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The Effect of Petroleum Prices on Basic Food and Energy Commodities: An investigation through Sequential ADF tests

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Abstract
This study examines the correlation between fluctuations in petrol prices and essential commodities in a developing economy, specifically Pakistan. Data from January 2012 to August 2022 has been collected from the Pakistan Bureau of Statistics (PBS), focusing on the most crucial commodities. Through a thorough analysis of a comprehensive dataset covering multiple years, study has delve into the impact of changes in petrol prices on a range of crucial food items and energy variables. This research has uncovered noteworthy connections between the cost of petrol and important everyday items like wheat, sugar, ghee, LPG, gas, and electricity. Findings indicate that there is a direct correlation between petrol prices and the prices of essential food items such as wheat, sugar, and ghee. This suggests that fluctuations in petrol prices can contribute to inflationary pressures on these commodities. In addition, analysis emphasizes the correlation between petrol prices and energy costs. It is found that when petrol prices experience sudden changes, it results in higher prices for LPG, gas, and electricity. In addition, specific commodities like electric charges, gas charges, and veg ghee can demonstrate explosive behaviors, suggesting significant volatility and the possibility of price distortions. According to our research, we suggest a range of policy recommendations. These include the management of vital costs for food, tackling the cost of energy and the welfare of consumers, fostering competition in the markets along with price regulation, diversified sources of energy, carrying out watching and early warning systems, bolstering the efficiency of the market, and enhancing food security. Implementing these policy interventions can effectively address the effects of petrol price fluctuations on essential commodities. This will lead to price stability, safeguard consumer welfare, and enhance food security even in the midst of external shocks. However, additional research and analysis are required to evaluate the practicality and potential consequences of these suggestions within the particular socio-economic setting.
Keywords: Petroleum Prices, Food and Energy Commodities, Sequential ADF Tests

1. Introduction

There are growing concerns regarding a worldwide shortage of food and a rise in food unrest in developing nations. Based on data from the Food and Agriculture Organization of the U.N., it has been observed that 37 countries are currently experiencing food crises (Rosegrant 20). Several lecturers and policymakers were quick to attribute higher food prices to the steady increase in the price of crude oil after 2003. They argued that the use of oil products in agricultural machinery increases the cost of producing food commodities. Additionally, they pointed out that higher oil prices could also lead to increased costs in processing, storing, and distributing food to retail customers. They also highlighted the increased dependence on biofuels in developed economies, particularly in the US. The subsequent surge in demand for ethanol (and subsequently for corn) was quickly followed by persistent increases in the price of corn and other food crops. It is a commonly held belief among policymakers that the use of corn and oilseeds as biofuel has also increased the impact of oil price shocks on agricultural commodity prices and retail food prices. One scenario involves commercial utilization. The rate of US retail meals will likely see a significant increase in the coming years. However, when taking inflation into account, the actual growth is relatively modest, even after the changes in US biofuel policies in 2006. On the other hand, there will be a rise in the prices of corn, soybeans, and wheat. The price of gas has a significant negative effect on the demand for coal on an international scale, in both directions. The international demand for coal does not have a significant impact on the selling price and sales volume of coal. The selling price of coal no longer has an important effect on sales volume. The increased prices of rice obtained from US farmers may be partly attributed to the rise in oil prices. That link, however, appears to primarily focus on the macroeconomic factors that influence the prices of oil and agricultural commodities, rather than the direct impact of higher oil prices.

There is insufficient evidence to support that claim. This study examines the impact of gas price, crude oil price, as well as international coal demand on coal sales volume, coal selling price, coal sales revenue, financial performance, business risk, and stock price. Coal mining in Indonesia is listed on the Indonesia Stock Exchange (IDX). This study investigates the connections between energy prices and food prices from 2000 to 2016 using a Panel-VAR model in the context of eight Asian economies. Our findings demonstrate that changes in power charges, particularly oil rates, have a significant impact on the prices of meals. Based on the implications of impulse reaction functions, agricultural food prices respond positively to any unexpected changes in oil prices. Our findings indicate a connection between power and food safety through price volatility. Given the potential risks to food security posed by inflation in oil prices, it is crucial to prioritize diversifying energy consumption in this sector. This means reducing our heavy dependence on fossil fuels and instead finding the optimal mix of both nonrenewable and renewable energy sources. By doing so, we can not only enhance energy security but also safeguard food security. Furthermore, the study found that the impact of biofuel costs on food prices is statistically significant but accounts for less than 2% of the variation in food prices. The brief evaluation reveals unfavorable results in terms of meal prices and oil costs, while positive results are observed in the long term. Based on the pattern in the United States, it appears that there is a causal relationship between food prices and oil prices. It is crucial for countries to prioritize the implementation of effective agricultural regulations, promote affordable food prices, and explore alternative energy sources in order to ensure a steady supply of food and oil.

Throughout the years, there has been a global interest in oil price fluctuations and rising food costs. It is widely recognized in the literature that rapid fluctuations in oil and food prices have a detrimental impact on the global economy. Numerous studies (Heady

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and Fan, 2008; Galesi and Lombardi, 2009; Hakro and Omezzine, 2010; Alom, 2011; Jongwanich and Park, 2011) have examined this phenomenon. So, in recent times, there has been a significant increase in the expenses of food crops. The prices of food crops such as rice, wheat, and cassava were steadily rising. According to Obadi (2014), the increase in meal fees was linked to the rise in oil prices, which affected the input costs of food production. These particular countries are at a higher risk of experiencing increased food prices because their food imports heavily rely on unpredictable oil revenues, which are influenced by sudden fluctuations in the global oil price. The neglect and decrease in agricultural activities over the years by some of the oil exporting developing nations, despite having ample arable land and favorable weather, is another significant factor contributing to vulnerability. This observation on the relationship between food prices and oil prices is important for two reasons. First, the increase in biofuel manufacturing due to improved oil fee incentives can reduce the available food supply and drive up its price.As an economic professor would know, Nigeria has made significant progress with 20 biofuel projects. According to a study by Ohimain (2015), 10 bio refineries utilized cassava, while eight utilized sugar cane and only two used sorghum. According to Mitchell (2008), the increase in biofuel production is negatively impacting the availability and affordability of food, leading to a decrease in global crop resources and higher food prices. Similarly, there has been a significant increase in global bio-gas production. According to the International Energy Agency (IEA) in 2017, bioethanol and biodiesel accounted for approximately 13% of the global demand for shipping fuel. Furthermore, the rapid increase in food prices coupled with the continuous decline in oil prices has led to a rise in food import expenditures for many nations that rely on oil exports. Furthermore, it has been established through extensive research that there is a correlation between food consumption and crude oil prices (Baffes, 2007). As an economics professor would explain, the meals hike disaster in 2007 and 2008 was closely tied to the excessive oil charges. This was evident when the oil charge fell from $US147 per barrel in 2008 to $US28, and the meals rate fell in tandem (Kilian, 2008). Thus, researchers have taken an interest in issues such as fluctuations in oil prices, rising food costs, and the potential connection between the energy sector and the rural economy (Mitchell, 2008).

The present study intends to investigate the effect of petroleum prices on most essential food, and energy commodities and to evaluate the performance of different tests to detect bubbles/explosive behavior and identify the best performer test. The study has the following thesis;

H_0 : There is no explosive behavior in food commodities

H_1 : There exists explosive behavior in food commodities

H_1 : There is no explosive behavior in energy commodities

H_1 : There exists explosive behavior in energy commodities

This study is important because it helps us better understand how changes in petrol prices can impact vital goods in a developing economy. This research offers useful information for policymakers, economists, and market participants by examining the possible effect of petrol price fluctuations on key food items and energy variables. First and foremost, the strong connection between petrol prices and essential food items like wheat, sugar, and ghee highlights the significance of effectively managing petrol price fluctuations in order to alleviate inflationary pressures on these commodities. These findings can be used by policymakers to create strategies that aim to stabilize food prices, guarantee affordability for consumers, and uphold food security in the face of unforeseen shocks. Additionally, the correlation among petrol prices and energy costs, such as LPG, gas, and electricity, emphasizes the importance of adopting a holistic approach to energy pricing. Price shocks in petrol can have far-reaching impacts on energy costs, impacting households, businesses, and the overall stability of the economy. Implementing policy interventions focused on energy diversity, market competition, and price regulation can effectively reduce the effects of petrol volatility on energy prices and improve consumer welfare.

In addition, the recognition of volatile patterns in specific goods, such as electric charges, gas charges, and veg ghee, suggests significant volatility and the possibility of price distortions. Understanding these patterns is essential for implementing efficient monitoring and early warning systems, allowing policymakers to foresee deal with possible market crashes. Overall, this study is significant because it can provide valuable insights for policymakers to make evidence-based recommendations that tackle the issues caused by fluctuations in petrol prices. Through the implementation of the suggested policy interventions, policymakers can work towards stabilizing prices of essential commodities, ensuring affordable energy, improving market efficiency, and fostering food security. However, more research is needed to evaluate the practicality and potential effects of these suggestions in particular socio-economic situations, ultimately aiding the creation of strong policy frameworks.

2. Review of the Literature

Afia Malik (2016) aimed to analyze the effects of oil price fluctuations on inflation in Pakistan. According to her, there have been significant fluctuations in oil prices in recent years, which have been the main focus of this research paper. Given Pakistan's reliance on imported energy, the country's economy is greatly affected by the volatile shifts in oil prices. The study emphasized the significant influence of energy costs on inflation rates in Pakistan. Using an extended Phillips curve framework, they examine the impact of oil price fluctuations on inflation in Pakistan. Research has uncovered a significant correlation between oil prices and inflation, particularly when oil prices have shown steady growth in the past year. They also emphasized the strong correlation between oil prices and inflation, highlighting the significant impact of oil on the economy. Oil plays a crucial role as an energy source in Pakistan, holding the second position in terms of usage and demand. Pakistan's heavy reliance on oil imports stems from its consistently low production rate. Based on the consistent energy intensity seen over the past forty years and a reliance on energy at approximately 33%, it is evident that Pakistan's inflation rates are heavily influenced by the unpredictable changes in global crude oil prices.In a study conducted by Attia Ayub (2018), the correlation between oil prices and the agriculture commodity and stock market in Pakistan was analyzed. She aimed to examine the relationship between crude oil market returns, six agricultural commodities, the exchange rate, and equity returns on the Pakistani stock market. The study employed the GARCH-M approach for mean and volatility spillover, which is highly regarded in the field. Monthly data from 1997 to 2017 has been collected, encompassing the interplay of crude oil, agricultural commodities, and exchange rates. This dataset is incredibly vast and enables a thorough and in-depth analysis. During

that period, data is gathered on the average daily transfers and fluctuations between crude oil and equities returns. The study's findings highlight the significant influence of market volatility on the returns of exchange rates and various commodities, including wheat, palm oil, and cotton.In addition, it is crucial to analyze the potential consequences of changes in crude oil prices on various sectors, such as currency exchange rates, stock markets, sugar, and palm oil. Based on research findings, the agricultural commodities market, currency rate, and stock market in Pakistan are all influenced by changes in the global crude oil market. In a recent study, a group of researchers examined the effects of the global increase in commodity prices in 2007-2008 on inflation rates in different countries. In 2014, there was a significant decline in global prices, resulting in a noticeable decrease in inflation in several countries and even deflation in certain economies. Our analysis explores the connections between changes in global commodity prices and inflation in Pakistan, a small open economy. Between July 1992 and June 2014, Pakistan's inflationary patterns were mainly shaped by the ups and downs in global prices. The fluctuations in global food prices have a substantial impact on both food inflation and overall inflation in Pakistan. The rise in non-food and managerial prices can be linked to the upward trajectory of global oil prices. Global core inflation is impacted by important factors such as the prices of cotton and metal. It is important to recognize that fluctuations in global commodity prices can have a significant impact on Pakistan's inflation rate, which can be adjusted quickly through monetary policy. Recovering from different shocks, such as changes in the overall price level, typically requires a significant amount of time for core inflation to stabilize. In Pakistan, the impact of inflation is shaped by monetary and exchange rate policies, with the exception of inflation caused by administrated pricing.

A study conducted by Aiza Shabbir and Shazia Kousar (2019) examined the significance of incorporating gold into investment portfolios to enhance diversification. It offers valuable insights on how investors can improve their strategies for saving. Including gold reserves in their portfolio can offer businesses protection against the impact of inflation. When inflation rates increase, gold prices tend to rise as well. This could offer valuable insights for families, investors, corporations, or the government. It is widely anticipated that the price of gold will increase during periods of inflation. For individuals seeking to optimize their gold returns and safeguard against inflation, it would be prudent to contemplate acquiring gold at this juncture. During periods of market volatility, investors often tend to follow popular sentiment. They frequently make decisions that are not grounded in rational thinking. The current pattern may shift in imperfect markets, and these changes are referred to as nonrandom. Some experts believe that there is no substantial long-term correlation between the oil and gold markets and the Indian stock market. On the contrary, it is widely believed that the stock market is mainly impacted by the price fluctuations of gold and oil. Investors often turn to the oil and gold markets as a safe haven in the face of more volatile investment options. In certain markets, the liquidity ratio tends to be noticeably higher. Based on their research findings, it seems that individuals' investment decisions are not significantly impacted by the value of gold and oil. Investments in gold and oil are highly regarded as valuable assets in emerging nations. Investing in the stock market is often seen as a highly profitable form of investment. The Pakistani economy is highly dependent on oil, and fluctuations in oil prices directly influence stock values. When the market is not operating at its best, there exists a distinct correlation between the price of oil and stock prices. When the price of oil rises, companies that depend on oil in their operations usually experience a decline in their stock prices. There could potentially be a delay in how oil prices react to fluctuations in stock prices within an inefficient market.

In a recent study, Sidra Nazir and Abdul Qayyum (2014) conducted an analysis on the influence of oil price fluctuations and shocks on Pakistan's economic growth. They argued that despite the alterations to US biofuel regulations in 2006, the rise in US retail food prices has been relatively modest in recent years when accounting for inflation. On the other hand, American farmers have encountered substantial price hikes for maize, soybeans, wheat, and rice. These increases can be partially attributed to the recent surge in the real price of oil. It appears that this relationship is primarily influenced by macroeconomic factors that affect the prices of agricultural commodities and oil, rather than indicating a correlation with increasing oil prices. Based on our analysis, it appears that there is no notable connection between the oil and agriculture markets in terms of the demand for maize ethanol. The minimal cost share of agricultural items in food prices is a crucial factor that restricts the influence of increasing agricultural commodity prices on US retail food costs. In simple terms, there is not much evidence to indicate that the recent increases in US retail food prices were anything more than a minor result of changes in oil prices. Furthermore, the existing evidence fails to sufficiently support the widely accepted belief that rises in oil prices result in increased expenses in food processing, packaging, transportation, and distribution.

Shoaib Bashir Khan and Muhammad Mohsin Haroon conducted a comprehensive analysis of the global decline in commodity prices and its potential implications for Pakistan's economy. Nevertheless, Baumeister and Kilian (2013) presented evidence that suggests fluctuations in oil prices have a substantial influence on food prices. Thoroughly examining the data can offer valuable insights. Based on my understanding of economics, I can demonstrate that the rise in the fluctuation of food retail prices in the US since 2006 has been relatively insignificant, which goes against common perception. In addition, there is no discernible trend of heightened instability in real food commodity prices. Contrary to what many people think, the price of corn saw a relatively small 11% increase, while the growth rate of the real price of rice and soybeans actually decreased. Price volatility for wheat has experienced a notable surge, surpassing that of maize. Biofuel regulations are anticipated to have a significant impact on maize, given that it is the crop that will be most affected.

3. Methodology

3.1. Sequential Augmented Dickey Fuller (SADF) test

$$\mathrm{SADF}(r_0) = \sup_{r_2 \in [r_0, 1]} \{\mathrm{ADF}_0^{r_2}\}$$

Phillips and Yu (2011), Phillips et al. (2011), Phillips et al. (2012), and Phillips et al. (2015) developed innovative methods to detect and analyze economic bubbles. Their study is grounded in the concept that there is a variation between random walk behavior and explosive behavior, and that speculative bubbles tend to form before they burst. They have developed a novel method for detecting bubbles that incorporates explosive unit roots. The standard test is limited to an autoregressive process where δ is less than or equal

to 1. Nevertheless, the test presented by Phillips and Yu (2011) takes into account the possibility of δ exceeding unity while remaining in close proximity to it. This tool assists in calculating the systematically right-tailed unit root test (RT-UR), which is utilized for analyzing all potential bubbles. When it comes to stationarity, the right-tailed test differs from the left-tailed test. According to Homm and Breitung (2012), the SADF test is a valuable tool for identifying bubbles. However, the SADF test does have several flaws. During a SADF test, the initial observation serves as a fixed reference point. In scenarios where there are two bubbles and one holds more influence, the SADF test might not be able to detect the presence of the second bubble, consequently failing to identify the first one.

3.2. Generalized sup Augmented Dickey Fuller (GSADF) test

Phillips et al. (2011) introduced a modified version of the SADF test where the initial window is not fixed and shifts throughout the dataset, while keeping the starting window size consistent. In order to address this issue, P. C. Phillips et al. (2015) incorporated the SADF and rolling SADF tests into the GSADF test. It has the capability to identify a significant number of bubbles.

$$\mathrm{GSADF}(r_0) = \sup_{r_2 \in [r_0, 1],\ r_1 \in [0,\ r_2 - r_0]} \{\mathrm{ADF}_{r_1}^{r_2}\}$$

In this scenario, r2 represents the extraction process, with a range from r0 to 1. The lowest window size is denoted by r0. Similarly, the value of r1 ranges from 0 to r2 r0. Consequently, the GSADF statistics undergo a change from r2 to r0. According to P. C. Phillips et al. (2015), the GSASDF spread is determined by the lowest window size r0. Estimation becomes challenging when r0 is too low, while a high value increases the risk of overlooking an initial bubble. Therefore, the formula for r0 is derived from the research of P. C. Phillips et al. (2015) and Hu and Oxley (2017). The formula for r0 is calculated as 0.01 plus 1.8 divided by the square root of T, where T represents the number of observations. According to Phillips et al. (2015), the criteria mentioned above results in a sufficient window size. They argue that using an excessively high lag order can lead to significant distortions in the estimated size. Therefore, the study selects a lag length of zero. Monte Carlo simulations are employed to determine constrained values through 1000 replications. Researchers conducted a thorough analysis of the explosive bubble, employing an econometric approach similar to that used by Phillips et al. (2015). In their study, Phillips et al. (2015) conducted tests on various regression model parameters. They compared models that had and did not have intercept, trend and no trend, and concluded that the model with an intercept term performed better when using actual data. In addition, the inclusion of an intercept can sometimes lead to misleading (positive) bubbles, despite the presence of a "collapse" or "collapse and evaluation phase" (Hu & Oxley, 2017). Through a careful examination, this issue can be easily resolved. This issue is being studied using backward SADF statistics and a 95% confidence level.

4. Results and Discussion

In this section, the study's findings are presented and assessed by initially describing the descriptive statistics of the variables being investigated. In the following section, we will examine the empirical results of various right tail ADF tests, including the ADF test, the SADF test, and the GSADF test. Table 1 presents the descriptive statistics for all the variables under consideration, including electric charges, gas charges, petrol, sugar, veg ghee, LPG, and wheat. The average electric charge is 2.81, while the average charges for gas, petrol, sugar, vegetable ghee, LPG, and wheat are 102.10, 100.32, 66.85, 579.20, 1435.68, and 423.99, respectively. The electric charges range from 1.87 to 9.38, while the gas charges range from 0.00 to 246.29. Petrol prices fluctuate between 63.50 and 240.21, while sugar prices range from 50.31 to 107.6. Veg ghee prices vary from 445.12 to 1421.92, and LPG prices range from 871.82 to 2684.50. Lastly, wheat prices fluctuate between 306.20 and 645.54. It has been observed that the average deviation of each value of electric charges from its mean value is 1.66. The average deviation for each value of gas charges, petrol, sugar, veg ghee, LPG, and wheat is as follows: 63.4, 29.03, 16.02, 202.54, 383.90, and 83.6, respectively. Based on the skewness measurement, it can be observed that electric charges, petrol, sugar, veg ghee, LPG, and wheat exhibit a positive skew, whereas gas charges display a negative skew. Based on the p-value of the Jarque-Bera test for electric charges, gas charges, petrol, sugar, veg ghee, LPG, and wheat being less than 0.05, it can be concluded that these variables do not adhere to a normal distribution.

Table 1: Descriptive Statistics of Essential Commodities

	Electric Charges	Gas Charges	Petrol	Sugar	Veg Ghee	LPG	Wheat
Mean	2.818086	102.1080	100.3224	66.85055	579.2016	1435.680	423.9996
Median	2.000000	128.7000	100.4050	59.68000	508.9250	1368.705	394.0500
Maximum	9.380000	246.2900	240.2100	107.5900	1421.920	2684.500	645.5409
Minimum	1.870000	0.000000	63.50000	50.31000	445.1200	871.8200	306.2000
Std. Dev.	1.660853	63.39914	29.02797	16.02030	202.5426	383.9031	83.58757
Skewness	1.898128	-0.630448	2.138442	1.001273	2.472432	1.436086	1.139655
Kurtosis	5.470745	2.514205	10.52545	2.657657	8.850294	4.974991	3.357717
Jarque-Bera	109.4194	9.737900	399.5954	22.01274	312.9473	64.79982	28.39048
Probability	0.000000	0.007681	0.000000	0.000017	0.000000	0.000000	0.000001
Sum	360.7150	13069.82	12841.26	8556.870	74137.80	183767.0	54271.95
Sum Sq. Dev.	350.3208	510470.2	107013.1	32594.57	5209983.	18717458	887334.0
Observations	128	128	128	128	128	128	128

Table 2 offers a detailed breakdown of the correlation matrix, showcasing the extent of correlation between different variables.

There is a clear and undeniable link between electric charges, gas charges, petrol, sugar, vegetable ghee, LPG, and wheat. There is a modest positive relationship between electric charges and gas charges, a robust positive relationship between petrol and electric charges, a highly significant positive relationship between sugar and electric charges, as well as a remarkably strong positive relationship between veg ghee and electric charges. Furthermore, there exists a significant positive correlation between LPG and electric charges, as well as an exceptionally strong positive correlation between wheat and electric charges. There are moderate positive correlations between petrol and gas charges, weak positive correlations between sugar and gas charges, another weak positive correlation between veg ghee and gas charges, as well as weak positive correlations between LPG and gas charges, and between wheat and gas charges. There appears to be a mild positive correlation between these variables (sugar, veg ghee, LPG, and wheat) and gas charges. There is a moderate positive correlation between sugar and petrol, a very strong positive correlation between veg ghee and petrol, and a strong positive correlation between LPG and petrol. Furthermore, there exists a significant positive correlation between wheat and petrol. There is a strong positive correlation between vegetable ghee and sugar, a moderate positive correlation between LPG and sugar, and a highly significant positive correlation between wheat and sugar. There is a clear and strong correlation between LPG and veg ghee, as well as between wheat and veg ghee. Furthermore, there is a significant positive correlation observed between wheat and LPG.

Table 2: Correlation Matrix of Essential Commodities

Correlation	Electric Charges	Gas Charges	Petrol	Sugar	Veg Ghee	LPG	Wheat
Electric Charges	2.736881						
	1.000000						
Gas Charges	32.27825	3988.048					
	0.308960	1.000000					
Petrol	33.96320	716.3123	836.0400				
	0.710014	0.392291	1.000000				
Sugar	21.91213	357.1841	215.1641	254.6451			
	0.830021	0.354441	0.466325	1.000000			
Veg Ghee	305.9711	4339.659	5051.243	2239.973	40702.99		
	0.916726	0.340614	0.865908	0.695764	1.000000		
LPG	461.0209	9024.789	9509.159	2721.565	65712.43	146230.1	
	0.728743	0.373713	0.860023	0.445998	0.851757	1.000000	
Wheat	121.2011	1642.543	1654.026	1161.806	14119.58	21205.44	6932.297
	0.879914	0.312391	0.687053	0.874435	0.840563	0.666024	1.000000

Table 3 presents a comprehensive analysis of the regression results for all the variables under consideration, specifically focusing on petrol prices. It is evident that the prices of petrol have a significant influence on essential food items such as wheat, sugar, and ghee. Furthermore, it is worth noting that changes in petrol prices have a significant impact on essential food items. This is evident from the statistically significant t-values of petrol prices in all three regression results of the food items. Additionally, when examining the relationship between petrol prices and energy variables such as LPG prices, gas prices, and electricity prices, it is evident that petrol prices have a positive impact on all of these variables. Furthermore, the statistical significance of petrol prices is confirmed by the t-values, which are greater than 2 in all three regression results. This demonstrates that the price of petrol has a beneficial effect on all variables, including energy and food items.

Table 3: Regression output of Wheat on Petrol Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	225.5213	19.46100	11.58837	0.0000
PETROL	1.978405	0.186397	10.61392	0.0000

R-squared 0.472042
Adjusted R-squared 0.46785

Table 4: Regression output of Sugar on Petrol Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	41.03148	4.540964	9.035852	0.0000
PETROL	0.257361	0.043493	5.917256	0.0000
R-squared	0.217459	Mean dependent var		66.85055
Adjusted R-squared	0.211248	S.D. dependent var		16.02030

Table 5: Regression output of Ghee on Petrol Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-26.93295	32.46289	-0.829654	0.4083
PETROL	6.041867	0.310929	19.43165	0.0000
R-squared	0.749796	Mean dependent var		579.2016
Adjusted R-squared	0.747810	S.D. dependent var		202.5426

Table 6: Regression output of Electricity Prices on Petrol Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.257400	0.374751	-3.355292	0.0010
PETROL	0.040624	0.003589	11.31786	0.0000
R-squared	0.504120	Mean dependent var		2.818086
Adjusted R-squared	0.500185	S.D. dependent var		1.660853

Table 7: Regression output of GAS Prices on Petrol Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.15256	18.68615	0.864414	0.3890
PETROL	0.856792	0.178976	4.787195	0.0000
R-squared	0.153892	Mean dependent var		102.1080
Adjusted R-squared	0.147177	S.D. dependent var		63.39914

Table 8: Regression output of LPG Prices on Petrol Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	294.6082	62.76717	4.693666	0.0000
PETROL	11.37405	0.601183	18.91943	0.0000
R-squared	0.739640	Mean dependent var		1435.680
Adjusted R-squared	0.737573	S.D. dependent var		383.9031

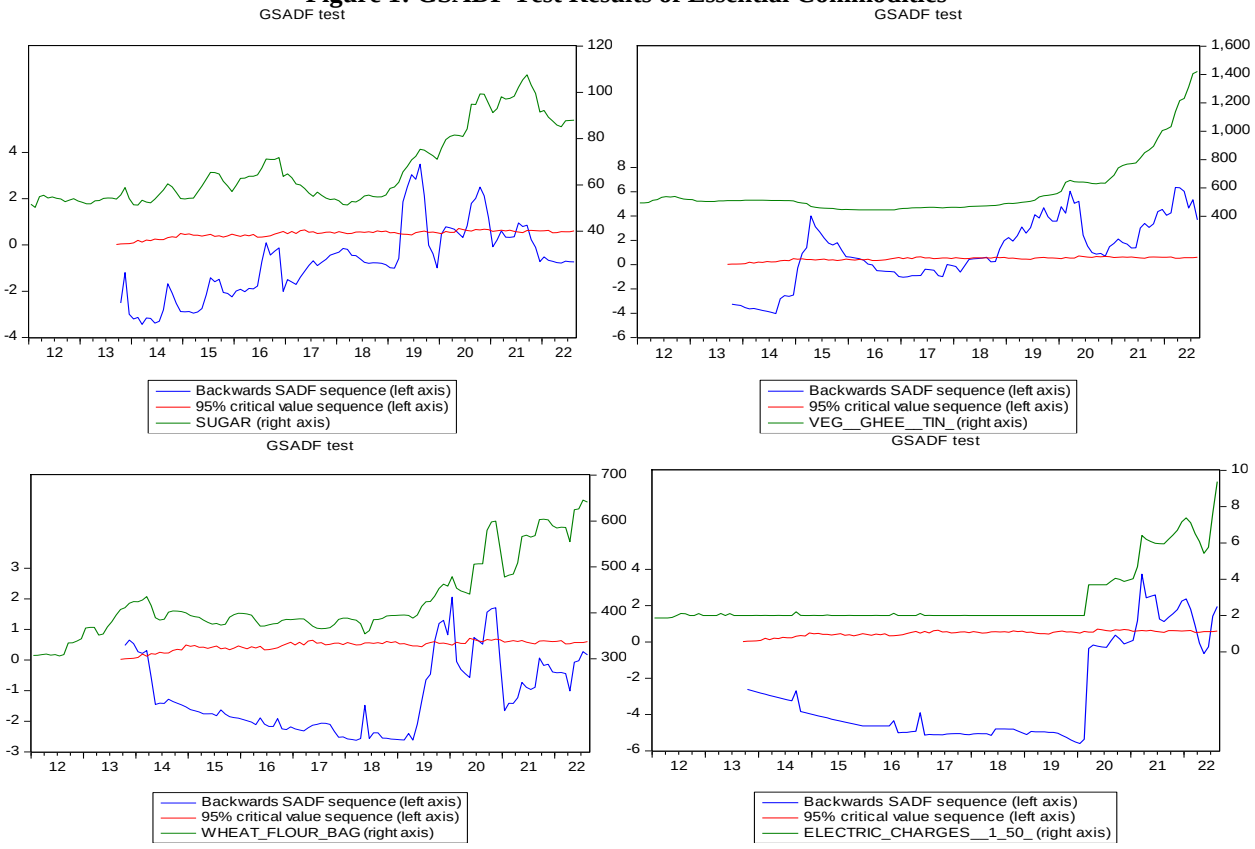
Table 9 presents the findings of the SADF and GSADF tests for essential commodities, including wheat, electric charges, gas charges, LPG, petrol, sugar, and vegetable ghee. The p-value for the wheat flour bag in the SADF test is greater than 0.05, suggesting that we accept the null hypothesis and conclude that the wheat flour bag does not exhibit explosive behavior. However, the p-value in the GSADF test is less than 0.05, leading us to reject the null hypothesis and conclude that the wheat flour bag does exhibit explosive behavior according to the GSADF test. Based on the results of the SADF and GSADF tests, the p-value for the electric charges is less than 0.05. Therefore, we can reject the null hypothesis and conclude that the electric charges exhibit explosive behavior. Based on the p-values of the SADF and GSADF tests, which are both less than 0.05, we can confidently reject the null hypothesis. This suggests that gas charges exhibit explosive behavior, as indicated by the SADF and GSADF tests. Based on the p-values of the SADF and GSADF tests, which are both greater than 0.05, we can conclude that the null hypothesis is accepted. This suggests that LPG does not exhibit explosive behavior. Based on the results of the SADF and GSADF tests, the p-value of petrol is less than 0.05. Therefore, we can reject the null hypothesis and conclude that petrol exhibits explosive behavior. The p-value for the sugar SADF test is greater than 0.05, suggesting that we accept the null hypothesis and do not reject it. This implies that sugar does not exhibit explosive behavior. However, the p-value for the GSADF test is less than 0.05, leading us to reject the null hypothesis

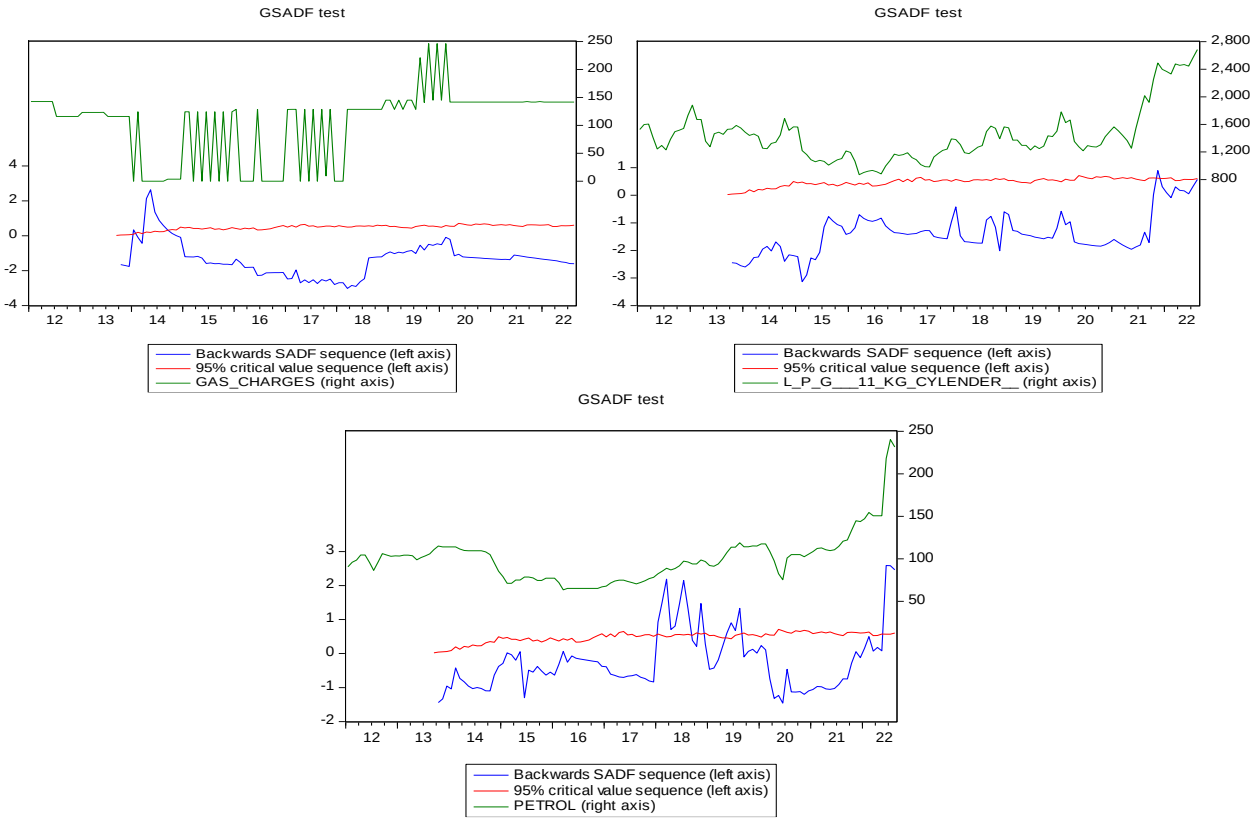
and conclude that sugar does display explosive behavior according to the GSADF test. Based on the results of the SADF and GSADF tests, the p-value for the veg ghee is less than 0.05. Therefore, we can reject the null hypothesis, suggesting that the veg ghee exhibits explosive behavior.

Table 9: SADF and GSADF Tests Results of Essential Commodities

Essential Commodities	Unit	SADF	GSADF
WHEAT_FLOUR_BAG	10 KG	0.6519	2.0551
		(0.2130)	(0.0470)
ELECTRIC_CHARGES__1_50_		3.7316	3.7316
		(0.0000)	(0.0000)
GAS_CHARGES		2.6346	2.6346
		(0.0020)	(0.0110)
L_P_G___11_KG_CYLENDER		0.8955	0.8955
		(0.4650)	(0.4650)
PETROL		1.9247	2.5883
		(0.0110)	(0.0120)
SUGAR		1.0064	3.4920
		(0.1040)	(0.0010)
VEG__GHEE__TIN		4.7922	6.3561
		(0.0000)	(0.0000)

Figure 1: GSADF Test Results of Essential Commodities





Here is a visual representation of the SDAF and GSADF tests for all factors considered from 2012 to 2022, as shown in Figure 1. In the final quarter of 2018, there was a notable surge in sugar prices per kg, which displayed a significant and explosive pattern. The increase in petrol prices was one of the main potential causes of this exposure, along with other factors like the overall rise in inflation. In several temporal dimensions, the prices of Ghee have shown an explosive pattern. This pattern was first observed in the beginning of the third quarter of 2014 and continued until the end of 2016. Furthermore, in the midst of 2018, a second pattern of significant magnitude was uncovered, and it has persisted in its explosive nature up until the present. In addition to factors such as political instability, law and order issues, and severe inflation, the fluctuating prices of petrol played a significant role in the volatility of Ghee pricing. Wheat prices also experienced significant inflation during the subsequent period when gasoline prices reached their highest point. Initially, a remarkable pattern emerged in the first quarter of 2019 and persisted throughout the rest of the year. Furthermore, there was a subsequent surge in activity during the second quarter of 2020, which persisted until the end of 2020 and extended until the conclusion of August 2022. Electric prices exhibited a consistently upward trajectory throughout the entirety of 2020. However, there was a significant increase in electricity prices during the last quarter of 2020. This increase was primarily attributed to the impact of the COVID-19 pandemic. The pattern of high prices persisted throughout 2021. After a brief respite, another surge in prices occurred at the beginning of the second quarter of 2022, which continued until the end of the study period. The rise in electricity prices can be attributed to various factors, such as the economic instability of the country, the impact of COVID-19, and the issues with the energy supply. These factors have contributed to a shortage of energy and subsequently led to an increase in electricity prices. There was a noticeable increase in gas prices starting from the 2nd quarter of 2014, and this trend is expected to continue until the last quarter of the year. The prices of LPG exhibited a volatile trend throughout the fourth quarter of 2021. The prices of petrol have shown a pattern of volatility, with periods of significant increases and decreases. This pattern was observed in the first quarter of 2018 and continued until the fourth quarter of that year. Another period of volatility was identified in the last quarter of 2018, which extended until the first quarter of 2019. The second quarter of 2019 saw another period of volatility, which lasted until the end of the third quarter. More recently, in the middle of the second quarter of 2022, another period of volatility began and has continued up to the present.

5. Conclusions

The study examined descriptive statistics and empirical results of several right tail ADF tests, including the ADF test, SADF test, and GSADF test. The descriptive statistics provided offer a comprehensive overview of the variables being examined, such as electric charges, gas charges, petrol, sugar, veg ghee, LPG, and wheat. The statistics provide a comprehensive overview of the variables, including their mean, maximum, minimum, standard deviation, skewness, and kurtosis. In addition, it is worth noting that the variables in question do not adhere to a normal distribution, as indicated by the Jarque-Bera test. Similarly, the correlation matrix demonstrates the strength of correlation between various variables. There are both positive and negative correlations among the variables, as the analysis suggests. For example, there is a clear relationship between electric charges and the prices of petrol, sugar, vegetable ghee, LPG, and wheat. In addition, there are moderate to weak positive correlations between other pairs of variables. The regression results revealed the influence of petrol prices on several dependent variables, such as wheat prices, sugar prices, ghee prices, and energy variables (LPG prices, gas prices, and electricity prices). Based on the findings, it is evident that the prices of petrol have a notable and statistically significant influence on all the variables under consideration. However, the findings from the

SADF and GSADF tests indicate that wheat flour bags display different behaviors. The SADF test suggests non-explosive behavior, while the GSADF test suggests explosive behavior. Electric charges, gas charges, petrol, and veg ghee exhibit remarkable behavior based on both tests. On the other hand, LPG does not display any explosive characteristics. Based on the SADF test, sugar shows non-explosive behavior. However, the GSADF test reveals that it exhibits explosive behavior. In summary, the research indicates that changes in petrol prices have a notable impact on both food items and energy variables. Furthermore, specific commodities exhibit a tendency for explosive behavior, suggesting the possibility of volatility and the presence of market dynamics. These findings offer valuable insights for policymakers, researchers, and market participants in comprehending the relationships and dynamics among the variables under study.

6. Recommendations

Given the findings presented in the study, we can derive several policy recommendations to effectively address the observed relationships and patterns. Considering the significant influence of petrol prices on essential food items like wheat, sugar, and ghee, it is crucial for policymakers to closely monitor and manage fluctuations in petrol prices. Efforts should be made to stabilize and control petrol prices in order to mitigate any potential inflationary impact on essential food commodities. Understanding the strong connection between petrol prices and energy variables like LPG, gas, and electricity prices, policymakers should contemplate implementing measures to lessen the impact of petrol price fluctuations on energy costs. One possible approach is to implement subsidy programs or price controls to guarantee affordable energy access for consumers, especially those who heavily depend on these energy sources. Considering the dynamic nature of electric charges, gas charges, and veg ghee, it is crucial for policymakers to prioritize the promotion of robust market competition and the implementation of efficient price regulation mechanisms. This can contribute to the prevention of excessive price volatility and the establishment of fair and stable prices for essential commodities, which can be advantageous for both producers and consumers. In order to mitigate the impact of petrol price fluctuations on essential commodities, policymakers should consider investigating alternative energy sources and encouraging their use. Expanding the energy mix can play a crucial role in reducing the effects of sudden increases in petrol prices on industries that heavily rely on energy, and in turn, stabilize prices, which is ultimately advantageous for consumers. In the same vein, implementing strong monitoring systems and early warning mechanisms allows policymakers to identify potential volatile behaviors or significant price changes in essential commodities at an early stage. This can help to proactively intervene with policies and avoid negative consequences for consumers and the economy as a whole. Efforts to enhance market efficiency, transparency, and competition can play a role in stabilizing prices and mitigating the effects of external shocks. One way to achieve this is by improving market infrastructure, encouraging fair trade practices, and ensuring stakeholders have access to market information. Understanding the significance of essential commodities for food security, it is crucial for policymakers to focus on initiatives that enhance domestic production, minimize supply chain inefficiencies, and guarantee sufficient availability of essential food items. This can include providing assistance to farmers, making investments in agricultural infrastructure, and advocating for sustainable agricultural practices. Policymakers should carefully consider these recommendations in light of their unique socio-economic conditions and conduct additional research and analysis to assess their feasibility and potential impact.

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