner (2008) explores the relationship between food inflation and non-food inflation. They have noted that, generally, non-food inflation does not revert to the headline inflation, however, if it does revert to the headline, second-round effects from higher prices of goods may develop. According to Hlédik (2004), these second-round effects may have indirect effects that are difficult to quantify.

1.5 Implications and Use of Non-food Inflation Rate

A high inflation may lead to loss of employment in the short run and may have effects on income shares in the long run (Hein, 2002). Although inflation is not a monetary phenomenon as Hein (2002) noted, Mishkin (2007) noted that a monetary policy is capable of controlling the overall inflation in the long run. A policy, planning, and research paper by Chhibber and Mundial (1989) mentioned that while it does not completely encompass solving the inflationary problems of a country, policy-makers often resort to monetary and fiscal measures such as wage policies to aid in steadying inflation rates. An instance to this is as noted by Perry, Baily, and Poole (1978) in their study on food demands in a macroeconomic view, wherein they observed the wage-price spiral in which rising prices increase demand for higher wages. Tightening monetary policy and using a fiscal measure such as this has a critical role in determining the second-round effects (e.g. effects of wage hike) associated with changes in the underlying trend of inflation as it may have a lasting effect (Mishkin, 2007).

In a paper by Aaronson (2001), the impacts of wage hikes are explored and findings show that an industry-wide increase in the price of labor is passed on to consumers through an increase in prices. In addition to this, a study by Woertz et al. (2008) implicate that raising salaries beyond a certain level may actually stimulate further inflation because much of the pay rise will be spent and this increase in demand will feed into higher prices if productivity has not increased concomitantly. Woertz et al. further argues that in the case of food, however, this will be admittedly unlikely, as demand is not likely to be very elastic which means that demand for food won't instantaneously go up due to pay hike as one can only eat so much regardless of salary. These studies can support the theory that wage hikes may even increase prices due to higher demands wherein it is more likely that increase will be felt in non-food items rather than food items due to its inelastic demand, implicating that if proper wage hike policies are implemented, food inflation may tend to stabilize. Furthermore, Lucas and Rapping (1969) also explored in their research the relationship of real wages, employment, and inflation. Findings established that labor supply increases when wage rates are increased.

Given the case, it should be taken to account that what is really needed to manage the inflation is to address it without increasing distortions or raising subsidies based on a transitory demand, and that the concern is not to avoid its rise but to manage a subsequent disinflationary process (Chhibber & Mundial, 1989). The magnitude of second-round effects that may happen upon implementing respective monetary policies depends on both the source of the shocks and the choice of reaction function of the central bank. Looking at non-food inflation, which smoothens volatile changes and identifies inflation signal from temporary noises, can help avoid mistakes in monetary policy making and refrain from inducing second-round effects (Mishkin, 2007).

2 The Data

The dataset used in this study contains three time series of monthly data on diesel prices, food component, and the non-food components of consumer price index. The 121 time points used were from January 2010 to January 2018. Table 2 displays the source and description for each variable used.

Table 2. Variable Description

Variable Name	Source	Description
Diesel	Bangko Sentral ng Pilipinas (BSP)	The price per liter of diesel in Philippine Pesos
Food Inflation	Philippine Statistics Authority (PSA)	Food Inflation Rate extracted from the food commodity group in Inflation Rate by Commodity Group using base 2006 = 100
Non-Food Inflation	Philippine Statistics Authority (PSA)	Non-Food Inflation Rate computed by getting the weighted mean of listed non-food items in section 1.2.2; Inflation Rate by Commodity Group using base 2006 = 100

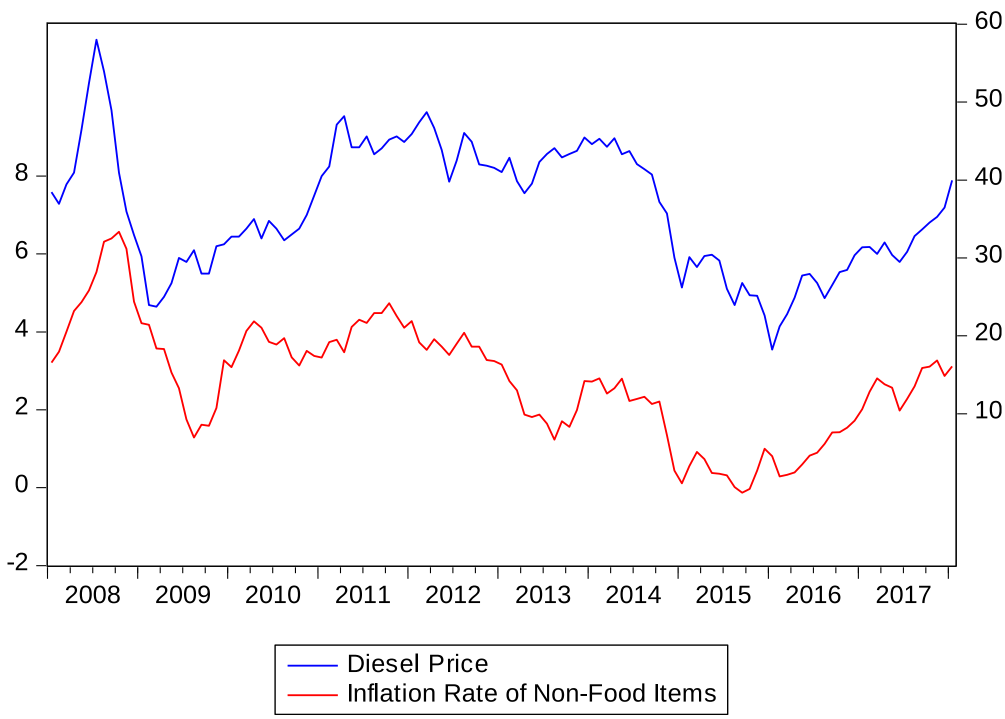
3 Descriptive Analysis

3.1 Trend in Diesel Prices and Non-Food Inflation Rate

Official inflation statistics from BSP show that the inflation rate of non-food items decreasing during the second quarter of 2013, from 2.8 percent in the first quarter, to 2.0 percent. In their report it was stated that this increase in inflation is owed to the lower electricity rates and domestic petroleum prices. Further, the slowdown in the headline inflation from that quarter, decreasing to 2.6 percent from 3.2 percent, was attributed to the lower non-food inflation as well. In the first quarter of 2014, non-food inflation rose up to 2.6 percent, and according to BSP, it was also associated with higher electricity rates. The relatively high inflation rate for non-food items subsisted until the last quarter of 2014, having 1.4 percent inflation, but eventually decelerated to 0.6 percent in the first quarter of 2015. This was due to lower prices of electricity, gas, and operation of personal transport equipment. A decline on generation charges and price reductions in kerosene and gasoline led to the lessening of the inflation in personal transport equipment.

For the first quarter of 2016, non-food inflation was steady at 0.5 percent. Housing, water, electricity, gas, and other fuels remained to have a negative inflation as utility rates declined. However, the negative inflation on the said items was negated by higher price increases of certain non-food items like health, recreation and culture, and restaurants and miscellaneous goods and services. For the next quarters of 2016, inflation rates of non-food items continue to rise, with 0.6 percent in the second quarter, 1.2 percent in the third quarter, and 1.5 percent in the fourth quarter. Clothing and footwear, health, and catering services contributed the most to non-food inflation in 2016, while due to the approved tuition fee hikes by the Commission on Higher Education (CHED) for academic year 2016-2017, education inflation also continued to increase. This inflation rate increase persisted until the first quarter of 2017 (2.4 percent), which reflected the elevated prices of international crude oil. The non-food inflation in its second quarter held steady at 2.4 percent, as some major commodity groups had varying figures. Clothing and footwear, medical products, as well as recreation and culture posted slower price increases during the quarter. Meanwhile, the price decrease in unleaded gasoline and diesel prices influenced by the downward trend in global oil prices was counterbalanced by the higher inflation of transport services. Historical data then shows that for the most part, adjustments in prices of petroleum prices have an effect in the inflation rate of non-food items.

Figure 1. Trend of monthly diesel prices and inflation rate of non-food items



3.2 Trend in the Headline, Food, and Non-Food Inflation Rate

Shown in Figure 2 below are the movements of the headline inflation rate, the food inflation rate, and the non-food inflation rate from January 2008 to January 2018. It is evident from the figure that the food inflation is much more volatile than the movement of the non-food items. During the global financial crisis, in the second quarter of 2008, it was reported by BSP that the inflation rate increased more dramatically than that of non-food items. In 2014, another significant rise in inflation rates is seen in the figure. From the 2014 third quarter inflation report of BSP, the continued uptrend in headline inflation was said to be driven mainly by the higher prices of food, due to the tight domestic supply conditions. In that same quarter, non-food inflation even decreased by 2 percent, further supporting the considerable volatility of food items. This therefore makes it clear as to how it is also important to monitor non-food items with regard to medium-term policies. Moreover, it is also clear in the figure that the movement of the non-food inflation rate follows the movement of the food inflation rate in periods wherein there are spikes in food inflation.

Figure 2. Trend of monthly headline inflation, inflation rate of food items and non-alcoholic beverages, and inflation rate of non-food items

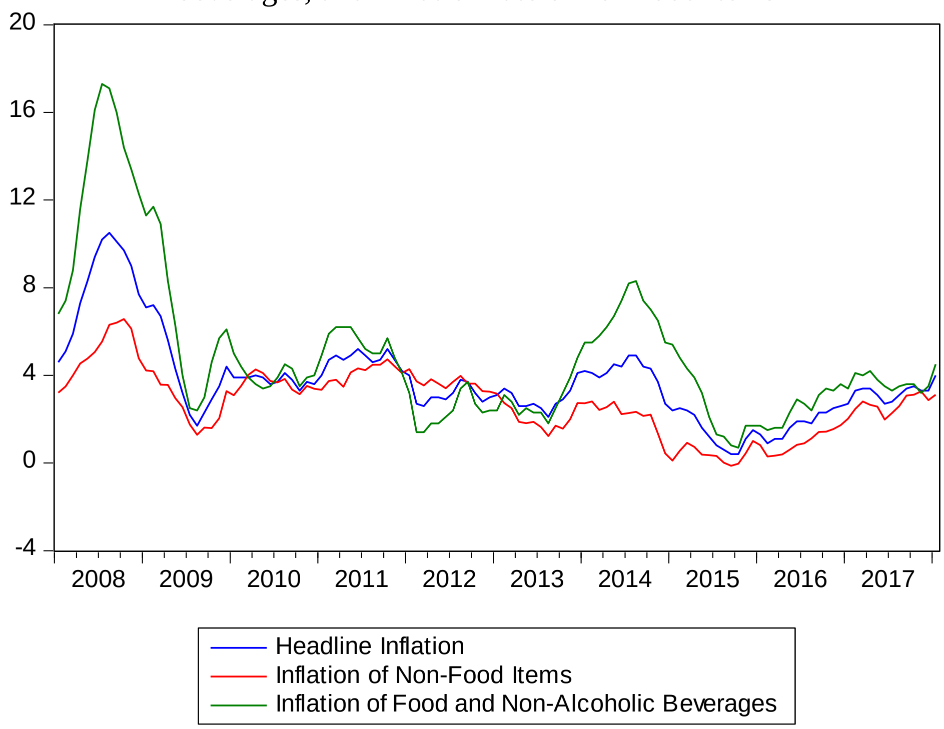


Table 3. Summary Statistics

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Food Inflation Rate	.70	17.30	4.9289	3.50422	1.830	3.273
Non-Food Inflation Rate	-.13	6.57	2.7450	1.49116	.085	-.290
Diesel Price	18.25	58.01	36.3673	8.09363	.061	-.785

4 Discussion of Models and Results

4.1 Augmented Dickey-Fuller (ADF) Test

The time series on diesel price, food component, and non-food component of the inflation rate were tested for presence of unit roots using the augmented dickey-fuller test prior to building the VAR model. The results in table 4 show that the time series food inflation rate is stationary. However, the time series diesel price and non-food inflation rate have unit roots and are therefore non-stationary. Hence, the first difference of the non-food inflation rate and the first difference of the natural logarithm of diesel price were used in building the VAR model.

Table 4. Results of the Augmented Dickey-Fuller (ADF) Tests

Variable	ADF Test Statistic	P-Value	Conclusion
Food Inflation Rate	-3.07	0.03	Stationary; I(0)
Non-Food Inflation Rate	-2.00	0.29	Non-Stationary; I(1)
Diesel Price	-0.30	0.57	Non-Stationary; I(1)

4.2 Bounds Test for Cointegration

One of the assumptions in building the VAR model is that the series are not cointegrated. That is, the variables do not have an existing long-run relationship; otherwise, it is more fitting to use the Vector Error Correction Model (VECM). Since the time series is a mixture of I(0) and I(1) variables, the Autoregressive Distributed Lag (ARDL) modelling approach to testing for cointegration using the Bounds Test is used. The ARDL (2, 1, 2) model used in the Bounds Test is shown in Table 5 below.

Table 5. ARDL Model used for the Bounds Test

Variable	Coefficient	Std. Error	t-Statistic	p-value
Non-Food Inflation^{d} (lag 1)	1.134	0.083	13.726	<0.001
Non-Food Inflation^{d} (lag 2)	-0.199	0.081	-2.461	0.015
Food Inflation	0.155	0.039	3.991	<0.001
Food Inflation (lag 1)	-0.137	0.040	-3.460	0.001
Diesel^{dlog} (lag 1)	0.041	0.013	3.235	0.002
Diesel^{dlog}(lag 2)	-0.038	0.013	-3.007	0.003

^{d} differenced time series
^{dlog} time series in dlog

Further, results from the Bounds Test for cointegration are interpreted such that if the F-statistic falls below the lower bound it is concluded that the variables are I(0), and hence, cointegration is possible. If the F-statistic exceeds the upper bound, it is concluded that there is cointegration. Finally, if the F-statistic falls between the bounds, the test is inconclusive. Table 6 shows that the F-statistic computed for the Bounds Test falls below the lower critical value bounds for all significance levels.

Table 6. Results of the Bounds Test for Cointegration

Null Hypothesis: No long-run relationships exist		
F-statistic		k
1.64		2
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.17	3.19
5%	2.72	3.83
2.50%	3.22	4.5
1%	3.88	5.3

4.3 Granger Causality Test

In regression, knowing how useful some variables are for forecasting others must be addressed. It is important to investigate whether past values of a time series x_t can help forecast another series y_t; if it cannot help forecast, then we say that x_t does not granger-cause y_t. The simplest approach to test for granger causality is through the use of the autoregressive (AR) specification. To utilize this test, a particular autoregressive lag p is assumed which is usually selected using the aikake information criterion (AIC) or the schwarz bayesian information criterion (BIC). The model setup in (1) is used in estimation by OLS.

$$y_t = \alpha + \delta_1 y_{t-1} + \delta_2 y_{t-2} + \cdots + \delta_p y_{t-p} + \beta_1 x_{t-1} + \cdots + \beta_p x_{t-p} + \varepsilon_t \quad (1)$$

The results of the Granger Causality tests which included 2 lags show that Diesel Price *Granger Causes* the Non-Food Inflation Rate at 1 percent level of significance, but not the other way around. Further, the Food Inflation Rate also *Granger Causes* Non-Food Inflation Rate at 1 percent level of significance, but also not the other way around. Lastly, Food Inflation Rate also *Granger Causes Diesel Price* at 1 percent level of significance.

Table 7. Results of the Granger Causality Test

Null Hypothesis:	F-Statistic	P-Value	
Non-Food Inflation Rate^{d} does not Granger Cause Diesel Price^{dlog}	0.57	0.56	
Diesel Price^{dlog} does not Granger Cause Non-Food Inflation Rate^{d}	7.50	0.0009	***
Non-Food Inflation Rate^{d} does not Granger Cause Food Inflation Rate	1.02	0.36	
Food Inflation Rate does not Granger Cause Non-Food Inflation Rate^{d}	8.04	0.0005	***
Diesel Price^{dlog} does not Granger Cause Food Inflation Rate	0.20	0.82	
Food Inflation Rate does not Granger Cause Diesel Price^{dlog}	4.88	0.0092	***

^{d} differenced time series
^{dlog} time series in dlog
***significant at 1% level**

4.4 Vector AutoRegressive (VAR) Model

The vector autoregressive model is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of shocks, or random disturbances, on the system of variables. The VAR model treats every endogenous variable as a function of the lagged values of all endogenous variables in the system, eliminating the need for structural modeling. It must be noted that when there is no assurance that a variable is exogenous, the variable may be treated symmetrically. In the three-variable case order one VAR model, we have:

$$\begin{aligned} y_t &= \beta_{10} - \beta_{12} z_t - \beta_{13} w_t + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \gamma_{13} w_{t-1} + \varepsilon_{yt} \\ z_t &= \beta_{20} - \beta_{21} y_t - \beta_{23} w_t + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \gamma_{23} w_{t-1} + \varepsilon_{zt} \\ w_t &= \beta_{30} - \beta_{31} y_t - \beta_{32} z_t + \gamma_{31} y_{t-1} + \gamma_{32} z_{t-1} + \gamma_{13} w_{t-1} + \varepsilon_{wt} \end{aligned} \quad (2)$$

where y_t is the non-food inflation rate, z_t is the diesel price, and w_t is the producer's price index, all at month t. The error terms are uncorrelated white noise disturbance terms with mean 0 and standard deviations $\sigma_{y,}$ σ_x, and σ_w respectively. To take for an example, parameter β_{12} is the contemporaneous effect of the unit change of z_t on y_t. Meanwhile, the effect of a unit change on z_{t-1} on y_t is explained by γ_{12}. However, the equations are not reduced-form equations since y_t has a contemporaneous effect on z_t and vice-versa. Hence, the equations must be converted so that least squares can be utilized for estimation. Using matrix algebra, the equations in (2) can be converted into the form of equation (3), the generalized mathematical representation of the reduced-form VAR model.

$$\underline{x}_t = A_0 + A_1\underline{x}_{t-1} + A_2\underline{x}_{t-2} + \cdots + A_p\underline{x}_{t-p} + \underline{e}_t \qquad (3)$$

For the reduced-form equations (3), $\underline{e}_t$ has zero means, constant variances and are individually serially uncorrelated but it must be noted that e_{1t}, e_{2t}, and e_{3t} are correlated.

The results of the VAR (1, 2, 11, 12) model using monthly time series data on non-food inflation, diesel price, and food inflation are given in Table 8 below. The study is interested in the first equation of the VAR where the dependent variable is non-food inflation rate (under the column non-food inflation). The non-food inflation rate can be explained significantly by the lag 11 and lag 12 values of food inflation rate and the lag 12 value of diesel price at 10 percent level. Moreover, the lag 1 and lag 2 values of food inflation rate also significantly explains inflation rate at 5 percent level. Lastly, the non-food inflation rate can be explained significantly by its own lag 12 value, plus the lag 1 value of diesel price at 1 percent level. It is important to note that even though the VAR model can be used to forecast future non-food inflation rates, the parameters estimated are not useful in assessing the dynamic relationships of food inflation rate and diesel price on non-food inflation rate. It is because the errors in the reduced-form VAR model are not the original structural errors, but the forecast errors.

Table 8. Results of the VAR(1, 2, 11, 12) Model

	Non-Food Inflation^{d}	Food Inflation	Diesel^{dlog}
Non-Food Inflation^{d} (lag 1)	0.033	-0.151	0.025
	(0.095)	(0.166)	(0.020)
	[0.353]	[-0.908]	[1.231]
Non-Food Inflation^{d} (lag 2)	-0.072	-0.268	0.014
	(0.082)	(0.145)	(0.018)
	[-0.880]	[-1.853]	[0.812]
Non-Food Inflation^{d} (lag 11)	0.127	0.194	-0.022
	(0.092)	(0.161)	(0.020)
	[1.383]	[1.204]	[-1.101]
Non-Food Inflation^{d} (lag 12)	-0.349	-0.184	0.026
	(0.080)	(0.140)	(0.017)

	***[-4.371]	[-1.311]	[1.518]
Food Inflation (lag 1)	0.126	1.426	0.009
	(0.055)	(0.097)	(0.012)
	**[2.291]	[14.728]	[0.773]
Food Inflation (lag 2)	-0.117	-0.464	-0.016
	(0.056)	(0.099)	(0.012)
	**[-2.080]	[-4.698]	[-1.339]
Food Inflation (lag 11)	-0.088	-0.254	0.010
	(0.046)	(0.082)	(0.010)
	*[-1.888]	[-3.111]	[1.029]
Food Inflation (lag 12)	0.087	0.215	-0.007
	(0.045)	(0.078)	(0.010)
	*[1.943]	[2.740]	[-0.735]
$Diesel^{dlog}$ (lag 1)	1.399	0.093	0.148
	(0.449)	(0.790)	(0.096)
	***[3.117]	[0.118]	[1.538]
$Diesel^{dlog}$ (lag 2)	-0.494	0.355	-0.156
	(0.485)	(0.853)	(0.104)
	[-1.019]	[0.416]	[-1.498]
$Diesel^{dlog}$ (lag 11)	-0.062	-0.860	-0.105
	(0.460)	(0.809)	(0.099)
	[-0.135]	[-1.063]	[-1.066]
$Diesel^{dlog}$ (lag 12)	-0.751	-0.307	0.348
	(0.453)	(0.796)	(0.097)
	*[-1.659]	[-0.386]	[3.590]
C	-0.043	0.307	0.018
	(0.077)	(0.135)	(0.016)
	[-0.556]	[2.268]	[1.066]
R-squared	0.398	0.939	0.204
Akaike AIC	0.528	1.657	-2.554
Schwarz SC	0.851	1.980	-2.231

Standard errors are enclosed in parentheses and t-statistics in brackets
lags 1, 2, 11, and 12 are selected as the appropriate lag order using the AIC
^{d} differenced time series; ^{dlog} time series in dlog
*** significant at 10% level; ** significant at 5% level; *** significant at 1%**

4.5 Impulse Response Function (IRF)

A one-time shock to the i^{th} variable (e.g. increase in the price of diesel) not only has a direct effect on the variable itself, but also to the other endogenous variables, and in this case, the non-food inflation, through the dynamic structure of the VAR model. The impulse response function traces the effect of a one-time exogenous shock in one of the variables on the current and future values of the endogenous variables.

4.5.1 Response of Non-Food Inflation to a Shock in Diesel Price

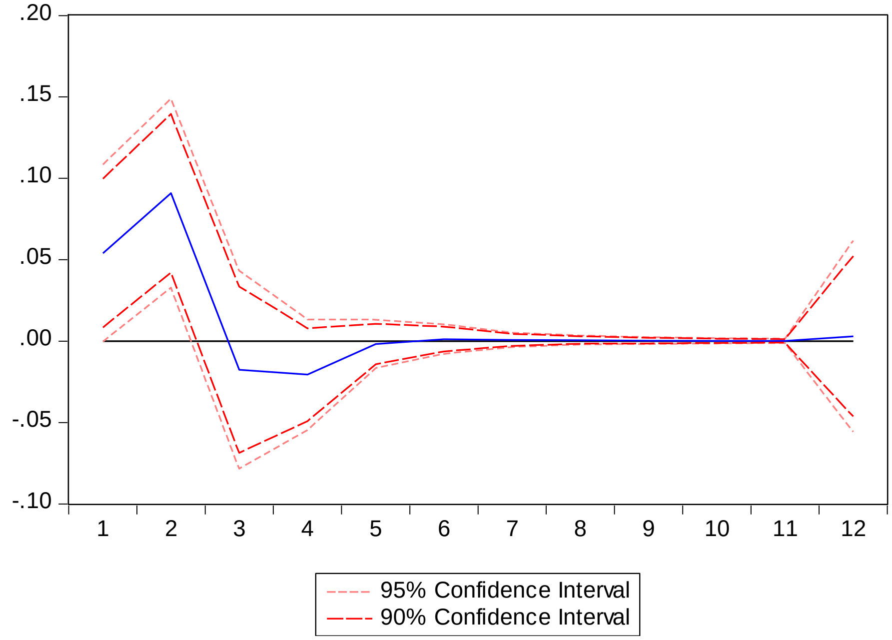
The impact of a shock in diesel price to non-food inflation is given in Table 9 below. The IRF shows that a one-time shock to diesel prices at month t will have a significant contemporaneous effect on non-food inflation at time t, plus a lingering effect for the succeeding month (t + 1). The contemporaneous effect of a shock in diesel price is significant to the increase of non-food inflation rates at 10 percent level, while the effect of a shock in diesel price for the succeeding month is significant at 1 percent level. After the succeeding month, the effect of a shock in diesel price to non-food inflation is no longer significantly different from zero, as shown in Figure 3. Hence, in particular, a one standard deviation increase in diesel price at month 1 will increase non-food inflation rate over the two subsequent months.

Table 9. Impulse Response Function – Response of Non-Food Inflation to a one standard deviation increase in Diesel Price at Month 1

Period	Impact of a shock in Diesel Price to Non-Food Inflation	S.E.	t-stat
*1	0.0540	0.0277	1.9480
***2	0.0909	0.0296	3.0682
3	-0.0176	0.0310	-0.5671
4	-0.0206	0.0173	-1.1916
5	-0.0018	0.0076	-0.2331
6	0.0012	0.0046	0.2571
7	0.0007	0.0023	0.3269
8	0.0006	0.0014	0.4172
9	0.0003	0.0011	0.2604
10	0.0001	0.0008	0.1372
11	0.0001	0.0007	0.1646
12	0.0030	0.0299	0.1010

***significant at the 10% level; *** significant at the 1% level**
Cholesky ordering: Food Inflation, Diesel, Non-Food Inflation

Figure 3. Increase in Diesel Price from Month 1 to Month 12 Resulting from One Standard Deviation Increase in Non-Food Inflation Rate



4.5.2 Response of Non-Food Inflation to a Shock in Food Inflation

While the impact of a shock to diesel prices affect the non-food inflation rate for a period of two months, the results of the IRF in Table 10 show that a one-time increase in food inflation rate will have significant effects on non-food inflation rate contemporaneously, plus a lingering effect for two succeeding months. Aside from these effects, the shock on food inflation also has an effect on the eleventh until the fourteenth succeeding months. The contemporaneous effect (t), the effect on the immediate succeeding month (t + 1), the effect on the eleventh (t + 11), and up until the thirteenth succeeding month (t + 13) of a shock in food inflation to non-food inflation is significant at 5 percent level, while the effect of the second succeeding month and the fourteenth month (t + 14) is significant at 10 percent level. Particularly, a one standard deviation increase in food inflation rate will increase non-food inflation rate over the three subsequent months. However, it will induce a negative effect on non-food inflation on the eleventh until the fourteenth subsequent months.

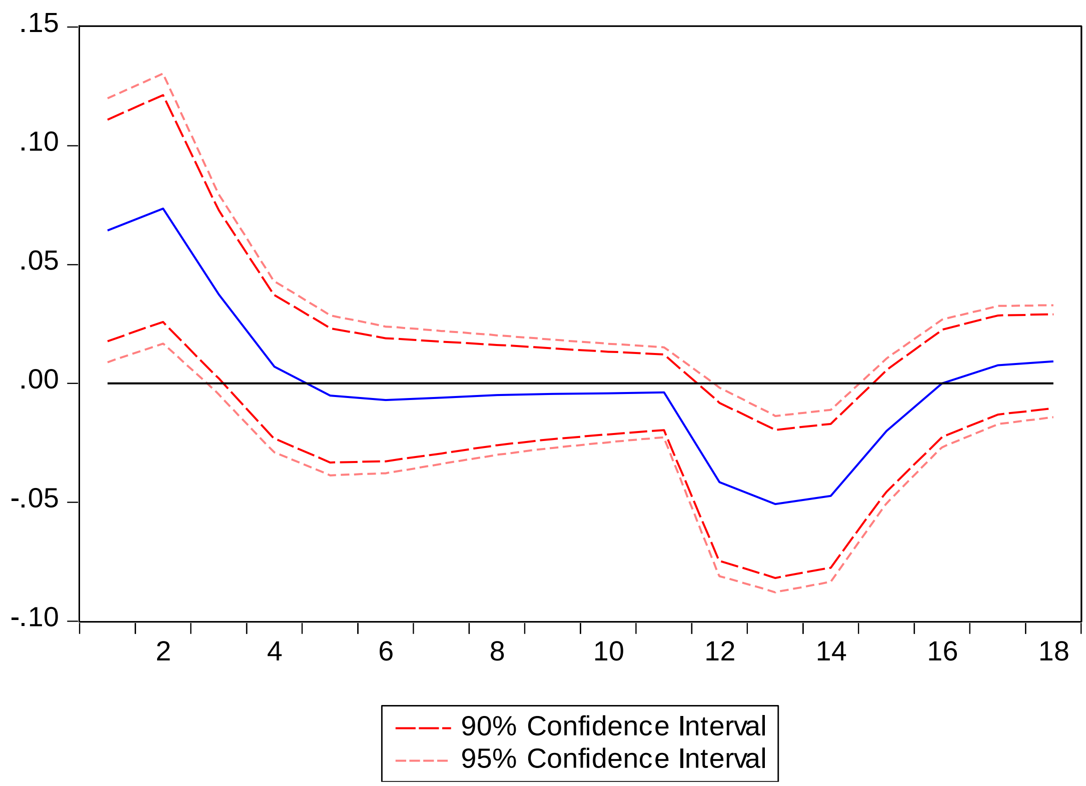
Table 10. Impulse Response Function – Response of Non-Food Inflation to a one standard deviation increase in Food Inflation at Month 1

Period	Impact of a shock in Food Inflation to Non-Food Inflation	S.E.	t-stat
**1	0.0644	0.0283	2.2719
**2	0.0736	0.0290	2.5375

*3	0.0374	0.0215	1.7423
4	0.0070	0.0184	0.3811
5	-0.0051	0.0172	-0.2966
6	-0.0070	0.0157	-0.4426
7	-0.0060	0.0143	-0.4183
8	-0.0049	0.0128	-0.3854
9	-0.0044	0.0116	-0.3778
10	-0.0041	0.0106	-0.3845
11	-0.0038	0.0097	-0.3927
**12	-0.0415	0.0202	-2.0511
**13	-0.0508	0.0189	-2.6863
**14	-0.0473	0.0184	-2.5689
*15	-0.0200	0.0156	-1.2856
16	0.0000	0.0137	0.0011
17	0.0077	0.0127	0.6086
18	0.0093	0.0120	0.7736

***significant at the 10% level (one-sided alternative); **significant at the 5% level**
Cholesky ordering: Food Inflation, Diesel, Non-Food Inflation

Figure 4. Increase in Food Inflation from Month 1 to Month 12 Resulting from One Standard Deviation Increase in Non-Food Inflation Rate



4.6 Forecast Error Variance Decomposition

The Forecast Error Variance Decomposition, unlike the impulse response function that traces the effects of a shock to one of the endogenous variables on the other variables, reveals how much of the forecast error variance in a certain variable can be explained by a shock to the variable in question (non-food inflation) versus the shocks to the other variables (diesel price and food inflation). In practice, it is common for the variable in question to explain almost all of its forecast error variance at short time horizons and less of its forecast error at longer time horizons. The variance decomposition shows the relative importance of each random error term in affecting the variables in the VAR model. Shown in Table 11 below is the variance decomposition of non-food inflation, which provides information on how much of the future error variance of non-food inflation can be explained by shocks to diesel price and food inflation at month t. The results show that a shock to non-food inflation ("own shock") can explain about 92.041 percent of the variance of the forecast error of non-food inflation rate at month (t + 1). However, shocks to diesel price and food inflation have little effect (7.96 percent) to the forecast error variance of non-food inflation rate at month (t + 1). At month (t + 2), a significant rise in the total variance explained by diesel price and food inflation is seen, now at 20.23 percent. This value plateaus at around 22.91 percent, which indicates that shocks to diesel price and food inflation explain about 23 percent of the future forecast error variance of non-food inflation rate, making the two variables important determinants of non-food inflation rate.

Table 11. Variance Decomposition of Non-Food Inflation

Period	S.E.	Non-Food Inflation	Food Inflation	Diesel Price
1	0.298	92.041	4.668	3.292
2	0.320	79.771	9.320	10.910
3	0.323	78.513	10.486	11.001
4	0.324	78.180	10.475	11.345
5	0.324	78.176	10.488	11.336
6	0.324	78.139	10.529	11.332

5 Conclusion and Recommendations

This paper aims to evaluate the relationship of changes in diesel prices on non-food inflation rate and the effect of changes in food inflation rate on non-food inflation rate using monthly data from Bangko Sentral ng Pilipinas (BSP) and Philippine Statistics Authority (PSA). With the use of econometric modelling, the vector autoregressive (VAR) model results show that a one-time shock to diesel prices will have a significant contemporaneous effect on non-food inflation. The lasting effect between the two variables indicates that an increase in diesel prices can lead to increase in non-food inflation that is found to last up to the succeeding month. This outcome supports the research of Sobrevinas (2009) that explains the direct and indirect effects of fuel price increase in non-food goods and services. The substantial effect of change in diesel price on inflation rate of non-food items may possibly be attributed to its direct effect on the transportation component and indirect effect on other commodities in the consumer price index such as communication and housing needs – electricity, water, gas, etc.

Findings from the vector autoregressive model also indicate that a one-time increase in food inflation rate will have significant effects on non-food inflation rate contemporaneously, plus a lingering effect for the two following months. Aside from these effects, the shock on food inflation also has an effect on the eleventh until the fourteenth succeeding months which is found to be a negative effect, indicating that an increase in food inflation can lead to a decrease in non-food inflation in the said months. The positive effect for three subsequent months between food and non-food inflation is consistent with the wage-price spiral observed by Perry (1978) wherein rising food prices increase demand for higher wages. Higher wages, in return, provide people with greater disposable income for spending on both food and non-food items, increasing demand for both. This results again to higher prices of goods and services. Recently, the Trade Union Congress of the Philippines (TUCP) filed House Bill No. 7805, or the proposed "Living Wage Act of 2018" (Agoncillo, 2018) which is expected to provide people with higher wages. However, Biberovic et. al (2008) indicated in his study that demand for food items is inelastic which means that one can only eat so much despite of salary and thus, limiting the increase in food demand. With Cabatic from National Food Authority (NFA) reporting that rice imports are anticipated to arrive soon, it is expected that the price of rice in the Philippines will stabilize causing the food inflation to stabilize as well. This potentially explains why the VAR model in this study indicates that after the food imports and wage hike, food inflation would tend to stabilize but non-food inflation may follow with an increased rate due to wage hikes encouraging higher demand for goods and services. The negative effect established on the eleventh until the fourteenth succeeding months, however, might be an indirect effect of the wage-price spiral where supply might progressively increase due to demand and build an imbalance in the equilibrium resulting to surplus and lower prices which may bring gradual decrease in non-food inflation rate. This negative effect may also be a direct effect of an occurrence where labor supply increases when wage rates are increased (Lucas and Rapping, 1969).

The modelling results also show that shocks to diesel price and food inflation explain about 23 percent of the future forecast error variance of non-food inflation rate, making the two variables important determinants of non-food inflation rate.

With the results of this study providing support for the theory that diesel prices play a crucial role in determining non-food inflation and that non-food inflation tends to increase and follow when there’s an increase in food inflation, the researchers recommend foremost that the government closely monitor all policy-based statistics as each may provide indispensable insights. It is also recommended that the government’s measures to stabilize the headline inflation rate should not stop at solving the food inflation through rice imports and price policies alone. It must be noted that non-food inflation contributes significantly to the headline inflation and must be addressed as well in order to stabilize headline inflation. In relation to this study, a recent publication from IBON Foundation (2018) states that raising the minimum wage to Php 750 is non-inflationary and may be good for the economy. According to their research, large corporations can easily adopt such substantial wage hike, and smaller producers in micro, small and medium enterprises (MSMEs) can also afford it if given government support, e.g. provision of cheap and easy credit, marketing support, nurturing of locally-integrated supply chains, and help in scientific and technological advancements. If their proposition is considered, carefully implementing corresponding wage policies may actually be beneficial to individual workers and corporations alike and to the economy in general.

With the study findings indicating that non-food inflation may increase and follow food inflation, policy-makers must be wary of the impact and problems the second round effects may bring. According to Hlédik (2004), these second-round effects may have indirect effects that are difficult to quantify. Hence, high importance must be given in the proper balance of price policies and other government strategies to stabilize not just food inflation, but both food and non-food inflation rate to alleviate the fluctuations of the headline inflation.

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Appendices

Figure 5. Residual Correlogram Graphs of the VAR (1, 2, 11, 12) model

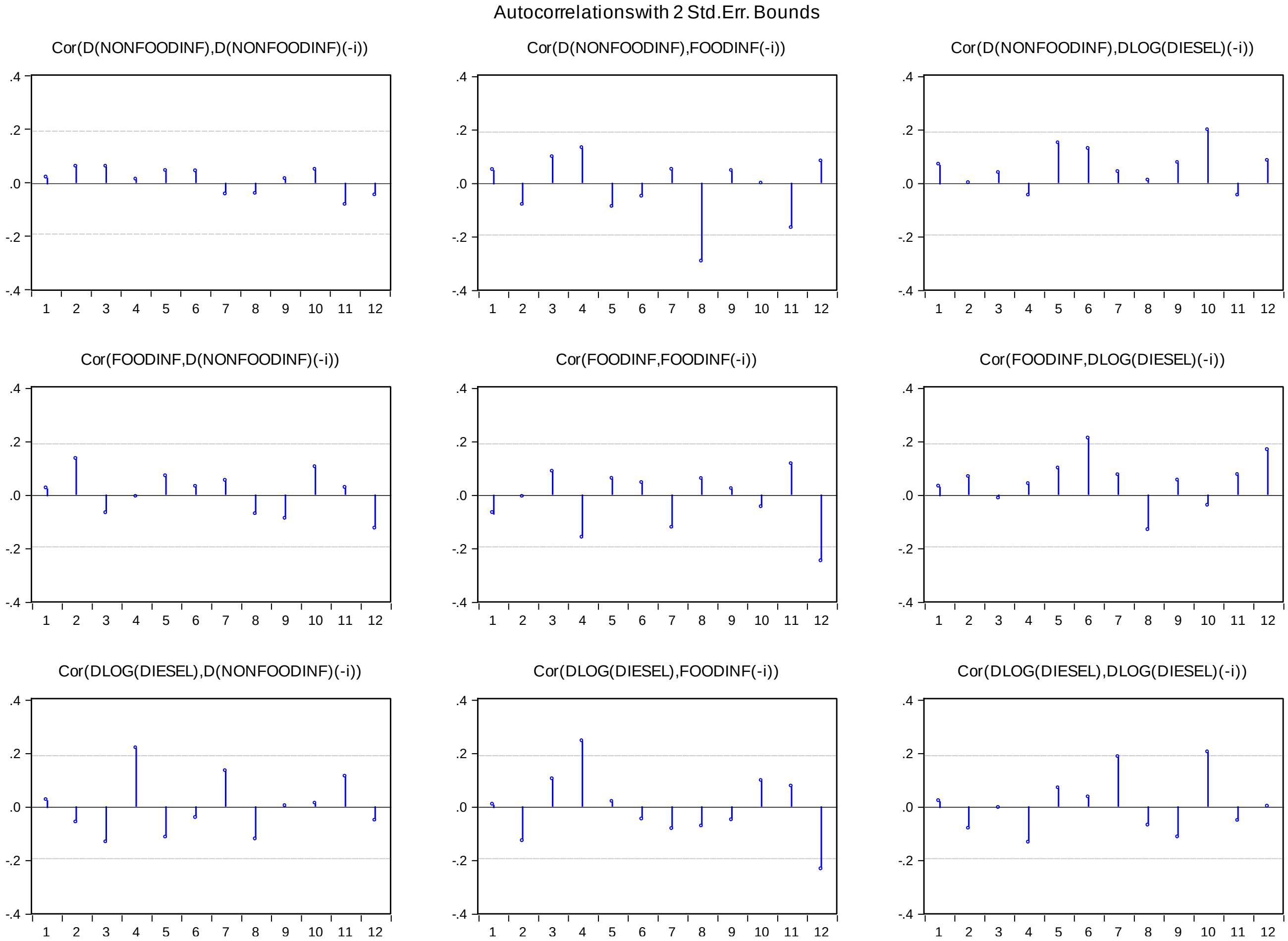

Table 12. Results of the VAR Residual Normality Test

Component	Jarque-Bera	df	P-value.
1	0.72	2	0.70
2	0.03	2	0.98
3	2.87	2	0.24
Joint	3.62	6	0.73

Table 13. Results of the VAR Residual Serial Correlation LM Test

Lags	LM-Stat	P-value
1	11.96	0.22
2	15.83	0.07
3	7.15	0.62

Table 14. Results of the VAR Residual Heteroskedasticity Test

Chi-sq	df	Prob.
166.106	144	0.10025