Gauging the Fuel Price Volatility using GARCH Models

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Abstract

This study presents a unique analysis of the volatility of fuel prices in Pakistan. The daily time series data for two fuel prices, petrol and diesel, were obtained from January 3, 2010, to October 30, 2023. This study applied the Auto Regressive Conditional Heteroskedasticity – a univariate time series econometric model and found that ARCH and GARCH effects are significant for both fuel price returns at a 1 per cent significance level. The mean reversion coefficients for petrol and diesel are 0.9076 and 0.8895, respectively, indicating a slow mean reversion for petrol as it is closer to 1 ($\alpha+\beta\to1$). This is further supported by the half-life analysis, which reveals the speed of mean reversion and concludes that petrol prices are more volatile as it takes eight days to revert to the mean position compared with six days for diesel.

INTRODUCTION

Price volatility refers to the degree of fluctuation in prices. Fuel price volatility affects the economy's different sectors, such as agriculture, manufacturing, industrial, etc. Fuel prices have a positive and negative impact on the economic sector. Our paper tries to investigate petroleum price volatility.(Habanabakize & Dickason-Koekemoer, 2021).

Furthermore, one of the most significant commodities in the international financial markets is the price of petrol. As a result, there was a period of extreme volatility in the fuel and financial markets, increasing concerns about shocks and contagion between them during the turbulent time. Research on how fuel price fluctuations affect stock prices is still in its infancy. Most of this research has documented the substantial effects of changes in gasoline prices on the economic sector; a variety of narratives may explain the impact of fuel prices on the economic sector,

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but the opposite effect is less pronounced. Because the industrial, agricultural, and personal sectors are forward-looking, they may decline before a downturn in the economy. In contrast, supply and demand fundamentals determine fuel prices, which fluctuate with business cycles. There is comparatively little research on the relationship between fuel prices and the economic sector in developing countries, in contrast to most developed nations. Moreover, there has been little discussion of how petroleum prices affect stocks from a sector perspective. This essay examines the relationships between rising fuel costs and economic expansion. (Hamma et al., 2014).

After the Second World War II, fluctuations in fuel prices have had a major supply-side effect on global economic activity. Fuel price shocks significantly affect most global economies, including those of industrialised and developing countries. Fuel is still, without a doubt, a vital energy source in the global economy. Fuel price fluctuations affect the global energy markets and the global economy. Despite the country's weak growth of less than 1% during the same period, inflation has increased. Because rising fuel prices lead to cost-push inflation and slow development, this study provides a fascinating insight into how fluctuations in gasoline prices affect the South African economy. To our knowledge, no recent analysis has been conducted on this occurrence. Thus, this study's main objective is to ascertain the problem's scope. Fuel price increases harm the economics sector and hurt macroeconomic variables like inflation and economic growth in developing countries. (Yasmeen et al., 2019).

The shock of rising petroleum prices has a major effect on global economic growth because fuel importers have limited purchasing power. But growing fuel import costs won't meet demand, affecting exports. Shocks to fuel prices, however, will impede its ability to expand trade and exports as a petroleum exporter. Petroleum is vital for an economy to grow.(Meyer, 2018) Recent developments in the global energy sector may mean that the effects of volatile gasoline prices will have less of an impact on the economy. In the industrialised world, the impact of such fluctuations increases when economies move away from being primarily dependent on energy sources that are highly dependent on gasoline prices and toward other, more efficient energy sources. As a result, the economy is better protected from negative shocks and the negative effects of fluctuations in fuel prices are mitigated. Fuel prices have historically fluctuated greatly in the global fuel market. This volatility is caused by various factors, including behavioural and political issues that fall outside the scope of this economic analysis, in addition to the short-term imbalance between supply and demand.

Since Pakistan is a major importer of gasoline, fluctuations in fuel prices tend to affect a wide range of industries and sectors, from transportation and industry to food and agriculture production. This study attempts to measure the impact of volatile fuel prices on Pakistan's economy. The selected factors are grounded in existing literature and effectively explain the impact of fluctuations in oil prices on different sectors within Pakistan. (Jawad, 2013).

Scope of the Study

The study aims to measure fuel price volatility and subsequently gauge the mean reversion phenomenon using univariate models. Moreover, the study also considers the speed of mean reversion, i.e., how long it takes to revert the prices to their mean position.

The objective of the Study

- To investigate the volatility in fuel prices.
- To investigate the mean reversion in the fuel prices

REVIEW OF LITERATURE

Literature Review

The price of fuel plays a crucial role in developing economies; the impact of oil price fluctuations on the economy may not be as great. The impact of such variations decreases in the industrialised world when economies move away from being primarily dependent on fuel-intensive energy sources and move toward other, more efficient energy sources. This protects the economy from adverse shocks and mitigates the negative effects of fluctuations in fuel prices.

Fuel prices have an impact on every industry in Pakistan. The nation's economy is impacted by the fluctuation of fuel prices, either directly or indirectly. The sharp fluctuations in fuel prices directly impact the global economy and financial markets. Given the wide range of productive endeavours, an economist with a deep understanding of these influences can select the best action for any given economic situation. Fuel price volatility is one of the main causes of inflation in Pakistan, according to an EU researcher who studied the impact of fuel price volatility on domestic economic growth. Fuel prices impacted the GDP. Fuel price volatility may positively or negatively affect the nation's economic growth (Min, 2022).

Fuel prices are another lucrative factor that jeopardises the deals and products of the manufacturing sector. The engine of input acquisition and affair distribution is the fuel. The cost of the product and the final goods' selling price rise due to high transportation costs (Habanabakize & Dickason-Koekemoer, 2021).

The theory is the calculation to investigate the relationship between fuel price changes and the expansion of various economic sectors. In the section that follows this one, will show the estimated models include independent variables that are truly proxies for consumption, investment, government spending, and international commerce (Carpio, 2019). Each model must include fuel price as an explanatory variable because the primary goal is to investigate the effects of changes in fuel prices on sector growth. The other independent variables are added to the models to enhance their model fitting. These independent variables are foreign direct investment, money in circulation, government spending, and the wholesale price index. The data was initially converted. The fluctuations in the price of fuel may affect Pakistan's real estate market's expansion. Pakistan's real economy comprises the agricultural, industrial, and service sectors. The theory emphasises more than four sub-sectors (manufacturing, power, transport and communication, and livestock) within these sectors essential to Pakistan's GDP. This theory will demonstrate how the development of a certain industry reacts to fuel price changes. By examining the effects of fuel price changes on the expansion of specific economic sectors, The Theory also presented a framework for policy so that the decision-maker may avoid overreacting or underreacting to shocks in the price of fuel by creating a sound monetary policy that is neither either contractionary nor over expansionary. (Abdul Rafay & Farid, 2015).

Additionally, it highlights the industries subject to fluctuations in the price of oil. This will assist decision-makers in refocusing their efforts on the weaker sectors and providing for them according to their particular needs. Investment in these areas is encouraged, and they are resilient to the negative effects of fluctuations in the price of oil.(Yasmeen et al., 2019).

Most countries' economies depend heavily on fuel, another type of energy, especially when producing food and beverages. Fuel is another input considered when producing and promoting manufactured foods and beverages. Food prices were evaluated as fuel prices in the previous study. Examining the unequal effects of oil prices on food prices. Since fuel imports are a major income source for Pakistan, a developing nation, fluctuations in fuel prices will affect the country's economy. However, little information about the relationship between fuel price shocks and stock market return volatility is available. The fluctuations in fuel costs and the unpredictability of the Pakistani stock market. (BAGH et al., 2017).

Upon examination of monthly data from 1998 through 2013, they discovered asymmetries between fuel prices and stock returns. The study investigated the potentially detrimental effects of fluctuations in fuel prices on the nation's economy.(Rahman et al., 2019).

The governments find it extremely difficult to raise fuel prices regularly. Along with raising fuel costs, these factors have decreased economic growth, product and service profit margins, and inflation. The government should address these concerns before deciding on fuel price increase (Jawad, 2013).

METHODOLOGY

Fuel prices are under consideration in investigating the variations in fuel prices in Pakistan. Fuel costs were observed weekly from January 3, 2010, until October 28, 2023. To scrutinise and evaluate the volatility of the gasoline price return. However, data will be collected via the Internet. We will also gather quantitative data and try to present it most effectively. Half-lives, the ARCH and GARCH models, descriptive statistics, Microsoft Excel, and E-views were used to obtain the analysis.

Data & Variables

This research follows the method of secondary data. It is based on Quantitative Research. The variable of this research paper is Fuel prices, and subsequently, returns have been obtained.

Sample

The time that will be focused on for the sample is from 3 January 2010 to 30 October 2023. The data has been collected via secondary sources, i.e., through different websites.

Models

The data has been analysed via uni-variate modelling. The Generalised Auto-Regressive Conditional Heteroscedasticity (GARCH) models were applied where ARCH and GARCH effects were gauged. The same parameters were subsequently used to compute the speed of mean reversion via Half-life models.

Analysis and Results

Graphical Analysis
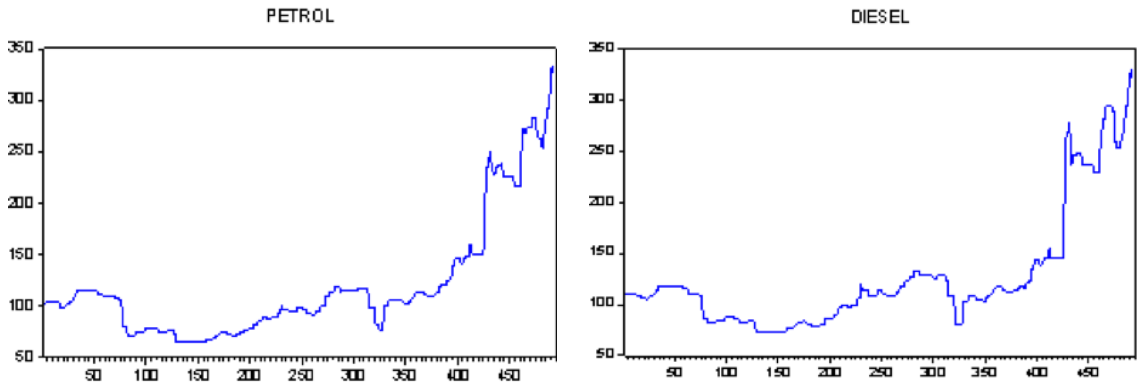
The petrol chart shows the fuel price volatility of the last thirteen years, from 3rd Jan 2010 to 19 Oct 2023. This figure shows the fuel price fluctuation on a weak basis. This figure is shown to determine the volatility of petrol prices; this data is collected from a secondary source.

The diesel chart shows the Diesel price volatility of the last thirteen years from 3rd Jan 2010 to 19 Oct 2023. This figure shows the Diesel price fluctuation on a weak basis. This figure shows how to determine the diesel price volatility; this data is collected from a secondary source.

Unit Root test

	t-static	prob
Diesel	0.046763	0.9613
D(Diesel)	-12.27495	0.0000
RDiesel	-19.72407	0.0000
Petrol	0.507232	0.9869
D(Petrol)	-8.581707	0.0000
RPetrol	-20.16321	0.0000

Unit root deals with the stationary issue. When a data set has a unit root, it is stationary. To work on the data set, we have to make it non-stationary, i.e., without a unit root. This table shows that the first difference and returns series have no unit root as their p-values are less than 0.01.

GARCH Models

Variables	α	β	α + β
R Petrol	0.078831***	0.828778***	0.907609
R Diesel	0.073126***	0.816397***	0.889523

*** 1% level of significance

This table shows that the variable returns on petrol prices (R Petrol) and returns on diesel

prices (R Diesel) have two parameters, ARCH (α) and GARCH (β), and both are significant for both fuels at a 1 per cent level of significance. The sum of the ARCH and GARCH coefficients approach 1. Closer to 1 signifies the series is more volatile. Here, the petrol price returns show more volatility (0.9076) than diesel price returns (0.889).

Half-life

Where λ (lambda) indicates α+β, i.e. the sum of ARCH and GARCH coefficients. Half-life computes the speed of mean reversion, i.e., how long it will take to revert to the mean position. Here, the return on petrol price series has eight days to revert to its mean position, whereas the diesel return on price series has six days to revert to its mean position. The longer a series takes, the higher the volatility is. This study provides empirical evidence that returns on petrol prices have higher volatility.

INDEX	λ	Half-Life
R Petrol	0.907609	8
R Diesel	0.889523	6

CONCLUSION

Petrol and diesel are two types of fuel in high demand across Pakistan. They are used by public and private transport. Fuel prices have risen almost every month for the last few years, making them more volatile. The study has been conducted to provide empirical evidence of the volatility observed by the fuel prices. The study concluded that both petrol and diesel have volatility as both have significant ARCH and GARCH effects. Moreover, both have mean reversion as the sum of coefficients approaches 1. The speed of mean reversion is, however, higher (8 days) in the returns on petrol prices than (6 days) in the returns on the diesel prices.

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