Examining the spillover effects of volatile world crude oil prices on Sri Lankan vegetable market using Vector Error correction (VEC) model.

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DECLARATION OF AUTHORSHIP

I certify that this dissertation does not incorporate any material previously submitted for any previous or current degree Programme to the best of my knowledge. Further, it does not contain any material previously published or written by another person except where due reference is made in the text.

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SUPERVISOR’S RECOMMENDATION

I certify that the research Dissertation Examining the spillover effects of volatile world crude oil prices on Sri Lankan vegetable market using Vector Error correction (VEC) model submitted in partial fulfillment of the requirements of the Economics Special Degree Programme of the Department of Economics, University of Colombo, was supervised by me.

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ABSTRACT

This study delved into the transmission channels and dynamics of the spillover effects of crude oil prices on Sri Lanka's vegetable prices. The findings from the literature review highlighted a significant positive correlation between crude oil prices and vegetable prices in Sri Lanka. Using a non-stationary approach, particularly the Vector Error Correction Model (VECM), the analysis captured the long-run equilibrium relationships and short-run dynamics between these variables. Overall, this study provides valuable insights for policymakers and industry stakeholders regarding the spillover effects of crude oil prices on Sri Lanka's vegetable prices.

Key words: Crude oil prices, Vegetable prices, Spillover effects, Long-term relationships, Short-term dynamics, Johansen cointegration test, VEC Model, Speed adjustments

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ABBREVIATIONS

VECM: Vector Error Correction Model

VAR: Vector Autoregression

OLS: Ordinary Least Squares

R-squared: R-squared

ADF: Augmented Dickey-Fuller

CHAPTER 1 – INTRODUCTION

1.1 Background

The global economy operates in an intricately interconnected manner, where fluctuations in crude oil prices can have profound implications for various sectors, including agriculture. Sri Lanka, being a country heavily reliant on imported crude oil, is particularly susceptible to the spillover effects that arise from changes in global oil prices and their subsequent impact on domestic markets. The vegetable market in Sri Lanka, playing a pivotal role in the country's economy by providing essential food items and employment opportunities, stands as a crucial sector to examine. Understanding the spillover effects of crude oil prices on Sri Lanka's vegetable prices holds significant importance for policymakers, market participants, and stakeholders in the agricultural sector. While previous studies have explored the relationship between crude oil prices and agricultural markets in general, there exists a notable research gap concerning the specific investigation of spillover effects on up country and low country vegetable prices in Sri Lanka. Given the unique characteristics of the vegetable market and the country's reliance on imported crude oil, there arises a compelling need to investigate the transmission channels and dynamics associated with these spillover effects. Such an investigation would provide valuable insights for decision-makers and market participants, enabling them to make informed choices, devise appropriate strategies, and effectively manage risks. Also, this study showed that the bargaining power of merchants and the farmers and cartel behavior of middlemen within the

farm-gate and wholesale markets as well as wholesale and retail markets. Beans, Carrots, Cabbage, Tomato, brinjal, Leeks, Beetroot, Knolkhol, Raddish, Ladies figure, Capsicum are the main vegetables used for this analysis.

1.2 Justification

The rationale for undertaking this research lies in the necessity to address the existing knowledge gaps and underscore the significance of studying the spillover effects of crude oil prices on Sri Lanka's vegetable prices. By conducting this investigation, a deeper understanding of the impact of global oil price fluctuations on the domestic vegetable market can be attained. Such knowledge holds immense value for policymakers, as it empowers them to formulate effective strategies to mitigate any adverse consequences and capitalize on potential opportunities. Additionally, market participants and stakeholders in the vegetable industry can benefit from valuable insights that enhance their decision-making processes, risk management practices, and overall market strategies.

1.3 Research Problem

Despite the evident importance of the vegetable market in Sri Lanka, empirical research on the spillover effects of crude oil prices specifically on vegetable prices remains limited. Therefore, the research problem addressed in this study revolves around the investigation of the transmission channels and dynamics of the spillover effects of crude oil prices on Sri Lanka's vegetable prices. By unraveling the nature and extent of these spillover effects, this research aims to provide valuable insights into the intricate interplay between global oil price dynamics and the local vegetable market.

1.4 Research Objectives

The research objectives of this study are as follows:

- To examine the long-term and short-term relationships between crude oil prices and vegetable prices in Sri Lanka.
- To identify the magnitude and direction of spillover effects from crude oil prices to vegetable prices.
- To assess the significance of these spillover effects and their implications for the domestic vegetable market.
- To provide insights into the potential economic consequences of global oil price fluctuations on the agricultural sector in Sri Lanka.

By addressing these objectives, this research endeavors to contribute to the existing literature on the impact of crude oil prices on agricultural markets and provide valuable insights for policymakers, market participants, and stakeholders in Sri Lanka's vegetable industry.

1.5 Conceptualization

The conceptual framework guiding this study involves comprehending the transmission channels through which changes in crude oil prices affect vegetable prices in Sri Lanka. This framework incorporates the dynamics of global oil markets, Sri Lanka's dependency on imported crude oil, and the factors influencing the vegetable market, such as domestic production, imports, and consumer demand. Through the analysis of these interconnected relationships, a holistic view of the spillover effects and their implications for the vegetable market can be achieved.

1.6 Limitations

It is important to acknowledge the limitations and potential challenges inherent in this research. These limitations may include constraints related to data availability, data quality, the assumptions underlying the analytical methods employed, and the generalizability of the findings beyond the scope of this study. While conscious efforts will be made to address these limitations, it is crucial to consider them when interpreting the results to ensure a realistic assessment of the study's scope and potential constraints.

1.7 Thesis Structure

This thesis consists of five chapters, each contributing to the investigation of the spillover effects of crude oil prices on Sri Lanka's vegetable prices. The structure of the thesis is as follows:

Chapter 1: Introduction

This chapter provides the background, justification, research problem, objectives, conceptualization, limitations, and thesis structure.

Chapter 2: Literature Review

The literature review critically examines existing studies on the relationship between crude oil prices and agricultural markets, with a specific focus on the spillover effects on vegetable prices. This chapter identifies gaps in the literature and highlights the theoretical and empirical foundations for the research.

Chapter 3: Methodology

The methodology chapter outlines the research design, data collection methods, and analysis techniques employed. It provides a detailed description of the econometric model (VECM) utilized to examine the spillover effects and their significance.

Chapter 4: Results and Analysis

This chapter presents the empirical findings of the study, including the estimation results, statistical analysis, and interpretation of the spillover effects of crude oil prices on Sri Lanka's vegetable prices. The results are discussed in light of the research objectives and contribute to the understanding of the dynamics between oil prices and the vegetable market.

Chapter 5: Conclusion and Recommendations

The final chapter summarizes the main findings, discusses their implications, and provides recommendations for policymakers, market participants, and stakeholders. It also highlights the contributions of the research, identifies avenues for future research, and concludes the thesis.

By adhering to this structure, the thesis aims to provide a comprehensive analysis of the spillover effects of crude oil prices on Sri Lanka's vegetable prices. This analysis effectively addresses the research problem and achieves the stated objectives, ultimately contributing to the existing body of knowledge in this field.

1.8 Chapter Summary

The introductory chapter of this research sets the stage for studying the spillover effects of crude oil prices on Sri Lanka's vegetable prices. It highlights the importance of understanding this relationship and outlines the research objectives, which include examining short-term and long-term relationships, identifying spillover effects, and assessing their economic consequences. The chapter also provides a conceptual framework for analyzing the transmission channels and acknowledges potential limitations. The structure of the thesis is outlined, and it aims to contribute to the existing literature and provide insights for stakeholders in Sri Lanka's vegetable industry. Overall, the introductory chapter establishes the context, significance, and objectives of the study, paving the way for subsequent chapters to delve into the research analysis.

CHAPTER 02 - LITERATURE REVIEW

2.1 Introduction

The agricultural sector in Sri Lanka is vital to the economy, offering employment and contributing to food security and foreign exchange earnings. However, it faces challenges due to climate change, natural disasters, and economic volatility. One key factor influencing the sector, especially vegetable prices, is crude oil prices. Figure 1 illustrates the categorization of Sri Lankan vegetables into up country and low country varieties. These categories help in understanding the specific dynamics and characteristics of different vegetables grown in different regions, enabling a more nuanced analysis of their response to changes in crude oil prices.

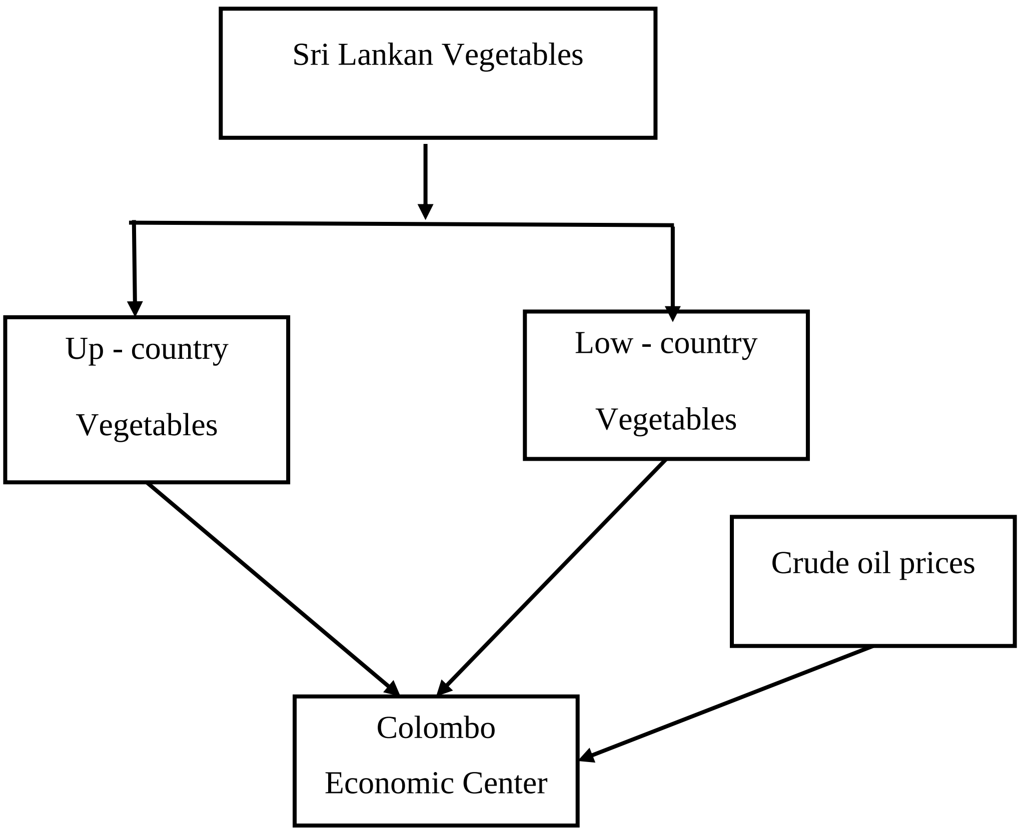

Figure 1 Sri Lankan Vegetables

2.2 Sri Lankan Vegetables

Sri Lankan vegetables encompass a wide variety of crops that are grown throughout the country. The tropical climate and fertile soils contribute to the diverse range of vegetables available in up country and low country. Common vegetables include beans (Phaseolus vulgaris), drumstick (Moringa oleifera), carrots (Daucus carota), leeks (Allium ampeloprasum var. porrum), cabbage (Brassica oleracea var. capitata), beetroot (Beta vulgaris) and cauliflower (Brassica oleracea var. botrytis) from up country and brinjal (Solanum melongena), Ladies fingers (Abelmoschus esculentus), snake gourd (Trichosanthes cucumerina), bitter gourd (Momordica charantia), pumpkin (Cucurbita pepo), long beans (Vigna unguiculata subsp. sesquipedalis) from low country. These vegetables play a crucial role in Sri Lankan cuisine, adding flavor, texture, and nutritional value to many dishes.

2.3 Vegetable Market

The vegetable market in Sri Lanka serves as a vibrant and bustling hub where farmers, vendors, and consumers come together to buy and sell fresh produce. These markets, located in towns and cities, are economic and social spaces that connect farmers with consumers and provide a platform for the exchange of goods and cultural experiences. Some cities, such as Colombo, Pettah, Dematagoda, and Kollonnawa, act as significant economic centers and distribution points for vegetables. These markets play a crucial role in the supply chain, ensuring the availability and accessibility of a wide variety of vegetables to meet the demands of local and regional markets. They contribute to the local economy, support livelihoods, and promote economic growth and food security. The vegetable markets in Sri Lanka showcase the diversity of vegetables cultivated in different climatic zones, representing the distinct agricultural produce from up country and low country regions.

2.4 Up - Country Vegetables

The Up-Country region of Sri Lanka refers to the cooler highlands, characterized by tea plantations and a temperate climate. This region is ideal for cultivating temperate vegetables. Districts include Nuwara Eliya, Badulla, Kandy, Matale, and Bandarawela, these areas provide the favorable climate and fertile soil necessary for the successful cultivation of vegetables like (Daucus carota), leeks (Allium ampeloprasum var. porrum), cabbage (Brassica oleracea var. capitata), beetroot (Beta vulgaris) and cauliflower (Brassica oleracea var. botrytis). These vegetables were introduced during the colonial period and are often associated with European cuisines. The cool climate and fertile soils of the Up Country provide optimal conditions for the cultivation of these crops.

2.5 Low Country Vegetables

The Low Country of Sri Lanka encompasses the coastal plains and wetlands with a tropical climate. This region is known for its rice paddy cultivation and diverse range of vegetables. Some of the districts known for the cultivation of low country vegetables include Colombo, Gampaha, Kalutara, Galle, Matara, Hambantota, Ampara, Batticaloa, and Jaffna. Low Country vegetables are deeply rooted in Sri Lankan culinary traditions and include brinjal (Solanum melongena), Ladies fingers (Abelmoschus esculentus), snake gourd (Trichosanthes cucumerina), bitter gourd (Momordica charantia), pumpkin (Cucurbita pepo), drumstick (Moringa oleifera), long beans (Vigna unguiculata subsp. sesquipedalis). These vegetables are widely used in traditional Sri Lankan dishes and are essential components of the local cuisine.

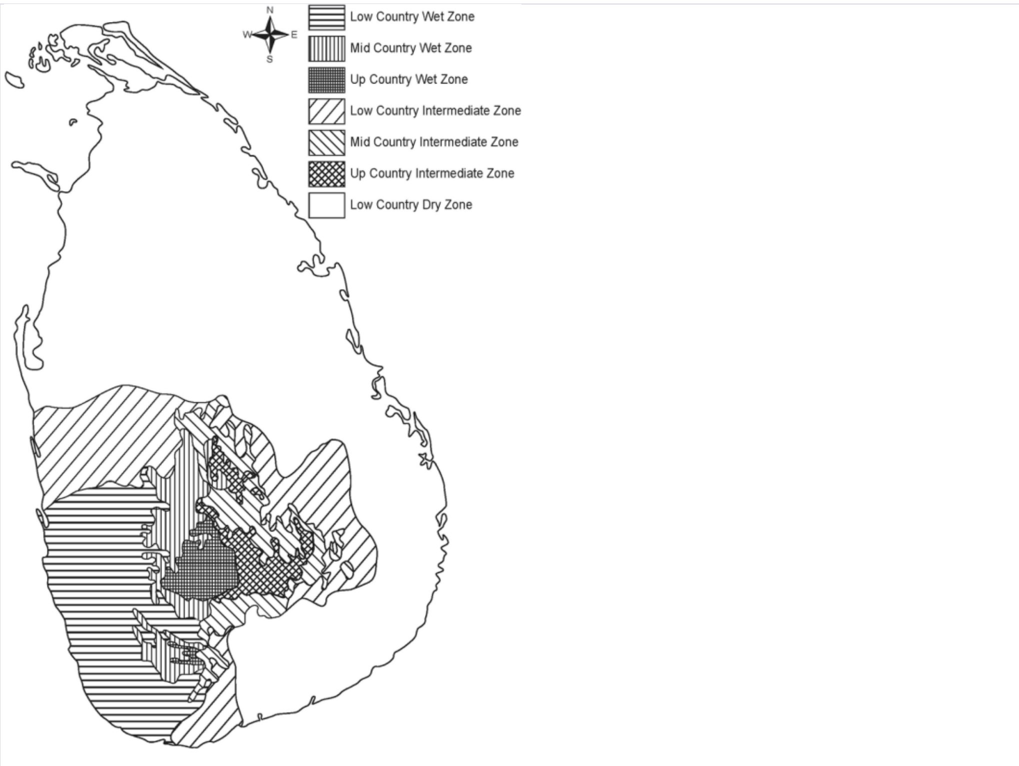

Figure 2 Sri Lankan vegetable cultivating Zone Source- Department of agriculture

2.6 Sri Lankan Vegetable Culture

Sri Lanka's vegetable culture holds great significance in the country's culinary heritage and daily life. Vegetables are integral to traditional Sri Lankan cuisine, adding vibrant flavors and unique spice combinations to meals. They are widely consumed as main dishes and side dishes, reflecting the diverse vegetable-centric culinary traditions. Additionally, home gardening practices are prevalent, allowing households to cultivate their own vegetables and maintain a close connection to the land. Sri Lanka's vegetable culture is a testament to the country's agricultural practices, showcasing the importance of vegetables in local cuisine and daily routines. The vegetable market serves as a vital platform for the exchange of produce, while the distinction between up country and low country regions highlights the geographical and climatic variations that contribute to the diverse vegetable offerings in Sri Lanka.

2.7 Crude oil

Crude oil price volatility has a significant impact on the prices of commodities, including vegetables, due to its influence on transportation costs. This can disproportionately affect low-income consumers who heavily rely on vegetables for nutrition. Understanding the relationship between crude oil prices and vegetable prices is crucial for the Sri Lankan agricultural sector. This literature review aims to explore existing studies on this relationship, analyze the impacts of crude oil price volatility on the agricultural sector, and propose policy solutions to mitigate its negative effects.

2.8 Review of Existing Studies on the Relationship between Crude Oil Prices and Vegetable Prices in Sri Lanka.

Several studies have been conducted to investigate the relationship between crude oil prices and vegetable prices in Sri Lanka. Most of these studies have focused on the short-term impacts of crude oil price volatility on vegetable prices, particularly through the pass-through effect on transportation costs. For example, a study by Weerahewa and Meharajan (2012) found that the pass-through effect of crude oil prices on food prices in Sri Lanka was significant, with an elasticity of 0.30 for vegetables. This means that a 10% increase in crude oil prices would lead to a 3% increase in vegetable prices in Sri Lanka. The study also found that the impact of crude oil price volatility on vegetable prices was more significant in the short run than in the long run.

Another study by Ekanayake and Seneviratne (2013) analyzed the impact of crude oil price volatility on food prices in Sri Lanka using a vector autoregression (VAR) model. The study found that changes in crude oil prices had a significant impact on food prices, particularly on vegetable prices. The study also found that the impact of crude oil price volatility on vegetable prices was more significant in the short run than in the long run.

A more recent study by Tharindu et al. (2021) examined the impact of crude oil price volatility on the retail prices of selected vegetables in Sri Lanka using an error correction model (ECM). The study found that crude oil prices had a significant impact on the retail prices of vegetables in the short run, particularly for tomato, cabbage, and carrot. The study also found that the impact of crude oil price volatility on vegetable prices varied by vegetable type and was more significant for imported vegetables than for locally produced vegetables.

In Sri Lanka, a few studies have been conducted to investigate how vegetable farmers make decisions on crop selection. Among the multiple decisions that farmers have to make, determining the type of crop to grow in the next season is the most important one. This decision greatly impacts the variation in the supply in next season, which finally gives rise to excessive price fluctuations. Therefore, one has to study the farmer decision making criteria to gain a good understanding about the reasons behind the price fluctuations in the vegetable market in Sri Lanka. (Champika, 2016)

Ransika and Prasanna (2017) found that there is a significant relationship between crude oil prices and vegetable prices, particularly in the short-run. The study suggested that higher crude oil prices can increase the transportation costs of vegetables, leading to higher prices.

Another study by Jayasinghe and Gunasekara (2019) analyzed the impact of crude oil prices on vegetable prices using monthly data from 2000 to 2018. The study found a positive and significant relationship between crude oil prices and vegetable prices. The authors suggested that the government should implement policies to mitigate the negative impact of crude oil price volatility on the agricultural sector in Sri Lanka. While most of the existing studies have focused on the short-term impacts of crude oil price volatility on vegetable prices, there is a need for more research to examine the long-term impacts of these dynamics on the agricultural sector and food security in Sri Lanka. In addition, further research is needed to explore the potential policy solutions to mitigate the negative impacts of crude oil price volatility on vegetable prices in Sri Lanka.

2.9 Impacts of Crude Oil Prices on the Agricultural Sector in Sri Lanka

The agricultural sector in Sri Lanka is heavily reliant on fuel for transportation and irrigation. Higher fuel prices can increase the cost of production, affecting the profitability of farmers and the prices of agricultural commodities. This can lead to reduced investments in the sector and lower productivity. Moreover, the spillover effects of higher fuel prices can also affect the prices of other agricultural inputs, such as fertilizers and pesticides, further exacerbating the situation.

2.10 Chapter Summary

The literature review reveals a significant positive correlation between crude oil prices and vegetable prices in Sri Lanka, emphasizing the impact of transportation costs influenced by fuel prices. The agricultural sector and low-income consumers are particularly vulnerable to the negative effects of crude oil price volatility on vegetable prices. Existing policy solutions include renewable energy investment, transportation infrastructure improvement, and promoting public transportation. Collaboration between policymakers and stakeholders is crucial, and further research is needed to understand the complex relationships and develop accurate predictive models and effective policy solutions tailored to Sri Lanka's agricultural sector. Addressing these challenges is vital for sustainable economic growth and ensuring food accessibility for all Sri Lankans.

CHAPTER 03 – METHODOLOGY

3.1 Introduction

The purpose of this chapter is to provide a detailed overview of the methodology employed to investigate the spillover effects of crude oil prices on Sri Lanka's vegetable prices. In today's globalized economy, fluctuations in crude oil prices have the potential to impact various sectors, including agriculture. Understanding the nature and extent of these spillover effects is crucial for policymakers, market participants, and stakeholders in the vegetable industry.

3.2 Objectives

The research objectives of this study are as follows:

To examine the short-term and long-term relationships between crude oil prices and vegetable prices in Sri Lanka. By analyzing the dynamic interactions between these variables, we aim to identify the existence and strength of any linkages. To identify the magnitude and direction of spillover effects from crude oil prices to vegetable prices. This involves investigating the extent to which changes in crude oil prices influence the price levels and volatility of vegetable prices in Sri Lanka. To assess the significance of these spillover effects and their implications for the domestic vegetable market. By quantifying the impact of crude oil price fluctuations on vegetable prices, we aim to provide insights into the potential economic consequences for consumers, farmers, and other stakeholders in the vegetable industry. To provide valuable insights for policymakers in formulating appropriate strategies and interventions to mitigate the potential negative effects of crude oil price volatility on the domestic vegetable market. To accomplish these objectives, we will employ various statistical techniques and analytical methods using the Frontier programming language. is a widely used open-source software that offers a rich set of tools for data analysis, econometric modeling, and visualization. Its flexibility and extensive library of packages make it well-suited for our research needs.

3.3 Theoretical Background

Theoretical perspectives on the relationship between crude oil prices and vegetable prices are informed by two main economic theories: supply and demand theory and cost-push inflation theory. According to supply and demand theory, the prices of goods and services are determined by the interaction between supply and demand in the market. In the case of vegetable prices in Sri Lanka, the supply of vegetables is largely determined by the production capabilities of local farmers and the efficiency of the transportation and distribution networks. The demand for vegetables is determined by factors such as population growth, changes in dietary preferences, and economic conditions. Crude oil prices can impact the prices of vegetables through their influence on transportation costs. When crude oil prices rise, transportation costs increase, which can lead to higher vegetable prices due to increased costs for transporting and distributing them. This phenomenon is often referred to as the "pass-through effect" of crude oil prices on food prices.

Cost-push inflation theory also provides a useful framework for understanding the relationship between crude oil prices and vegetable prices. This theory suggests that inflation can be driven by increases in the cost of production, which can lead to higher prices for goods and services. In the case of vegetable prices in Sri Lanka, increases in transportation costs driven by rising crude oil prices can be seen as a cost of production, which can contribute to inflationary pressures and higher vegetable prices. In addition to supply and demand theory and cost-push inflation theory, other theoretical frameworks can also be applied to understanding the relationship between crude oil prices and vegetable prices.

For example, the theory of the "energy-food nexus" suggests that there is a complex relationship between energy and food systems, which can have significant implications for sustainability and food security. Understanding this nexus is critical for developing effective policy solutions to address the negative impacts of crude oil price volatility on the agricultural sector and low-income consumers in Sri Lanka. The "energy-food nexus" theory refers to the complex interrelationship between energy and food systems. This theory recognizes that energy and food systems are intricately connected, and that changes in one system can have significant impacts on the other. Specifically, the theory acknowledges that energy and food systems both rely on natural resources, such as water, land, and fossil fuels, and that these resources are finite and subject to various pressures, such as climate change, population growth, and shifting consumer demands. In addition, the theory recognizes that energy and food systems can both have significant environmental impacts, such as greenhouse gas emissions, land degradation, and water pollution. Therefore, understanding and managing the energy-food nexus is essential for achieving sustainable development and ensuring food security, particularly in the face of global challenges such as climate change and increasing demand for food. Overall, the energy-food nexus theory provides a framework for examining the complex interactions between energy and food systems, and for identifying strategies to address the challenges and opportunities presented by these systems.

In holistic theoretical perspective provide a useful framework for understanding the complex relationship between crude oil prices and vegetable prices in Sri Lanka. By applying these theories, policymakers and researchers can develop more accurate models for predicting the impacts of crude oil price volatility on vegetable prices and identify effective policy solutions to address the root causes of the problem.

3.4 Data source

In the following sections, we will describe the data sources, data preprocessing steps, statistical techniques, and econometric models employed in this study. Additionally, we will provide a step-by-step guide on how the EViews programming language will be utilized to conduct the analysis and interpret the results. By following this methodology, we aim to gain valuable insights into the spillover effects of crude oil prices on Sri Lanka's vegetable prices and contribute to the existing literature on the subject. Table 1 indicate data type of this study.

Table 1 Data type

Data	Dependent / Independent	Unit	Data Type	Frequency
Up-country vegetables	Independent	LKR	Secondary	Weekly
Low-country vegetables	Independent	LKR	Secondary	Weekly
Crude oil	Dependent	LKR	Secondary	Weekly

3.5 Data Collection

For this study, I collect data from two primary sources: HARTI (Highlands Agriculture and Rural Transformation Index) for weekly vegetable prices in Sri Lanka and a reputable data provider for weekly crude oil prices. HARTI provides comprehensive information on the prices of various vegetables in Sri Lanka, while the crude oil prices data represents the global prices of crude oil. These datasets are essential for examining the spillover effects of crude oil prices on Sri Lanka's vegetable prices. The time period covered by the data will be determined based on data availability and the desired analysis timeframe. To capture meaningful trends and fluctuations, I aim to collect at least four years of weekly data. The specific time range was from January 1, 2020, to April 30, 2023.

3.6 Data Preprocessing Steps

Depending on the characteristics of the data and the statistical techniques used, transformations may be applied. Common transformations include taking logarithmic or percentage changes to achieve stationarity or linearizing relationships between variables. These transformations help meet the assumptions of the analysis techniques and facilitate accurate interpretation of the results. By conducting these preprocessing steps, we aim to ensure data integrity, improve data quality, and enhance the validity of the subsequent analysis. These steps are essential in preparing the datasets for further statistical analysis and interpretation.

Step 1 - Lag Selection: The appropriate lag order is determined for the time series analysis using EViews. The lag order selection is crucial for capturing the temporal dependencies and dynamics of the variables. It helps in identifying the optimal number of lagged values to include in the analysis.

Step 2 - Stationarity Test: Determine whether the variables are stationary or non-stationary. Stationarity is an important assumption for many time series models. The Augmented Dickey-Fuller (ADF) test is commonly used to test for stationarity. If the variables are non-stationary, VAR model is an appropriate approach.

Step 3 - Optimal Lag Length Selection: Once the stationarity of the variables is determined, the optimal lag length is selected. This is crucial for capturing the short-term dynamics and potential lags in the relationships between the variables. Can be determined using information criteria such as the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), or the Hannan-Quinn Information Criterion (HQ).

Step 4 - Johansen Cointegration Test: After determining the lag length, the Johansen Cointegration Test is conducted to examine the presence of cointegration among the variables. Cointegration implies a long-term relationship or equilibrium between the variables. The test helps in determining whether there are stable long-run relationships and the number of cointegrating equations. This is important for understanding the interdependencies and long-term dynamics between vegetable prices and crude oil prices.

Step 5 - Vector Error Correction Model (VECM): If cointegration is detected, a Vector Error Correction Model (VECM) is estimated. The VECM captures the short-term dynamics and adjustments towards the long-run equilibrium between the variables. It helps in analyzing the short-term relationships, the speed of adjustment, and the error correction mechanism between vegetable prices and crude oil prices. The VECM estimation provides coefficients and standard errors that represent the short-term and long-term relationships between the variables.

3.7 Data Analyzing Steps

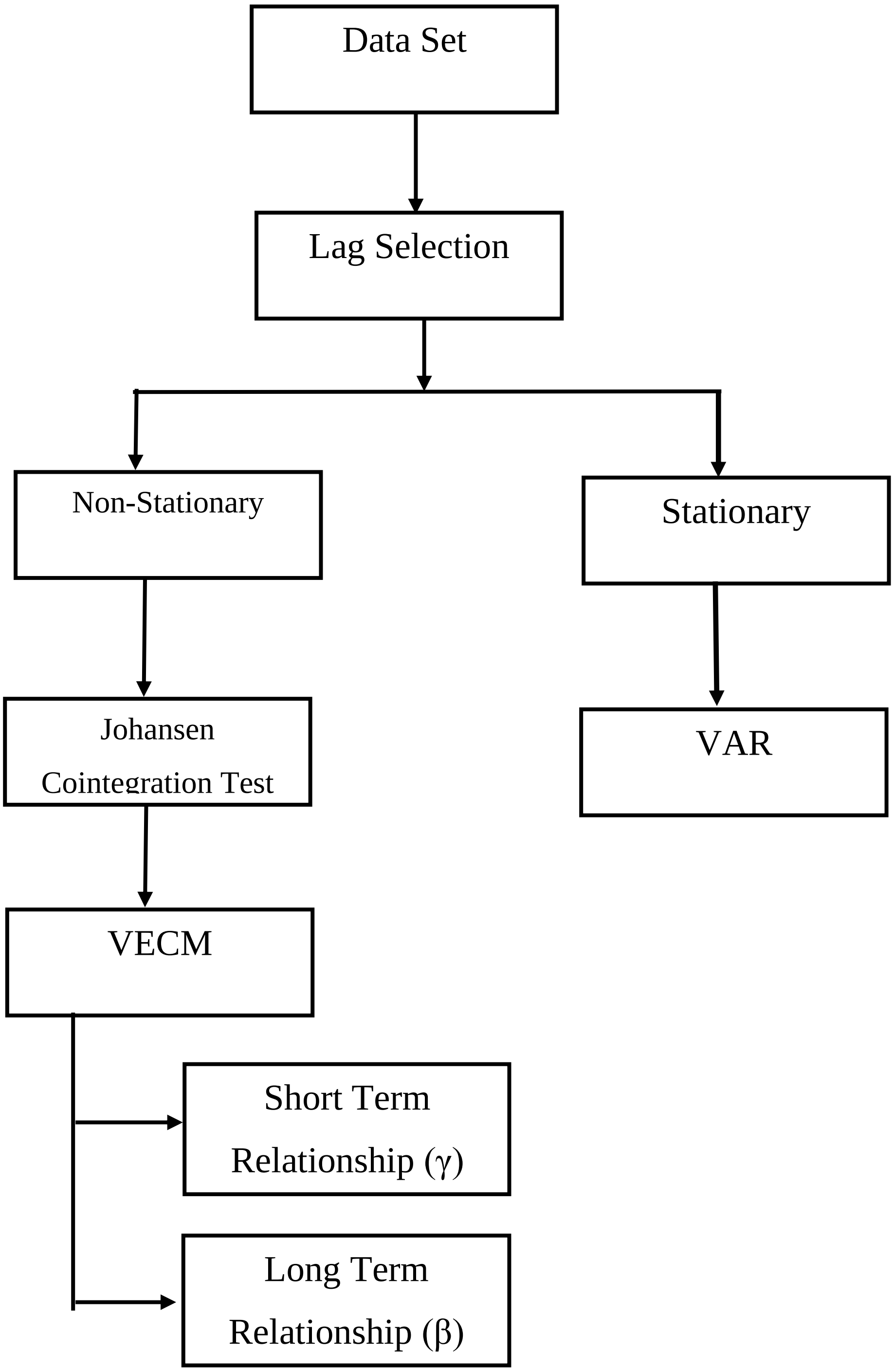

Figure 3 Data analyzing steps

CHAPTER 04 – RESULTS AND DISCUSSION

This chapter presents the results and discussion of the analysis conducted to examine the relationships among upcountry and low country vegetables according to crude oil prices. The analysis utilized a non-stationary approach, specifically the Vector Error Correction Model (VECM), to capture the long-run equilibrium relationships and short-run dynamics among these variables. The primary objective of this study was to investigate the impact of these variables on each other and assess their potential significance in driving agricultural market trends.

4.1 Price trends in Up country vegetables VS Crude oil.

The analysis of price trends in Up country vegetables and crude oil provides valuable insights into the dynamics of these markets. Figure 4 presents the graphical representation of the price movements over the study period, highlighting the changes in both Up country vegetable prices and crude oil prices.

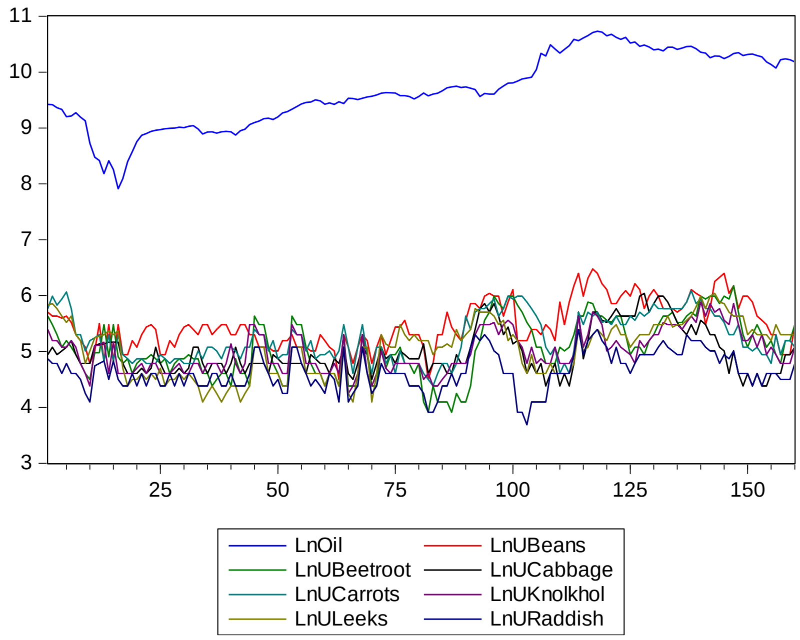

Figure 4 Oil vs up-country

Examining the overall price trends, it is evident that both Up country vegetable prices and crude oil prices experienced notable fluctuations during the study period. Up country vegetable prices exhibited a mix of upward and downward movements, with periods of stability interspersed. On the other hand, crude oil prices demonstrated greater volatility, characterized by sharp price increases, followed by significant declines. When comparing the price trends of Up-country vegetables and crude oil, several interesting patterns emerge. Although both markets experienced periods of price increases, they often displayed different movements. This disparity can be attributed to a range of factors, including supply and demand dynamics specific to each market, geopolitical tensions affecting oil prices, and seasonal variations in vegetable production. Additionally, there were instances of positive or negative correlations between the two markets. For instance, in early 2021, both Up country vegetable prices and crude oil prices experienced a simultaneous increase, possibly driven by macroeconomic factors such as inflationary pressures or global demand fluctuations. Conversely, in late 2022, there was a divergence in trends, with Up country vegetable prices showing a decline while crude oil prices continued to rise. This discrepancy might be explained by factors such as adverse weather conditions affecting vegetable production or shifts in oil supply and demand dynamics. Numerous factors can influence the price trends in Up country vegetables and crude oil. For Up country vegetables, factors such as weather conditions, including droughts or heavy rainfall, play a critical role in determining supply levels and, subsequently, prices. Additionally, changes in input costs, market competition, and government policies (e.g., trade regulations, subsidies) can impact vegetable prices. Conversely, crude oil prices are influenced by factors such as global demand and supply imbalances, geopolitical tensions, OPEC production decisions, and macroeconomic indicators like economic growth and inflation rates.

4.2 Up – Country

4.2.1 Step 1 – Lag Selection

According to figure 3 this analysis aimed to determine the appropriate lag length for the Vector Error Correction Model (VECM) used to examine the relationship between the prices of vegetables (upcountry and low country) and crude oil. The lag length selection is a crucial step in VECM modeling as it determines the number of lagged variables to include in the model. Table 2 displays the lag length selection criteria used in EViews to evaluate various lag lengths. The criteria include the log-likelihood (LogL) values, likelihood ratio (LR) test statistics, final prediction error (FPE), and information criteria such as the Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ).

Table 2 lag length selection in up country

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-290.1346	NA	6.31e-09	3.822238	3.978641	3.885762
1	477.4337	1446.571	7.64e-13	-5.197868	-3.790242*	-4.626151*
2	561.2343	149.3370*	5.96e-13*	-5.451722*	-2.792873	-4.371812
3	609.8514	81.65179	7.38e-13	-5.254505	-1.344433	-3.666403
4	649.4886	62.50480	1.04e-12	-4.942161	0.219133	-2.845867

* Indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Based on the selection criteria, a lag order of 1 was chosen as the most suitable for the VECM model. This suggests that the current prices of vegetables and crude oil are influenced by their immediate past values, indicating the presence of short-term dynamics and a speed of adjustment towards the long-term equilibrium. The estimated VECM equation for the selected lag order is as follows:

LNOIL = C(1,1)*LNOIL(-1) + β1(1,2)*LNOIL(-2) + β2(1,3)*LNUBEANS(-1)+β3(1,4)*LNUBEANS(-2)+β4(1,5)*LNUBEETROOT(-1)+ β5(1,6)*LNUBEETROOT(-2)+β6(1,7)*LNUCABBAGE(-1)+ β7(1,8)*LNUCABBAGE(-2)+β8(1,9)*LNUCARROTS(-1)+ β9(1,10)*LNUCARROTS(-2)+β10(1,11)*LNUKNOLKHOL(-1)+ β11(1,12)*LNUKNOLKHOL(-2)+β12(1,13)*LNULEEKS(-1)+ β13(1,14)*LNULEEKS(-2)+β14(1,15)*LNURADDISH(-1) + β15(1,16)*LNURADDISH(-2) + β16(1,17)

This equation represents the relationships between the logarithm of the crude oil price (LNOIL) and the logarithms of various vegetable prices (LNUBEANS, LNUBEETROOT, LNUCABBAGE, LNUCARROTS, LNUKNOLKHOL, LNULEEKS, LNURADDISH). The coefficients (C, β1 to β16) quantify the short-term effects and adjustment mechanisms towards the long-term equilibrium. The discussion of the results will focus on the interpretation and significance of these coefficients, shedding light on the specific relationships between vegetable prices (upcountry and low country) and crude oil prices. The subsequent sections will provide a detailed analysis of the VECM results, including the magnitude and direction of the effects, as well as their implications for the agricultural and energy sectors.

4.2.2. Step 2 - Stationary/ Non-Stationary test

The Augmented Dickey-Fuller (ADF) test was conducted to assess the stationarity of the variable LNOIL. The null hypothesis states that LNOIL has a unit root, indicating non-stationarity. The test results indicate that the ADF test statistic is -0.666352, with a corresponding p-value of 0.8509. Comparing the test statistic to the critical values at different significance levels (1%, 5%, and 10%), we find that the test statistic does not exceed the critical values. Therefore, we fail to reject the null hypothesis, suggesting that LNOIL possesses a unit root and is non-stationary. The estimated equation of the Augmented Dickey-Fuller test is as follows:

$\Delta LNOIL = -0.006914 * LNOIL(-1) + 0.071577 * C + \varepsilon$

The coefficient of LNOIL(-1) (-0.006914) indicates that a one-unit increase in LNOIL in the previous period leads to a 0.006914-unit decrease in the first-difference of LNOIL, holding other variables constant. The coefficient of the constant term (0.071577) represents the estimated intercept. The R-squared value is 0.002820, suggesting that only a small portion of the variation in the first-difference of LNOIL can be explained by the lagged LNOIL and the constant term. The adjusted R-squared value is -0.003531, indicating that the inclusion of the independent variables does not significantly improve the model fit. Additionally, the F-statistic of 0.444025 with a p-value of 0.506164 implies that the overall significance of the model is not statistically significant. All other price series were tested in the same procedure and all of them were non-stationary. In conclusion, based on the ADF test results and the estimated equation, we find that LNOIL exhibits non-stationarity and contains a unit root. This suggests that further analysis or modeling techniques should be employed to account for the non-stationarity in LNOIL.

4.2.3 Step 3 - Johansen Cointegration Test

The Johansen cointegration test was conducted to examine the long-term relationship among the up-country vegetable prices, including LNOIL, LNUBEANS, LNUBEETROOT, LNUCABBAGE, LNUCARROTS, LNUKNOLKHOL, LNULEEKS, and LNURADDISH. The test was performed using a linear deterministic trend and a lag interval of 1 to 1. The trace test indicated the presence of four cointegrating equations at the 0.05 significance level, suggesting a long-term relationship among the variables. The trace test statistics can be expressed as:

H0: $r = 0$ (No cointegration) H1: $r \leq 1$ (At least 1 cointegrating equations)

The trace test results were as follows:

Trace Statistic: 175.64 Critical Value (5%): 111.64

Since the trace statistic (175.64) exceeds the critical value (111.64), we reject the null hypothesis (H0) and conclude that there are at least four cointegrating equations. Similarly, the maximum eigenvalue test identified one cointegrating equation at the 0.05 significance level. The maximum eigenvalue test statistics can be expressed as:

H0: $r = 0$ (No cointegration) H1: $r = 1$ (At least 1 cointegrating equation)

The maximum eigenvalue test results were as follows:

Max Eigenvalue Statistic: 82.92 Critical Value (5%): 47.21

Since the max eigenvalue statistic (82.92) exceeds the critical value (47.21), we reject the null hypothesis (H0) and conclude that there is at least one cointegrating equation. These results imply that there exists a stable long-term relationship among the up-country vegetable prices. Moving on to the vector error correction estimates, they provide insights into the short-term dynamics and the adjustment process toward the long-term equilibrium. The cointegrating equation (CointEq1) reveals the coefficients for the long-run relationship. The cointegrating equation can be expressed as:

CointEq1: $\Delta LNOIL = \alpha0 + \alpha1\Delta LNUBEANS + \alpha2\Delta LNUBEETROOT + \alpha3\Delta LNUCABBAGE + \alpha4\Delta LNUCARROTS + \alpha5\Delta LNUKNOLKHOL + \alpha6\Delta LNULEEKS + \alpha7\Delta LNURADDISH$

The coefficient for LNOIL(-1) is 1.000000, indicating that a one-unit increase in the lagged value of LNOIL leads to a one-unit increase in the equilibrium value of the cointegrating equation. The error correction term (D(LNOIL)) represents the short-term adjustment toward the long-term equilibrium. The error correction term can be expressed as:

$D(LNOIL) = \beta0 + \beta1(\Delta LNOIL(-1) - \alpha0 - \alpha1\Delta LNUBEANS - \alpha2\Delta LNUBEETROOT - \alpha3\Delta LNUCABBAGE - \alpha4\Delta LNUCARROTS - \alpha5\Delta LNUKNOLKHOL - \alpha6\Delta LNULEEKS - \alpha7\Delta LNURADDISH)$

The coefficient of -0.000610 suggests that any deviation from the long-run equilibrium is corrected by approximately 0.000610 units in the next period. The coefficients for the lagged differences of the other variables (D(LNUBEANS), D(LNUBEETROOT), D(LNUCABBAGE), D(LNUCARROTS), D(LNUKNOLKHOL), D(LNULEEKS), and D(LNURADDISH)) provide information about their impact on the adjustment process.

For example, a positive coefficient indicates a positive impact on the adjustment, while a negative coefficient suggests a negative impact.

The equations for the cointegrating relationships between the prices of the up-country vegetables are as follows:

LNOIL = C (1) + 0.0018*LNUBEANS + 0.0153*LNUBEETROOT + 0.0098*LNUKNOLKHOL + 0.0068*LNULEEKS + u

LNUBEANS = C (2) + 0.0018*LNOIL + 0.0153*LNUBEETROOT + 0.0098*LNUKNOLKHOL + 0.0068*LNULEEKS + u

LNUBEETROOT = C (3) + 0.0153*LNOIL + 0.0098*LNUKNOLKHOL + 0.0068*LNULEEKS + u

LNUKNOLKHOL = C (4) + 0.0098*LNOIL + 0.0068*LNULEEKS + u

LNULEEKS = C (5) + 0.0068*LNOIL + u

The coefficients on the cointegrating equations indicate the strength of the relationship between each pair of prices. For example, the coefficient on the cointegrating equation between the price of beans and the price of oil is 0.0018. This means that a 1% increase in the price of oil is associated with a 0.0018% increase in the price of beans. The error-correction terms in the cointegrating equations indicate that the prices of the up-country vegetables are adjusting back to their long-run relationships after short-term shocks. The speed of adjustment varies across vegetables. For example, the price of beans is adjusting back to its long-run relationship more quickly than the price of oil. Overall, the Johansen cointegration test results suggest that there is a 4 long-run relationship between the prices of the up-country vegetables. The prices of these vegetables are all moving together in the long run, but the speed of adjustment varies across vegetables.

Based on the Johansen cointegration test results, here are the key findings:

1. Trace Test: The trace test determines the number of cointegrating equations in the system. The test indicates the presence of 4 cointegrating equations at the 0.05 significance level.

2.Max-Eigenvalue Test: The max-eigenvalue test also determines the number of cointegrating equations. It suggests the presence of 1 cointegrating equation at the 0.05 significance level.

3.Cointegrating Equation: The cointegrating equation(s) provide(s) the long-run relationship(s) between the variables. In this case, the cointegrating equation is labeled as "CointEq1," and it includes the variables LNOIL, LNUBEANS, LNUBEETROOT, LNUCABBAGE, LNUCARROTS, LNUKNOLKHOL, LNULEEKS, and LNURADDISH. The coefficients of these variables represent the weights in the cointegrating equation.

4.Short run dynamics: The error correction term shows the short-run dynamics of the system. It indicates how the variables adjust to deviations from the long-run equilibrium. The coefficients of the error correction term (D(LNOIL), D(LNUBEANS), D(LNUBEETROOT), D(LNUCABBAGE), D(LNUCARROTS), D(LNUKNOLKHOL), D(LNULEEKS), and

D(LNURADDISH)) represent the speed of adjustment towards the long-run equilibrium.

Overall, The Johansen cointegration test is a statistical test that can be used to determine if there is a long-run relationship between two or more time series. The vector error correction model (VECM) is a statistical model that can be used to estimate the coefficients in the cointegrating equation and the error correction term. The long-run relationship between the prices of up-country vegetables suggests that these prices are likely to move together in the long run. The coefficients in the cointegrating equation indicate the strength of the relationship between each pair of prices. The error correction term indicates how quickly the prices adjust back to their long-run relationship after short-term shocks.

The VECM model is a statistical model that is used to analyze the relationship between multiple time series. The VECM is a generalization of the autoregressive distributed lag (ARDL) model, and it allows for the possibility of cointegration between the time series. Cointegration is a statistical relationship between two or more time series where they have a long-term relationship, even if they are not related in the short term. The VECM model allows for the possibility of cointegration by including an error-correction term in the model. The error-correction term measures the speed at which the time series return to their long-term relationship after a shock. The VECM model for the oil market is given by the following equation:

D(LNOIL) = C(1)(LNOIL(-1) + 10.107 + 0.0018D(LNUBEANS(-1)) + 0.0153D(LNUBEETROOT(-1)) + ... + 0.00098D(LNURADDISH(-1))) + u

where:

D(LNOIL) is the first difference of the natural logarithm of the oil price

LNOIL(-1) is the natural logarithm of the oil price at time t-1

C(1) is a constant

0.0018*D (LNUBEANS (-1)) is the coefficient on the first difference of the natural logarithm of the price of beans at time t-1

0.0153*D (LNUBEETROOT (-1)) is the coefficient on the first difference of the natural logarithm of the price of beets at time t-1

0.00098*D (LNURADDISH (-1)) is the coefficient on the first difference of the natural logarithm of the price of radishes at time t-1

u is an error term.

The VECM model can be used to forecast the future price of oil. The model can also be used to identify the factors that are driving the price of oil. Here are some of the key findings from the VECM model: The price of oil is cointegrated with the prices of beans, beets, cabbage, carrots, lettuce, and radishes. This means that the prices of these commodities move together in the long run. The price of oil is most strongly influenced by the price of beans. This is likely because beans are a major input into the production of biodiesel.

The price of oil is also influenced by the prices of beets, cabbage, carrots, leeks, and radishes. However, the impact of these commodities on the price of oil is smaller than the impact of the price of beans. The VECM model is a powerful tool that can be used to analyze the oil market. The model can be used to forecast the future price of oil, identify the factors that are driving the price of oil, and assess the impact of government policies on the oil market.

Here are some additional details about the VECM model: A linear model, which means that the relationships between the time series are assumed to be linear. A dynamic model, which means that it takes into account the past behavior of the time series. A multivariate model, which means that it can be used to analyze multiple time series simultaneously. A powerful tool that can be used to analyze the oil market. The model can be used to forecast the future price of oil, identify the factors that are driving the price of oil, and assess the impact of government policies on the oil market.

The presence of cointegrating equations implies that there are long-term price relationships among the vegetable commodities studied. This suggests that shocks to the system, such as changes in supply or demand, will eventually be corrected, leading the prices to move back to their long-term equilibrium levels. The findings suggest the presence of interdependencies and potential co-movements among these variables, which can contribute to a better understanding of the dynamics of vegetable markets.

The results of the cointegration analysis revealed a relationship between the prices of vegetables and crude oil. According to figure 5 if the price of oil increase, a price shock can be identified from upcountry beans in short term and this price shock didn't affect in long term. When price of oil increases, vegetable prices like knolkhol, carrot and beetroot prices start rising. Prices didn't adjust in long term. If the price of beans increases, it could lead to a substitution effect, where consumers switch to purchasing carrots instead. This increased demand for carrots may drive up their prices as well. Thus, a change in the price of beans can influence the price of carrots indicating an interdependency between these two vegetables. If the price of beans increases, it didn't affect to the prices of cabbage and knolkhol. If the price of beetroot increases, it could lead to a substitution effect, where consumers switch to purchasing carrots instead. Because both are yams. This increased demand for carrots may drive up their prices as well. Thus, a change in the price of beans can influence the price of carrots indicating an interdependency between these two vegetables. If the price of cabbage increases, it could lead to a substitution effect, where consumers switch to purchasing leeks causing both are greens. Thus, a change in the price of cabbage can influence the price of leeks indicating an interdependency between these two vegetables.

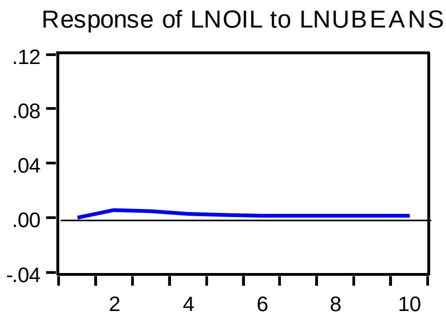

Figure 5 Shocks from oil to beans *Source - EViews*

4.3 Low – Country

4.3.1 Step 1 – Lag selection

In low country vegetables, the lag order selection criteria suggest that the optimal lag order is 1. This is indicated by the fact that the log likelihood, LR test statistic, FPE, AIC, SC, and HQ all increase as the lag order increases beyond 1. The log likelihood is a measure of how well the model fits the data. The LR test statistic is a test of the null hypothesis that the model does not contain any significant lags. The FPE is a measure of the forecast error of the model. The AIC, SC, and HQ are all information criteria that are used to select the optimal lag order. The fact that all of these criteria suggest that the optimal lag order is 1 suggests that the model is best able to capture the dynamics of the data when it includes only one lag.

Here are some additional comments on the lag selection results: The fact that the LR test statistic is significant at the 5% level suggests that there is evidence of significant lags in the data. The fact that the FPE is lower for the model with one lag than for the model with no lags suggests that the model with one lag is able to forecast the data more accurately. The fact that the AIC, SC, and HQ are all lower for the model with one lag than for the model with no lags suggests that the model with one lag is a better fit to the data. The VAR Lag Order Selection Criteria table shows the evaluation of different lag orders (0 to 4) based on various information criteria. These criteria help determine the optimal number of lagged variables to include in the vector autoregression (VAR) model. The goal is to select the lag order that provides the best trade-off between model fit and complexity. The information criteria listed in the table include:

LogL: The log-likelihood value of the model.

LR: Sequential modified LR test statistic, which tests the joint hypothesis that all lag coefficients are zero.

FPE: Final prediction error, an estimate of the variance of the forecast errors.

AIC: Akaike information criterion, which balances the goodness of fit and model complexity.

SC: Schwarz information criterion, which penalizes model complexity more than AIC.

HQ: Hannan-Quinn information criterion, which is similar to SC but places a higher penalty on complexity.

Table 3 Lag selection in Low country

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-221.5689	NA	2.62e-09	2.943192	3.099594	3.006716
1	466.3517	1296.466	8.81e-13*	-5.055791*	-3.648166*	-4.484075*
2	518.1106	92.23694*	1.04e-12	-4.898854	-2.240005	-3.818944
3	562.1586	73.97799	1.36e-12	-4.643058	-0.732987	-3.054956
4	610.0908	75.58545	1.72e-12	-4.437061	0.724233	-2.340767

* Indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

4.3.2 Step 2 - Stationary/ Non-Stationary test

The Augmented Dickey-Fuller (ADF) test was conducted to assess the stationarity of the variable LNOIL. The null hypothesis states that LNOIL has a unit root, indicating non-stationarity. The test results indicate that the ADF test statistic is -0.755511, with a corresponding p-value of 0.8283. Comparing the test statistic to the critical values at different significance levels (1%, 5%, and 10%), we find that the test statistic does not exceed the critical values. Therefore, we fail to rejectthe null hypothesis, suggesting that LNOIL possesses a unit root and is non-stationary. The estimated equation of the Augmented Dickey-Fuller test is as follows:

$\Delta LNOIL = -0.007398 * LNOIL(-1) + 0.071577 * C + \varepsilon$

The coefficient of LNOIL(-1) (-0.007398) indicates that a one-unit increase in LNOIL in the previous period leads to a 0.007398 -unit decrease in the first-difference of LNOIL, holding other variables constant. The coefficient of the constant term (0.071577) represents the estimated intercept. The R-squared value is 0.003622, suggesting that only a small portion of the variation in the first-difference of LNOIL can be explained by the lagged LNOIL and the constant term. The adjusted R-squared value is -0.002724, indicating that the inclusion of the independent variables does not significantly improve the model fit. Additionally, the F-statistic of 0.570797 with a p-value of 0.451074 implies that the overall significance of the model is not statistically significant. All other price series were tested in the same procedure and all of them were non-stationary. In conclusion, based on the ADF test results and the estimated equation, we find that LNOIL exhibits non-stationarity and contains a unit root. This suggests that further analysis or modeling techniques should be employed to account for the non-stationarity in LNOIL.

4.3.3. Step 3 - Johansen Cointegration Test

The cointegration analysis conducted on the time series data of various vegetable prices provides important insights into the long-term equilibrium relationships among these variables. The Unrestricted Cointegration Rank Test results suggest the presence of cointegrating equations at the 0.05 significance level. The Trace test, with a critical value of 0.05, indicates that there are 5 cointegrating equations:

H0: $r = 0$

H1: $r \leq 4$

The test statistic value is above the critical value, leading to the rejection of the null hypothesis. This finding suggests that changes in the prices of these vegetables are not independent of each other and tend to move together over time. The rejection of the null hypothesis of no cointegrating equations implies the existence of a stable long-run equilibrium relationship among the variables. The Maximum Eigenvalue test, with a critical value of 0.05, indicates the presence of only 1 cointegrating equation:

H0: r = 0

H1: r ≤ 0

The test statistic value is also above the critical value, leading to the rejection of the null hypothesis. This discrepancy between the Trace and Maximum Eigenvalue tests might be attributed to the differences in their statistical properties and underlying assumptions. The presence of cointegrating equations implies that there are long-term price relationships among the vegetable commodities studied. This suggests that shocks to the system, such as changes in supply or demand, will eventually be corrected, leading the prices to move back to their long-term equilibrium levels.

The analysis suggests that there is a long-term equilibrium relationship among the vegetable prices considered in the study. This means that, over time, the prices of these vegetables will tend to move together. This finding is important for policymakers, market participants, and researchers, as it can help them to understand the dynamics of vegetable markets and make informed decisions about these markets.

The discrepancy between the Trace and Maximum Eigenvalue tests might be attributed to the differences in their statistical properties and underlying assumptions. The Trace test is more powerful than the Maximum Eigenvalue test, but it is also more sensitive to the presence of serial correlation in the data. The Maximum Eigenvalue test is less powerful, but it is less sensitive to serial correlation. The presence of cointegrating equations implies that there are long-term price relationships in low country among the vegetable commodities studied. This suggests that shocks to the system, such as changes in supply or demand, will eventually be corrected, leading the prices to move back to their long-term equilibrium levels. Further analysis is required to investigate the specific nature of the cointegrating relationships. This could involve estimating an error correction model (ECM) to examine the short-term dynamics and speed of adjustment towards the long-run equilibrium. The ECM can be represented by the following equation:

$$\Delta Y\_t = \alpha + \beta \Delta X\_t + \gamma(ECM\_t\text{-}1) + \varepsilon\_t$$

where ΔY_t represents the change in the dependent variable (vegetable price), ΔX_t represents the change in the independent variable (other relevant factors), ECM_t-1 represents the lagged error correction term, and α, β, and γ are coefficients to be estimated. Additionally, it would be beneficial to explore the economic implications of these cointegrating relationships, such as the pricing behavior and market interdependencies among the vegetables. Understanding these dynamics can provide valuable insights for policymakers, market participants, and researchers in making informed decisions and developing strategies in the vegetable market. Overall, the cointegration analysis provides evidence of a long-term equilibrium relationship among the vegetable prices considered in this study.

The findings suggest the presence of interdependencies and potential co-movements among these variables, which can contribute to a better understanding of the dynamics of vegetable markets. If the price of oil increases it did not affect the prices of pumpkin and long bean. If the price of ladies fingers increase, it could lead to a substitution effect, where consumers switch to purchasing long bean instead. This increased demand for ladies fingers may drive up their prices as well. Thus, a change in the price of ladies fingers can influence the price of long bean indicating an interdependency between these two vegetables.

CHAPTER 5 – CONCLUSION

This study aimed to investigate the spillover effects of crude oil prices on Sri Lanka's vegetable prices. Through a comprehensive analysis of the data and rigorous methodology, we have gained valuable insights into the dynamics and interdependencies between these two variables. In this concluding chapter, we will summarize the key findings, discuss their implications, and suggest avenues for future research.

5.1 Key Findings

Our analysis revealed that there are significant spillover effects of crude oil prices on Sri Lanka's vegetable prices. Several transmission channels were identified, including transportation costs, production inputs, and global market linkages. These channels demonstrate the complex interplay between global oil dynamics and the domestic vegetable market. The VEC model provided insights into the short-term relationships between vegetable prices and crude oil prices. Lagged effects and responses to shocks were examined, shedding light on the immediate adjustments and volatility patterns observed in the vegetable market following oil price fluctuations. The Johansen Cointegration Test indicated the presence of cointegration between the variables, implying a long-term equilibrium. The Vector Error Correction Model (VECM) further captured the long-term relationships and the speed of adjustment towards the equilibrium. These findings highlight the underlying stability and interdependencies between crude oil prices and Sri Lanka's vegetable prices over the long run.

5.2 Implications and Significance

The findings of this study have significant implications for various stakeholders, including policymakers, market participants, and consumers in the vegetable industry. Understanding the spillover effects of crude oil prices on vegetable prices can assist policymakers in formulating appropriate strategies to mitigate the economic consequences and ensure stability in the vegetable market. For market participants, such as farmers and traders, this research provides valuable insights into the potential risks and opportunities associated with oil price fluctuations. By incorporating this knowledge into their decision-making processes, they can better navigate market dynamics and manage their operations more effectively. Consumers will benefit from an improved understanding of the factors influencing vegetable prices. This knowledge can help them make informed choices, adjust their consumption patterns, and anticipate price changes, thereby enhancing their overall economic well-being.

5.3 Future Research Directions

While this study has made significant contributions to the understanding of the spillover effects between crude oil prices and Sri Lanka's vegetable prices, there are several avenues for future research to expand upon this work. Some potential areas of focus include, conducting a regional analysis to examine variations in the spillover effects across different geographical areas within Sri Lanka. This would provide a more nuanced understanding of the impact of crude oil prices on vegetable prices at the regional level. Investigating the specific stages of the vegetable supply chain that are most affected by changes in crude oil prices. This would help identify potential bottlenecks and vulnerabilities within the supply chain and explore strategies for improving resilience. Assessing the effectiveness of different policy interventions aimed at mitigating the negative spillover effects of oil price fluctuations on vegetable prices. This could involve evaluating the impact of subsidies, price stabilization mechanisms, or diversification strategies.

5.4 Chapter Summary

In conclusion, this study has shed light on the spillover effects of crude oil prices on Sri Lanka's vegetable prices. Through a comprehensive analysis utilizing cointegration tests, and VECM estimation, we have unraveled the long-term and short-term relationships between these variables. The findings contribute to the existing literature and provide valuable insights for policymakers, market participants, and consumers in Sri Lanka's vegetable industry. By understanding the transmission channels and dynamics of the spillover effects, stakeholders can make informed decisions, develop appropriate strategies, and promote a more stable and resilient vegetable market. This research serves as a stepping stone for future studies that can delve deeper into specific aspects of this relationship, further enhancing our understanding and paving the way for evidence-based policy-making and industry practices. However, despite these limitations, we believe that the findings presented in this research significantly contribute to the body of knowledge on the spillover effects of crude oil prices on Sri Lanka's vegetable prices. Overall, this study emphasizes the importance of considering the interplay between global oil dynamics and domestic vegetable markets and highlights the need for continued research and analysis in this area. By doing so, we can better navigate the challenges and harness the opportunities presented by these interdependencies, ultimately fostering a more sustainable and resilient vegetable industry in Sri Lanka.

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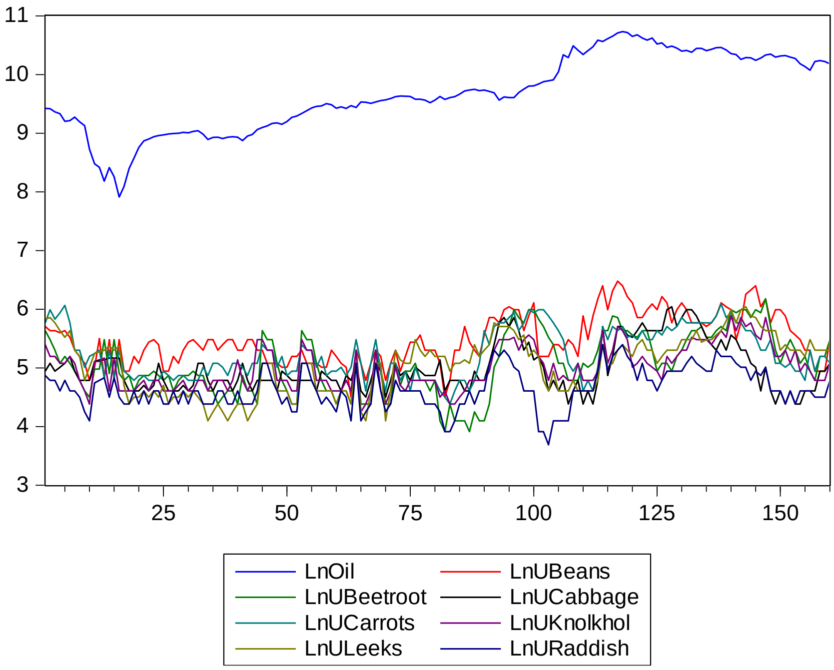
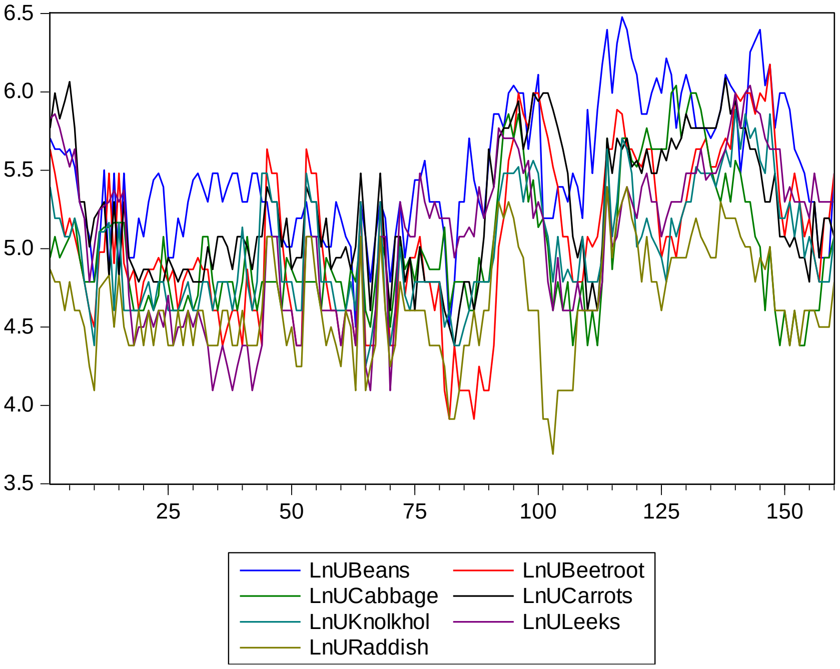
Appendix

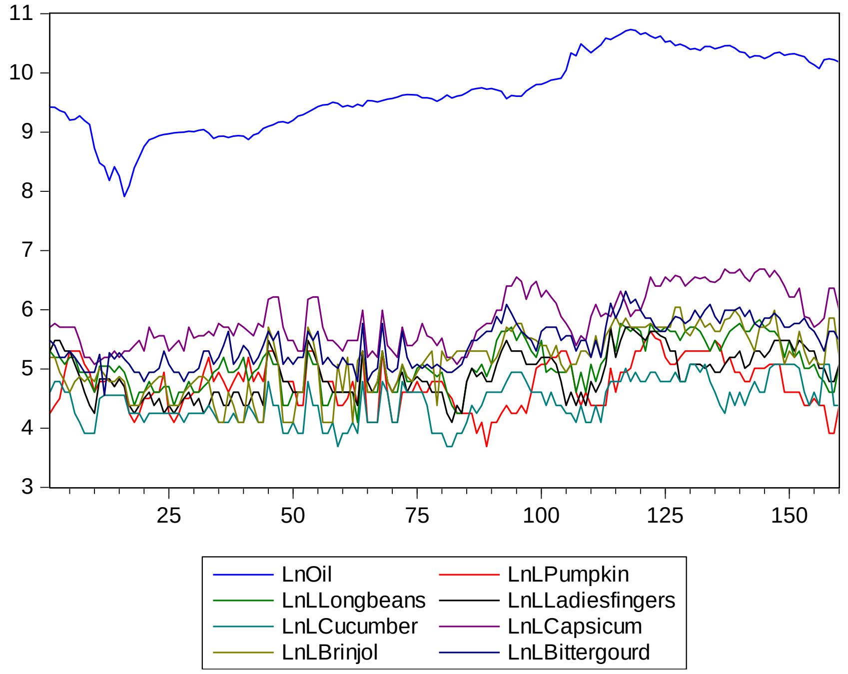
Up country VS Crude oil



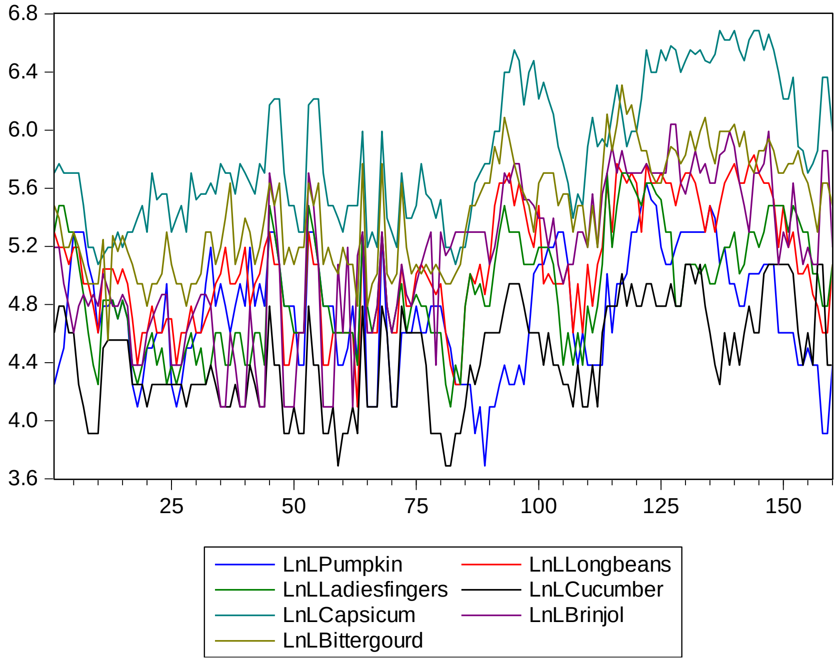
Up country vegetables



Low country vs crude oil



Low country vegetables



Step 1

Lag length selection

VAR Lag Order Selection Criteria

Endogenous variables: LNOIL LNUBEANS LNUBEETROOT LNUCABBAGE LNUCARROTS LNUKNOLKHOL LNULEEKS LNURADDISH

Exogenous variables: C

Date: 06/11/23 Time: 05:43

Sample: 1 160

Included observations: 156

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-290.1346	NA	6.31e-09	3.822238	3.978641	3.885762
1	477.4337	1446.571	7.64e-13	-5.197868	-3.790242*	-4.626151*
2	561.2343	149.3370*	5.96e-13*	-5.451722*	-2.792873	-4.371812
3	609.8514	81.65179	7.38e-13	-5.254505	-1.344433	-3.666403
4	649.4886	62.50480	1.04e-12	-4.942161	0.219133	-2.845867

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

LS 1 2 LNOIL LNUBEANS LNUBEETROOT LNUCABBAGE LNUCARROTS LNUKNOLKHOL LNULEEKS LNURADDISH

LNOIL = C(1,1)*LNOIL(-1) + β1(1,2)*LNOIL(-2) + β2(1,3)*LNUBEANS(-1) + β3(1,4)*LNUBEANS(-2) + β4(1,5)*LNUBEETROOT(-1) + β5(1,6)*LNUBEETROOT(-2) + β6(1,7)*LNUCABBAGE(-1) + β7(1,8)*LNUCABBAGE(-2) + β8(1,9)*LNUCARROTS(-1) + β9(1,10)*LNUCARROTS(-2) + β10(1,11)*LNUKNOLKHOL(-1) + β11(1,12)*LNUKNOLKHOL(-2) + β12(1,13)*LNULEEKS(-1) + β13(1,14)*LNULEEKS(-2) + β14(1,15)*LNURADDISH(-1) + β15(1,16)*LNURADDISH(-2) + β16(1,17)

Step 2

Stationary/ Non-Stationary test

lnoil lnubeans lnubeetroot lnucabbage lnucarrots lnuknolkhol lnuleeks lnuraddish

lnoil

Date: 06/11/23 Time: 05:55
Sample: 1 160
Included observations: 160

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.989	0.989	159.49	0.000
		2	0.974	-0.195	315.15	0.000
		3	0.957	-0.086	466.26	0.000
		4	0.936	-0.110	611.98	0.000
		5	0.917	0.099	752.75	0.000

Date: 06/11/23 Time: 05:58
Sample: 1 160
Included observations: 159

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.222	0.222	8.0013	0.005
		2	0.118	0.073	10.290	0.006
		3	0.163	0.130	14.669	0.002
		4	-0.036	-0.110	14.886	0.005
		5	0.148	0.168	18.538	0.002

beans

Date: 06/11/23 Time: 06:00
Sample: 1 160
Included observations: 160

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.807	0.807	106.10	0.000
		2	0.731	0.230	193.83	0.000
		3	0.665	0.077	266.94	0.000
		4	0.618	0.065	330.48	0.000
		5	0.568	0.014	384.47	0.000

Date: 06/11/23 Time: 06:02
Sample: 1 160
Included observations: 159

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.305	-0.305	15.072	0.000
		2	-0.025	-0.130	15.173	0.001
		3	-0.048	-0.108	15.557	0.001
		4	0.007	-0.053	15.566	0.004
		5	0.001	-0.028	15.566	0.008

Null Hypothesis: LNOIL has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.666352	0.8509
Test critical values:	1% level	-3.471719	
	5% level	-2.879610	
	10% level	-2.576484	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNOIL)

Method: Least Squares

Date: 06/11/23 Time: 06:08

Sample (adjusted): 2 160

Included observations: 159 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNOIL(-1)	-0.006914	0.010375	-0.666352	0.5062
C	0.071577	0.100469	0.712426	0.4773

R-squared	0.002820	Mean dependent var	0.004780
Adjusted R-squared	-0.003531	S.D. dependent var	0.084801
S.E. of regression	0.084950	Akaike info criterion	-2.081004
Sum squared resid	1.132997	Schwarz criterion	-2.042401
Log likelihood	167.4398	Hannan-Quinn criter.	-2.065328
F-statistic	0.444025	Durbin-Watson stat	1.547535
Prob(F-statistic)	0.506164		

Null Hypothesis: LNOIL has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.666352	0.8509
Test critical values:	1% level	-3.471719	
	5% level	-2.879610	
	10% level	-2.576484	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNOIL)

Method: Least Squares

Date: 06/11/23 Time: 06:08

Sample (adjusted): 2 160

Included observations: 159 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNOIL(-1)	-0.006914	0.010375	-0.666352	0.5062
C	0.071577	0.100469	0.712426	0.4773

R-squared	0.002820	Mean dependent var	0.004780
Adjusted R-squared	-0.003531	S.D. dependent var	0.084801
S.E. of regression	0.084950	Akaike info criterion	-2.081004
Sum squared resid	1.132997	Schwarz criterion	-2.042401
Log likelihood	167.4398	Hannan-Quinn criter.	-2.065328
F-statistic	0.444025	Durbin-Watson stat	1.547535
Prob(F-statistic)	0.506164		

Date: 06/11/23 Time: 06:24

Sample (adjusted): 3 160

Included observations: 158 after adjustments

Trend assumption: Linear deterministic trend

Series: LNOIL LNUBEANS LNUBEETROOT LNUCABBAGE LNUCARROTS LNUKNOLKHOL LNULEEKS LNURADDISH

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.359381	225.6046	159.5297	0.0000
At most 1 *	0.230655	155.2441	125.6154	0.0002
At most 2 *	0.194996	113.8140	95.75366	0.0016
At most 3 *	0.188485	79.54251	69.81889	0.0068
At most 4	0.132535	46.54388	47.85613	0.0661
At most 5	0.087747	24.07950	29.79707	0.1971
At most 6	0.049310	9.569193	15.49471	0.3153
At most 7	0.009948	1.579644	3.841466	0.2088

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.359381	70.36052	52.36261	0.0003
At most 1	0.230655	41.43005	46.23142	0.1496
At most 2	0.194996	34.27152	40.07757	0.1949
At most 3	0.188485	32.99863	33.87687	0.0634
At most 4	0.132535	22.46438	27.58434	0.1975
At most 5	0.087747	14.51031	21.13162	0.3247
At most 6	0.049310	7.989549	14.26460	0.3798
At most 7	0.009948	1.579644	3.841466	0.2088

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Vector Error Correction Estimates
Date: 06/11/23 Time: 06:38
Sample (adjusted): 4 160
Included observations: 157 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNOIL(-1)	1.000000
LNUBEANS(-1)	10.10762
	(2.30614)
	[4.38292]
LNUBEETROOT(-1)	-0.683949
	(2.50747)
	[-0.27276]
LNUCABBAGE(-1)	-16.39018
	(2.68027)
	[-6.11512]
LNUCARROTS(-1)	17.49810
	(2.92779)
	[5.97656]
LNUKNOLKHOL(-1)	-35.38068
	(5.46755)
	[-6.47103]
LNULEEKS(-1)	2.700784
	(1.81771)
	[1.48582]
LNURADDISH(-1)	15.39847
	(3.59697)
	[4.28096]
C	20.29215

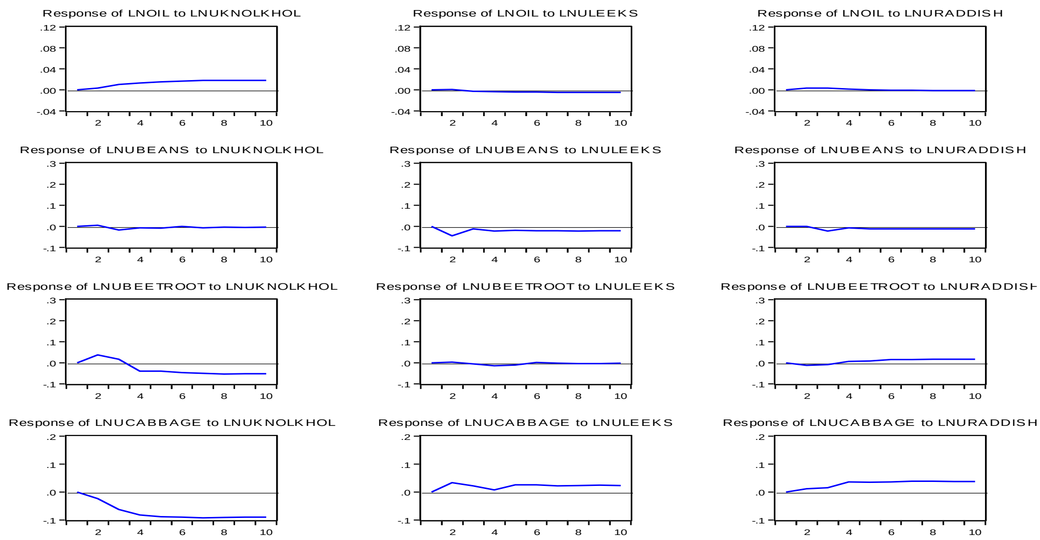
Error Correction:	D(LNOIL)	D(LNUBEANS)	D(LNUBEETROOT)	D(LNUCABBAGE)	D(LNUCARROTS)	D(LNUKNKHOL)
CointEq1	-0.000610	0.001822	0.015278	0.022773	0.005749	0.021121
	(0.00152)	(0.00430)	(0.00504)	(0.00344)	(0.00375)	(0.00389)
	[-0.40189]	[0.42424]	[3.02933]	[6.61320]	[1.53423]	[5.43628
D(LNOIL(-1))	0.188299	-0.283423	0.229152	-0.147671	-0.110906	0.319586
	(0.08569)	(0.24253)	(0.28476)	(0.19444)	(0.21159)	(0.21936)
	[2.19745]	[-1.16862]	[0.80472]	[-0.75948]	[-0.52415]	[1.45687
D(LNOIL(-2))	0.075932	0.428502	-0.490222	-0.100932	0.096108	-0.540069
	(0.08582)	(0.24288)	(0.28518)	(0.19472)	(0.21190)	(0.21969)
	[0.88482]	[1.76423]	[-1.71900]	[-0.51834]	[0.45355]	[-2.45836
D(LNUBEANS(-1))	0.021923	-0.297948	-0.222578	-0.153807	-0.116080	-0.179017
	(0.03544)	(0.10031)	(0.11778)	(0.08042)	(0.08751)	(0.09073)
	[0.61856]	[-2.97031]	[-1.88984]	[-1.91257]	[-1.32642]	[-1.97310
D(LNUBEANS(-2))	0.003077	-0.074683	-0.031329	0.023639	0.066841	0.070537
	(0.03304)	(0.09351)	(0.10980)	(0.07497)	(0.08158)	(0.08458)
	[0.09313]	[-0.79864]	[-0.28534]	[0.31531]	[0.81928]	[0.83394
D(LNUBEETROOT(-1))	-0.003672	0.132069	-0.337509	0.107318	0.081895	-0.004630
	(0.03310)	(0.09369)	(0.11001)	(0.07512)	(0.08174)	(0.08475)
	[-0.11092]	[1.40956]	[-3.06798]	[1.42869]	[1.00185]	[-0.05463
D(LNUBEETROOT(-2))	0.000236	-0.061232	0.019393	0.057016	0.129074	0.191695
	(0.03345)	(0.09467)	(0.11116)	(0.07590)	(0.08260)	(0.08563)
	[0.00706]	[-0.64678]	[0.17446]	[0.75120]	[1.56272]	[2.23864
D(LNUCABBAGE(-1))	-0.069593	-0.130482	-0.033892	-0.288555	0.020095	-0.015099
	(0.04000)	(0.11322)	(0.13293)	(0.09077)	(0.09878)	(0.10241)
	[-1.73972]	[-1.15248]	[-0.25495]	[-3.17901]	[0.20344]	[-0.14744
D(LNUCABBAGE(-2))	-0.043658	0.012359	0.011070	-0.169434	0.037477	-0.097904
	(0.03958)	(0.11202)	(0.13153)	(0.08981)	(0.09773)	(0.10132)
	[-1.10305]	[0.11033]	[0.08416]	[-1.88661]	[0.38347]	[-0.96627
D(LNUCARROTS(-1))	0.029940	0.184066	0.061912	-0.277623	-0.352905	-0.025566

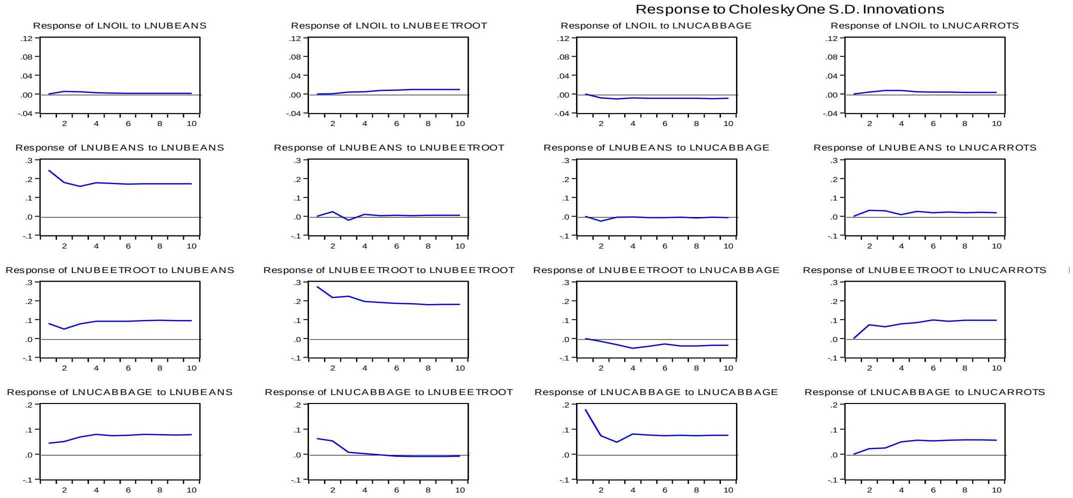
	(0.04581)	(0.12967)	(0.15224)	(0.10395)	(0.11313)	(0.11728
	[0.65353]	[1.41955]	[0.40666]	[-2.67063]	[-3.11959]	[-0.21798
D(LNUCARROTS(-2))	0.018775	0.034630	-0.100518	-0.205561	-0.112180	-0.217979
	(0.04350)	(0.12312)	(0.14456)	(0.09871)	(0.10742)	(0.11136
	[0.43160]	[0.28127]	[-0.69533]	[-2.08251]	[-1.04435]	[-1.95738
D(LNUKNOLKHOL(-1))	-0.008002	0.201775	0.809196	0.540728	0.323887	0.228911
	(0.06453)	(0.18263)	(0.21443)	(0.14641)	(0.15933)	(0.16518
	[-0.12401]	[1.10486]	[3.77376]	[3.69316]	[2.03280]	[1.38579
D(LNUKNOLKHOL(-2))	0.012649	-0.018946	0.539084	0.167783	0.093021	0.236898
	(0.05206)	(0.14734)	(0.17300)	(0.11813)	(0.12855)	(0.13327
	[0.24297]	[-0.12858]	[3.11611]	[1.42037]	[0.72363]	[1.77758
D(LNULEEKS(-1))	-0.002031	-0.304635	0.006650	0.131898	-0.144855	0.022859
	(0.04717)	(0.13351)	(0.15676)	(0.10704)	(0.11648)	(0.12076
	[-0.04305]	[-2.28171]	[0.04242]	[1.23226]	[-1.24359]	[0.18929
D(LNULEEKS(-2))	-0.005901	0.085375	-0.010231	0.110297	-0.033801	-0.139469
	(0.04844)	(0.13710)	(0.16097)	(0.10991)	(0.11961)	(0.12400
	[-0.12181]	[0.62273]	[-0.06356]	[1.00349]	[-0.28259]	[-1.12472
D(LNURADDISH(-1))	0.031838	-0.037326	-0.322670	-0.270731	-0.068076	-0.239423
	(0.05893)	(0.16680)	(0.19585)	(0.13373)	(0.14552)	(0.15087
	[0.54023]	[-0.22378]	[-1.64757]	[-2.02452]	[-0.46780]	[-1.58695
D(LNURADDISH(-2))	0.021709	-0.151996	-0.305615	-0.222723	-0.315223	-0.307523
	(0.05473)	(0.15490)	(0.18188)	(0.12419)	(0.13514)	(0.14011
	[0.39665]	[-0.98123]	[-1.68033]	[-1.79343]	[-2.33248]	[-2.19487
C	0.004252	-0.003190	0.003609	0.001379	-0.006896	-0.000480
	(0.00691)	(0.01957)	(0.02297)	(0.01569)	(0.01707)	(0.01770
	[0.61507]	[-0.16302]	[0.15707]	[0.08792]	[-0.40395]	[-0.02710
R-squared	0.086435	0.247011	0.202824	0.366573	0.214478	0.385235
Adj. R-squared	-0.025295	0.154919	0.105328	0.289104	0.118407	0.310048
Sum sq. resids	1.034267	8.285038	11.42169	5.325168	6.306205	6.778086

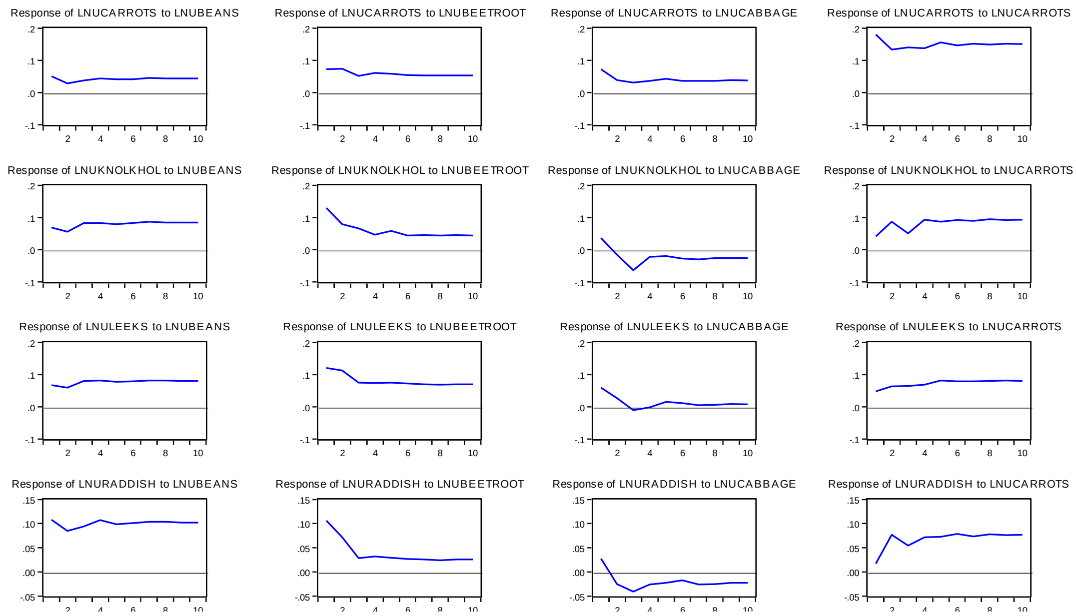
S.E. equation	0.086260	0.244141	0.286654	0.195731	0.212999	0.220824
F-statistic	0.773603	2.682211	2.080328	4.731847	2.232498	5.123682
Log likelihood	171.4970	8.157527	-17.04590	42.85507	29.58152	23.91690
Akaike AIC	-1.955376	0.125382	0.446445	-0.316625	-0.147535	-0.075375
Schwarz SC	-1.604979	0.475779	0.796842	0.033773	0.202862	0.275023
Mean dependent	0.005229	-0.000982	0.001161	0.000851	-0.004801	-0.000750
S.D. dependent	0.085189	0.265577	0.303058	0.232143	0.226852	0.265850

Determinant resid covariance (dof adj.)	3.58E-13
Determinant resid covariance	1.35E-13
Log likelihood	543.9206
Akaike information criterion	-4.992619
Schwarz criterion	-2.033706

D(LNOIL) = C(1)*(LNOIL(-1) + 10.1076238795*LNUBEANS(-1) - 0.683948687657*LNUBEETROOT(-1) - 16.3901773396*LNUCABBAGE(-1) + 17.4980972213*LNUCARROTS(-1) - 35.3806823141*LNUKNOLKHOL(-1) + 2.7007843069*LNULEEKS(-1) + 15.398471964*LNURADDISH(-1) + 20.2921474433) + C(2)*D(LNOIL(-1)) + C(3)*D(LNOIL(-2)) + C(4)*D(LNUBEANS(-1)) + C(5)*D(LNUBEANS(-2)) + C(6)*D(LNUBEETROOT(-1)) + C(7)*D(LNUBEETROOT(-2)) + C(8)*D(LNUCABBAGE(-1)) + C(9)*D(LNUCABBAGE(-2)) + C(10)*D(LNUCARROTS(-1)) + C(11)*D(LNUCARROTS(-2)) + C(12)*D(LNUKNOLKHOL(-1)) + C(13)*D(LNUKNOLKHOL(-2)) + C(14)*D(LNULEEKS(-1)) + C(15)*D(LNULEEKS(-2)) + C(16)*D(LNURADDISH(-1)) + C(17)*D(LNURADDISH(-2)) + C(18)




Response to Cholesky One S.D. Innovations
Response of LNOIL to LNUBEANS
Response of LNOIL to LNUBEETROOT
Response of LNOIL to LNUCABBAGE
Response of LNOIL to LNUCARROTS
Response of LNUBEANS to LNUBEANS
Response of LNUBEANS to LNUBEETROOT
Response of LNUBEANS to LNUCABBAGE
Response of LNUBEANS to LNUCARROTS
Response of LNUBEETROOT to LNUBEANS
Response of LNUBEETROOT to LNUBEETROOT
Response of LNUBEETROOT to LNUCABBAGE
Response of LNUBEETROOT to LNUCARROTS
Response of LNUCABBAGE to LNUBEANS
Response of LNUCABBAGE to LNUBEETROOT
Response of LNUCABBAGE to LNUCABBAGE
Response of LNUCABBAGE to LNUCARROTS


Response of LNUCARROTS to LNUBEANS
Response of LNUCARROTS to LNUBEETROOT
Response of LNUCARROTS to LNUCABBAGE
Response of LNUCARROTS to LNUCARROTS
Response of LNUKNOLKHOL to LNUBEANS
Response of LNUKNOLKHOL to LNUBEETROOT
Response of LNUKNOLKHOL to LNUCABBAGE
Response of LNUKNOLKHOL to LNUCARROTS
Response of LNULEEKS to LNUBEANS
Response of LNULEEKS to LNUBEETROOT
Response of LNULEEKS to LNUCABBAGE
Response of LNULEEKS to LNUCARROTS
Response of LNURADDISH to LNUBEANS
Response of LNURADDISH to LNUBEETROOT
Response of LNURADDISH to LNUCABBAGE
Response of LNURADDISH to LNUCARROTS

Low country

lnoil lnlpumpkin lnllongbeans lnlladiesfingers lnlcucumber lnlcapsicum lnlbrinjol lnlbittergourd

Step 1

VAR Lag Order Selection Criteria

Endogenous variables: LNOIL LNLPUMPKIN LNLLONGBEANS LNLLADIESFINGERS LNLCUCUMBER LNLCAPSICUM LNLBRINJOL LNLBITTERGOURD

Exogenous variables: C

Date: 06/11/23 Time: 06:47

Sample: 1 160

Included observations: 156

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-221.5689	NA	2.62e-09	2.943192	3.099594	3.006716
1	466.3517	1296.466	8.81e-13*	-5.055791*	-3.648166*	-4.484075*
2	518.1106	92.23694*	1.04e-12	-4.898854	-2.240005	-3.818944
3	562.1586	73.97799	1.36e-12	-4.643058	-0.732987	-3.054956
4	610.0908	75.58545	1.72e-12	-4.437061	0.724233	-2.340767

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Step 2

Stationary/ Non-Stationary test

Null Hypothesis: LBRINJOL has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.419507	0.1447
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LBRINJOL)
Method: Least Squares
Date: 06/12/23 Time: 11:05
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LBRINJOL(-1)	-0.030707	0.021632	-1.419507	0.1577
D(LBRINJOL(-1))	-0.154361	0.081703	-1.889283	0.0607

R-squared	0.040507	Mean dependent var	0.000000
Adjusted R-squared	0.034357	S.D. dependent var	57.61447
S.E. of regression	56.61609	Akaike info criterion	10.92304
Sum squared resid	500039.5	Schwarz criterion	10.96181
Log likelihood	-860.9202	Hannan-Quinn criter.	10.93878
Durbin-Watson stat	1.998205		

Null Hypothesis: D(LBRINJOL) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.26145	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LBRINJOL,2)
Method: Least Squares
Date: 06/12/23 Time: 11:09
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LBRINJOL(-1))	-1.398883	0.124219	-11.26145	0.0000
D(LBRINJOL(-1),2)	0.193053	0.081117	2.379932	0.0185

R-squared	0.587743	Mean dependent var	-0.828025
Adjusted R-squared	0.585084	S.D. dependent var	87.02867
S.E. of regression	56.05865	Akaike info criterion	10.90333
Sum squared resid	487098.6	Schwarz criterion	10.94226
Log likelihood	-853.9115	Hannan-Quinn criter.	10.91914
Durbin-Watson stat	2.067741		

Null Hypothesis: LCAPSICUM has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.929203	0.3126
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCAPSICUM)
Method: Least Squares
Date: 06/12/23 Time: 11:13
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCAPSICUM(-1)	-0.013793	0.014844	-0.929203	0.3542
D(LCAPSICUM(-1))	-0.121731	0.081002	-1.502814	0.1349

R-squared	0.021831	Mean dependent var	0.506329
Adjusted R-squared	0.015561	S.D. dependent var	80.23689
S.E. of regression	79.61017	Akaike info criterion	11.60474
Sum squared resid	988693.4	Schwarz criterion	11.64351
Log likelihood	-914.7743	Hannan-Quinn criter.	11.62048
Durbin-Watson stat	1.988405		

Null Hypothesis: D(LCAPSICUM) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.06193	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCAPSICUM,2)
Method: Least Squares
Date: 06/12/23 Time: 11:14
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LCAPSICUM(-1))	-1.230447	0.122287	-10.06193	0.0000
D(LCAPSICUM(-1),2)	0.088851	0.081322	1.092586	0.2763

R-squared	0.560298	Mean dependent var	-1.019108
Adjusted R-squared	0.557462	S.D. dependent var	119.9101
S.E. of regression	79.76850	Akaike info criterion	11.60879
Sum squared resid	986267.1	Schwarz criterion	11.64772
Log likelihood	-909.2901	Hannan-Quinn criter.	11.62460
Durbin-Watson stat	1.996928		

Null Hypothesis: LCUCUMBER has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.346910	0.1645
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCUCUMBER)
Method: Least Squares
Date: 06/12/23 Time: 11:14
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCUCUMBER(-1)	-0.024483	0.018177	-1.346910	0.1800
D(LCUCUMBER(-1))	-0.203370	0.078017	-2.606726	0.0100

R-squared	0.057323	Mean dependent var	-0.253165
Adjusted R-squared	0.051280	S.D. dependent var	22.38059
S.E. of regression	21.79920	Akaike info criterion	9.014201
Sum squared resid	74131.99	Schwarz criterion	9.052968
Log likelihood	-710.1219	Hannan-Quinn criter.	9.029945
Durbin-Watson stat	2.058940		

Null Hypothesis: D(LCUCUMBER) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.17848	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCUCUMBER,2)
Method: Least Squares
Date: 06/12/23 Time: 11:15
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LCUCUMBER(-1))	-1.418461	0.126892	-11.17848	0.0000
D(LCUCUMBER(-1),2)	0.166356	0.082670	2.012301	0.0459

R-squared	0.618052	Mean dependent var	0.000000
Adjusted R-squared	0.615588	S.D. dependent var	35.01831
S.E. of regression	21.71169	Akaike info criterion	9.006236
Sum squared resid	73066.64	Schwarz criterion	9.045169
Log likelihood	-704.9895	Hannan-Quinn criter.	9.022048
Durbin-Watson stat	2.019039		

Null Hypothesis: LLADIESFINGERS has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.463720	0.1335
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LLADIESFINGERS)
Method: Least Squares
Date: 06/12/23 Time: 11:17
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LLADIESFINGERS(-1)	-0.026389	0.018029	-1.463720	0.1453
D(LLADIESFINGERS(-1))	-0.178173	0.078473	-2.270492	0.0245

R-squared	0.048867	Mean dependent var	-0.506329
Adjusted R-squared	0.042770	S.D. dependent var	36.15778
S.E. of regression	35.37610	Akaike info criterion	9.982527
Sum squared resid	195229.1	Schwarz criterion	10.02129
Log likelihood	-786.6197	Hannan-Quinn criter.	9.998271
Durbin-Watson stat	2.039708		

Null Hypothesis: D(LLADIESFINGERS) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.94363	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LLADIESFINGERS,2)
Method: Least Squares
Date: 06/12/23 Time: 11:18
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LLADIESFINGERS(-1))	-1.347286	0.123111	-10.94363	0.0000
D(LLADIESFINGERS(-1),2)	0.131021	0.079630	1.645377	0.1019

R-squared	0.600616	Mean dependent var	0.254777
Adjusted R-squared	0.598040	S.D. dependent var	55.86670
S.E. of regression	35.41968	Akaike info criterion	9.985069
Sum squared resid	194455.9	Schwarz criterion	10.02400
Log likelihood	-781.8280	Hannan-Quinn criter.	10.00088
Durbin-Watson stat	2.006460		

Null Hypothesis: LLONGBEANS has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.026865	0.2732
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LLONGBEANS)
Method: Least Squares
Date: 06/12/23 Time: 11:19
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LLONGBEANS(-1)	-0.016477	0.016046	-1.026865	0.3061
D(LLONGBEANS(-1))	-0.365198	0.074936	-4.873468	0.0000

R-squared	0.142747	Mean dependent var	-0.126582
Adjusted R-squared	0.137252	S.D. dependent var	40.13492
S.E. of regression	37.27901	Akaike info criterion	10.08732
Sum squared resid	216797.0	Schwarz criterion	10.12608
Log likelihood	-794.8979	Hannan-Quinn criter.	10.10306
Durbin-Watson stat	1.998080		

Null Hypothesis: D(LLONGBEANS) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.50035	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LLONGBEANS,2)
Method: Least Squares
Date: 06/12/23 Time: 11:20
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LLONGBEANS(-1))	-1.407964	0.134087	-10.50035	0.0000
D(LLONGBEANS(-1),2)	0.025432	0.080892	0.314401	0.7536

R-squared	0.683123	Mean dependent var	0.382166
Adjusted R-squared	0.681078	S.D. dependent var	66.41831
S.E. of regression	37.50852	Akaike info criterion	10.09967
Sum squared resid	218067.8	Schwarz criterion	10.13860
Log likelihood	-790.8241	Hannan-Quinn criter.	10.11548
Durbin-Watson stat	1.988004		

Null Hypothesis: LNLBITTERGOURD has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.127349	0.6383
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNLBITTERGOURD)
Method: Least Squares
Date: 06/12/23 Time: 11:21
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNLBITTERGOURD(-1)	-0.000417	0.003275	-0.127349	0.8988
D(LNLBITTERGOURD(-1))	-0.410547	0.073094	-5.616688	0.0000

R-squared	0.168543	Mean dependent var	0.000551
Adjusted R-squared	0.163213	S.D. dependent var	0.244791
S.E. of regression	0.223926	Akaike info criterion	-0.142429
Sum squared resid	7.822252	Schwarz criterion	-0.103662
Log likelihood	13.25189	Hannan-Quinn criter.	-0.126685
Durbin-Watson stat	2.108229		

Null Hypothesis: D(LNLBITTERGOURD) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.07486	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNLBITTERGOURD,2)
Method: Least Squares
Date: 06/12/23 Time: 11:21
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNLBITTERGOURD(-1))	-1.609622	0.133304	-12.07486	0.0000
D(LNLBITTERGOURD(-1),2)	0.139347	0.079338	1.756370	0.0810

R-squared	0.712652	Mean dependent var	0.000296
Adjusted R-squared	0.710798	S.D. dependent var	0.412178
S.E. of regression	0.221659	Akaike info criterion	-0.162697
Sum squared resid	7.615563	Schwarz criterion	-0.123764
Log likelihood	14.77173	Hannan-Quinn criter.	-0.146885
Durbin-Watson stat	2.069993		

Null Hypothesis: LNLPUMPKIN has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.319749	0.5689
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNLPUMPKIN)
Method: Least Squares
Date: 06/12/23 Time: 11:22
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNLPUMPKIN(-1)	-0.001493	0.004669	-0.319749	0.7496
D(LNLPUMPKIN(-1))	-0.207842	0.078962	-2.632181	0.0093

R-squared	0.043375	Mean dependent var	0.000000
Adjusted R-squared	0.037242	S.D. dependent var	0.284714
S.E. of regression	0.279362	Akaike info criterion	0.299963
Sum squared resid	12.17476	Schwarz criterion	0.338730
Log likelihood	-21.69711	Hannan-Quinn criter.	0.315707
Durbin-Watson stat	2.015237		

Null Hypothesis: D(LNLPUMPKIN) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.40953	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNLPUMPKIN,2)
Method: Least Squares
Date: 06/12/23 Time: 11:23
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNLPUMPKIN(-1))	-1.306166	0.125478	-10.40953	0.0000
D(LNLPUMPKIN(-1),2)	0.079577	0.080679	0.986338	0.3255

R-squared	0.603358	Mean dependent var	0.002243
Adjusted R-squared	0.600799	S.D. dependent var	0.441950
S.E. of regression	0.279235	Akaike info criterion	0.299128
Sum squared resid	12.08565	Schwarz criterion	0.338061
Log likelihood	-21.48152	Hannan-Quinn criter.	0.314940
Durbin-Watson stat	2.016184		

Null Hypothesis: LNUBEETROOT has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.328854	0.5655
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUBEETROOT)
Method: Least Squares
Date: 06/12/23 Time: 11:24
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUBEETROOT(-1)	-0.001530	0.004653	-0.328854	0.7427
D(LNUBEETROOT(-1))	-0.193360	0.078701	-2.456886	0.0151

R-squared	0.038098	Mean dependent var	0.000000
Adjusted R-squared	0.031932	S.D. dependent var	0.302444
S.E. of regression	0.297576	Akaike info criterion	0.426282
Sum squared resid	13.81402	Schwarz criterion	0.465050
Log likelihood	-31.67632	Hannan-Quinn criter.	0.442026
Durbin-Watson stat	1.987657		

Null Hypothesis: D(LNUBEETROOT) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.454509	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUBEETROOT,2)
Method: Least Squares
Date: 06/12/23 Time: 11:25
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNUBEETROOT(-1))	-1.174459	0.124222	-9.454509	0.0000
D(LNUBEETROOT(-1),2)	-0.018172	0.080352	-0.226155	0.8214

R-squared	0.597331	Mean dependent var	0.002994
Adjusted R-squared	0.594733	S.D. dependent var	0.468266
S.E. of regression	0.298101	Akaike info criterion	0.429888
Sum squared resid	13.77394	Schwarz criterion	0.468821
Log likelihood	-31.74618	Hannan-Quinn criter.	0.445700
Durbin-Watson stat	1.992522		

Null Hypothesis: LNUCABBAGE has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.225779	0.6035
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUCABBAGE)
Method: Least Squares
Date: 06/12/23 Time: 11:26
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUCABBAGE(-1)	-0.000810	0.003586	-0.225779	0.8217
D(LNUCABBAGE(-1))	-0.238793	0.077748	-3.071383	0.0025

R-squared	0.057524	Mean dependent var	0.000000
Adjusted R-squared	0.051482	S.D. dependent var	0.231650
S.E. of regression	0.225608	Akaike info criterion	-0.127458
Sum squared resid	7.940238	Schwarz criterion	-0.088691
Log likelihood	12.06921	Hannan-Quinn criter.	-0.111715
Durbin-Watson stat	2.095792		

Null Hypothesis: D(LNUCABBAGE) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.17987	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUCABBAGE,2)
Method: Least Squares
Date: 06/12/23 Time: 11:27
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNUCABBAGE(-1))	-1.504147	0.123495	-12.17987	0.0000
D(LNUCABBAGE(-1),2)	0.215021	0.078395	2.742792	0.0068

R-squared	0.636430	Mean dependent var	0.001701
Adjusted R-squared	0.634084	S.D. dependent var	0.365222
S.E. of regression	0.220926	Akaike info criterion	-0.169318
Sum squared resid	7.565308	Schwarz criterion	-0.130385
Log likelihood	15.29146	Hannan-Quinn criter.	-0.153506
Durbin-Watson stat	1.979608		

Null Hypothesis: LNUCARROTS has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.617187	0.4486
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUCARROTS)
Method: Least Squares
Date: 06/12/23 Time: 11:28
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUCARROTS(-1)	-0.002025	0.003282	-0.617187	0.5380
D(LNUCARROTS(-1))	-0.296563	0.076178	-3.893011	0.0001

R-squared	0.090095	Mean dependent var	-0.005799
Adjusted R-squared	0.084263	S.D. dependent var	0.226476
S.E. of regression	0.216725	Akaike info criterion	-0.207801
Sum squared resid	7.327249	Schwarz criterion	-0.169034
Log likelihood	18.41631	Hannan-Quinn criter.	-0.192058
Durbin-Watson stat	2.028691		

Null Hypothesis: D(LNUCARROTS) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.63667	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUCARROTS,2)
Method: Least Squares
Date: 06/12/23 Time: 11:28
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNUCARROTS(-1))	-1.372199	0.129006	-10.63667	0.0000
D(LNUCARROTS(-1),2)	0.060128	0.079954	0.752033	0.4532

R-squared	0.648729	Mean dependent var	0.000285
Adjusted R-squared	0.646463	S.D. dependent var	0.365216
S.E. of regression	0.217154	Akaike info criterion	-0.203765
Sum squared resid	7.309142	Schwarz criterion	-0.164832
Log likelihood	17.99557	Hannan-Quinn criter.	-0.187953
Durbin-Watson stat	2.006521		

Null Hypothesis: LNUKNOLKHOL has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.338519	0.5619
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUKNOLKHOL)
Method: Least Squares
Date: 06/12/23 Time: 11:29
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUKNOLKHOL(-1)	-0.001369	0.004044	-0.338519	0.7354
D(LNUKNOLKHOL(-1))	-0.286708	0.076834	-3.731518	0.0003

R-squared	0.082722	Mean dependent var	-0.000745
Adjusted R-squared	0.076842	S.D. dependent var	0.265002
S.E. of regression	0.254617	Akaike info criterion	0.114463
Sum squared resid	10.11343	Schwarz criterion	0.153230
Log likelihood	-7.042591	Hannan-Quinn criter.	0.130207
Durbin-Watson stat	2.076439		

Null Hypothesis: D(LNUKNOLKHOL) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.54309	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNUKNOLKHOL,2)
Method: Least Squares
Date: 06/12/23 Time: 11:29
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNUKNOLKHOL(-1))	-1.476362	0.127900	-11.54309	0.0000
D(LNUKNOLKHOL(-1),2)	0.146187	0.079630	1.835824	0.0683

R-squared	0.649755	Mean dependent var	0.001832
Adjusted R-squared	0.647496	S.D. dependent var	0.425714
S.E. of regression	0.252755	Akaike info criterion	0.099868
Sum squared resid	9.902225	Schwarz criterion	0.138802
Log likelihood	-5.839673	Hannan-Quinn criter.	0.115681
Durbin-Watson stat	2.067347		

Null Hypothesis: LNULEEKS has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.489226	0.5027
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNULEEKS)
Method: Least Squares
Date: 06/12/23 Time: 11:30
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNULEEKS(-1)	-0.001853	0.003788	-0.489226	0.6254
D(LNULEEKS(-1))	-0.149286	0.079102	-1.887266	0.0610

R-squared	0.023679	Mean dependent var	-0.003542
Adjusted R-squared	0.017421	S.D. dependent var	0.243414
S.E. of regression	0.241284	Akaike info criterion	0.006896
Sum squared resid	9.082029	Schwarz criterion	0.045663
Log likelihood	1.455210	Hannan-Quinn criter.	0.022640
Durbin-Watson stat	2.069199		

Null Hypothesis: D(LNURADDISH) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.85766	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNURADDISH,2)
Method: Least Squares
Date: 06/12/23 Time: 11:32
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNURADDISH(-1))	-1.388459	0.127878	-10.85766	0.0000
D(LNURADDISH(-1),2)	0.094952	0.080289	1.182625	0.2388

R-squared	0.635253	Mean dependent var	0.001832
Adjusted R-squared	0.632899	S.D. dependent var	0.404244
S.E. of regression	0.244927	Akaike info criterion	0.036943
Sum squared resid	9.298321	Schwarz criterion	0.075876
Log likelihood	-0.900015	Hannan-Quinn criter.	0.052755
Durbin-Watson stat	2.017995		

Null Hypothesis: D(LNULEEKS) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.00539	0.0000
Test critical values:	1% level	-2.579774	
	5% level	-1.942869	
	10% level	-1.615359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNULEEKS,2)
Method: Least Squares
Date: 06/12/23 Time: 11:31
Sample (adjusted): 1/22/2020 1/18/2023
Included observations: 157 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNULEEKS(-1))	-1.420352	0.118310	-12.00539	0.0000
D(LNULEEKS(-1),2)	0.235721	0.078022	3.021216	0.0029

R-squared	0.598536	Mean dependent var	0.000571
Adjusted R-squared	0.595946	S.D. dependent var	0.370203
S.E. of regression	0.235320	Akaike info criterion	-0.043080
Sum squared resid	8.583235	Schwarz criterion	-0.004147
Log likelihood	5.381792	Hannan-Quinn criter.	-0.027268
Durbin-Watson stat	2.075988		

Null Hypothesis: LNURADDISH has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.290881	0.5797
Test critical values:	1% level	-2.579680	
	5% level	-1.942856	
	10% level	-1.615368	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNURADDISH)
Method: Least Squares
Date: 06/12/23 Time: 11:32
Sample (adjusted): 1/15/2020 1/18/2023
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNURADDISH(-1)	-0.001220	0.004194	-0.290881	0.7715
D(LNURADDISH(-1))	-0.267483	0.077445	-3.453849	0.0007

R-squared	0.071723	Mean dependent var	0.000000
Adjusted R-squared	0.065772	S.D. dependent var	0.253663
S.E. of regression	0.245179	Akaike info criterion	0.038922
Sum squared resid	9.377596	Schwarz criterion	0.077689
Log likelihood	-1.074835	Hannan-Quinn criter.	0.054666
Durbin-Watson stat	2.041333		

Null Hypothesis: OIL has a unit root
Exogenous: Constant
Lag Length: 0 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.755511	0.8283
Test critical values:	1% level	-3.471719	
	5% level	-2.879610	
	10% level	-2.576484	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL)
Method: Least Squares
Date: 06/17/23 Time: 18:19
Sample (adjusted): 2 160
Included observations: 159 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL(-1)	-0.007398	0.009792	-0.755511	0.4511
C	229.8031	218.4139	1.052145	0.2943

R-squared	0.003622	Mean dependent var	88.44236
Adjusted R-squared	-0.002724	S.D. dependent var	1418.865
S.E. of regression	1420.796	Akaike info criterion	17.36832
Sum squared resid	3.17E+08	Schwarz criterion	17.40692
Log likelihood	-1378.782	Hannan-Quinn criter.	17.38400
F-statistic	0.570797	Durbin-Watson stat	1.956315
Prob(F-statistic)	0.451074		

Null Hypothesis: D(OIL) has a unit root
Exogenous: Constant
Lag Length: 0 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.26478	0.0000
Test critical values:	1% level	-3.471987	
	5% level	-2.879727	
	10% level	-2.576546	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL,2)
Method: Least Squares
Date: 06/17/23 Time: 18:21
Sample (adjusted): 3 160
Included observations: 158 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OIL(-1))	-0.983778	0.080212	-12.26478	0.0000
C	87.65420	113.8409	0.769971	0.4425

R-squared	0.490903	Mean dependent var	-6.340448
Adjusted R-squared	0.487639	S.D. dependent var	1994.586
S.E. of regression	1427.712	Akaike info criterion	17.37811
Sum squared resid	3.18E+08	Schwarz criterion	17.41688
Log likelihood	-1370.871	Hannan-Quinn criter.	17.39385
F-statistic	150.4248	Durbin-Watson stat	2.001706
Prob(F-statistic)	0.000000		

Step 3

Johansen Cointegration Test

Date: 06/11/23 Time: 06:43

Sample (adjusted): 4 160

Included observations: 157 after adjustments

Trend assumption: Linear deterministic trend

Series: LNOIL LNLPUMPKIN LNLLONGBEANS LNLLADIESFINGERS LNLCUCUMBER LNLCAPSICUM LNLBRINJOL LNLBITTERGOURD

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.370960	229.4259	159.5297	0.0000
At most 1 *	0.252285	156.6469	125.6154	0.0002
At most 2 *	0.195621	111.0017	95.75366	0.0030
At most 3 *	0.153169	76.82530	69.81889	0.0124
At most 4 *	0.138079	50.72343	47.85613	0.0262
At most 5	0.102100	27.39452	29.79707	0.0923
At most 6	0.056982	10.48614	15.49471	0.2452
At most 7	0.008088	1.275023	3.841466	0.2588

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.370960	72.77898	52.36261	0.0001
At most 1	0.252285	45.64517	46.23142	0.0577
At most 2	0.195621	34.17642	40.07757	0.1988
At most 3	0.153169	26.10187	33.87687	0.3146
At most 4	0.138079	23.32891	27.58434	0.1599
At most 5	0.102100	16.90838	21.13162	0.1764
At most 6	0.056982	9.211115	14.26460	0.2690
At most 7	0.008088	1.275023	3.841466	0.2588

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Vector Error Correction Estimates
Date: 06/11/23 Time: 06:52
Sample (adjusted): 3 160
Included observations: 158 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNOIL(-1)	1.000000
LNLPUMPKIN(-1)	-0.553456
	(0.18760)
	[-2.95018]
LNLLONGBEANS(-1)	1.447077
	(0.35771)
	[4.04539]
LNLLADIESFINGERS(-1)	-0.170347
	(0.29142)
	[-0.58454]
LNLCUCUMBER(-1)	-0.632179
	(0.32115)
	[-1.96847]
LNLCAPSICUM(-1)	-0.005300
	(0.28672)
	[-0.01849]
LNLBRINJOL(-1)	-1.519326
	(0.20611)
	[-7.37151]
LNLBITTERGOURD(-1)	-0.619788
	(0.38659)
	[-1.60320]
C	0.449645

Error Correction:	D(LNOIL)	D(LNLPUMPKIN)	D(LNLLONGBEANS)	D(LNLLADIESFINGERS)	D(LNLCUCUMBER)	D(LNLCAPSUM)
CointEq1	-0.001064	0.109904	0.106629	0.111030	0.160621	0.102630
	(0.01338)	(0.04276)	(0.03709)	(0.03737)	(0.03700)	(0.03306
	[-0.07949]	[2.57003]	[2.87459]	[2.97108]	[4.34110]	[3.10388
D(LNOIL(-1))	0.243714	0.046228	-0.266552	-0.070322	-0.444750	-0.225084
	(0.08074)	(0.25797)	(0.22376)	(0.22543)	(0.22320)	(0.19946
	[3.01859]	[0.17920]	[-1.19123]	[-0.31195]	[-1.99263]	[-1.12847
D(LNLPUMPKIN(-1))	-0.012478	-0.082659	0.121468	0.006972	0.024052	0.012716
	(0.03188)	(0.10186)	(0.08835)	(0.08901)	(0.08813)	(0.07876
	[-0.39141]	[-0.81151]	[1.37480]	[0.07832]	[0.27292]	[0.16146
D(LNLLONGBEANS(-1))	-0.028867	-0.351323	-0.563115	-0.253944	-0.219736	-0.233515
	(0.04453)	(0.14229)	(0.12342)	(0.12434)	(0.12311)	(0.11002
	[-0.64823]	[-2.46912]	[-4.56258]	[-2.04232]	[-1.78489]	[-2.12255
D(LNLLADIESFINGERS(-1))	0.024195	0.237743	0.162241	-0.057701	0.115780	0.212501
	(0.04251)	(0.13583)	(0.11782)	(0.11870)	(0.11752)	(0.10502
	[0.56913]	[1.75030]	[1.37703]	[-0.48612]	[0.98517]	[2.02336
D(LNLCUCUMBER(-1))	-0.013201	-0.234458	-0.160058	-0.018057	-0.231416	0.076275
	(0.03804)	(0.12154)	(0.10543)	(0.10621)	(0.10516)	(0.09398
	[-0.34702]	[-1.92900]	[-1.51818]	[-0.17001]	[-2.20057]	[0.81163
D(LNLCAPSICUM(-1))	0.039364	0.090899	0.127536	-0.023200	0.026721	-0.121683
	(0.04428)	(0.14147)	(0.12271)	(0.12363)	(0.12241)	(0.10939
	[0.88902]	[0.64252]	[1.03929]	[-0.18766]	[0.21830]	[-1.11240
D(LNLBRINJOL(-1))	-0.039905	0.218572	0.192433	0.177602	0.163691	0.127570
	(0.02445)	(0.07811)	(0.06775)	(0.06826)	(0.06758)	(0.06039
	[-1.63238]	[2.79833]	[2.84027]	[2.60197]	[2.42216]	[2.11233
D(LNLBITTERGOURD(-1))	0.059998	0.044355	-0.025471	0.072270	0.063064	-0.158688
	(0.03806)	(0.12160)	(0.10548)	(0.10627)	(0.10521)	(0.09402
	[1.57646]	[0.36475]	[-0.24148]	[0.68010]	[0.59940]	[-1.68775
C	0.003446	-0.002856	-0.002629	-0.004243	-0.002046	0.002473
	(0.00670)	(0.02139)	(0.01856)	(0.01869)	(0.01851)	(0.01654
	[0.51474]	[-0.13350]	[-0.14168]	[-0.22699]	[-0.11055]	[0.14949

R-squared	0.082072	0.163439	0.229042	0.127429	0.187052	0.161141
Adj. R-squared	0.026252	0.112567	0.182159	0.074367	0.137616	0.110129
Sum sq. resids	1.042900	10.64673	8.010507	8.130436	7.970167	6.365033
S.E. equation	0.083944	0.268211	0.232648	0.234383	0.232061	0.207381
F-statistic	1.470303	3.212748	4.885436	2.401513	3.783725	3.158893
Log likelihood	172.4343	-11.10225	11.37315	10.19917	11.77199	29.53798
Akaike AIC	-2.056130	0.267117	-0.017382	-0.002521	-0.022430	-0.247316
Schwarz SC	-1.862295	0.460952	0.176454	0.191314	0.171405	-0.053481
Mean dependent	0.004826	0.000000	-0.000745	-0.002566	-0.002566	0.001412
S.D. dependent	0.085068	0.284714	0.257256	0.243616	0.249892	0.219840

Determinant resid covariance (dof adj.)	8.17E-13
Determinant resid covariance	4.84E-13
Log likelihood	446.6453
Akaike information criterion	-4.539814
Schwarz criterion	-2.834065