How do Petrol Prices Respond to Variations in Crude oil and the Exchange Rate? Evidence from South Africa

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Abstract

This study investigated the response of petrol prices to domestic and international component variations. Monthly time series data from 2002M1 to 2021M12 was analysed using econometric modelling, including the structural Vector autoregression. The structural impulse response function indicated that basic petrol prices respond positively to shocks and shocks in brent crude oil prices, and this response was found to be substantial in size. In contrast, basic petrol prices respond negatively to shocks in exchange rates, albeit the response is small. The variance decomposition revealed that variations in basic petrol prices are explained mainly by their shocks in the short run and by shocks in brent crude oil prices in the long run. Domestically, petrol pump prices respond positively to shocks in basic petrol prices, inland transport costs, and wholesale and retail profit margins. On the contrary, the response of petrol pump prices was found to be hostile towards shocks in the road accident fund levy and muted towards shocks in fuel taxes. Given the rise in crude oil prices, the government can consider reviewing the current fuel structure and suspending several fuel levies indefinitely to provide much-needed financial relief to households and businesses.

Keywords: fuel prices; exchange rates; crude oil; South Africa
JEL Classification: B22; B27; C13; E31; Q4

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1. Introduction

Globally, energy plays a crucial role in producing and facilitating goods and services. As such, the availability of electricity and fuel has been recognized as an economic driver. Fuel has generated revenue and covered numerous government fiscal deficits while enabling mobility for motorists and businesses globally. Each country’s fuel pricing structure makes up the overall price of fuel. The extended structure

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of fuel pricing in South Africa has raised the overall fuel price over time. In addition, this has negatively affected businesses and households in different ways, including through higher food prices, increased public transport fares, and electricity generation, to name a few. In South Africa, the key variables that impact fuel prices include the exchange rate, fuel levies and taxes, refinery costs, and the price of crude oil. Other factors, however, indirectly influence fuel prices, including the inflation rate, interest rate, political stability, and level of economic development. These factors are often overlooked in economic literature. The significance of this study lies in its relevance to the current economic status quo in South Africa. Fuel prices and levies have increased firmly in the last two decades, regardless of the domestic economic climate.

To some extent, this increased the standard of living in the country, which has pronounced a crisis for those in low-income and middle-income households. The fuel pricing structure in South Africa comprises several components, such as the primary fuel price, fuel levies, transport costs, and profit margins. It is worth noting that the introductory fuel price is primarily determined by the international crude oil price and the US/ZAR exchange rate. As such, an increase in the international oil price or depreciation of the exchange rate would translate into an increase in the introductory fuel price. In contrast, a decline in the international oil price or an exchange rate appreciation would translate into a decline in the introductory fuel price. Of concern, however, Sabelo (2018) finds that decreases in international oil prices or an appreciation of the exchange rate do not always translate into decreases in the introductory fuel price in South Africa.

This is why this study aims to statistically examine the response rate of basic fuel prices to shocks in international oil prices and the exchange rate in South Africa. This study will contribute significantly to the existing body of literature by providing a statistical analysis of the drivers of fuel prices in South Africa and the response of basic fuel prices to changes in the domestic and international markets. Also, to the best of the authors’ knowledge, such a study has not been conducted in South Africa, a gap that this study aims to fill. This study is particularly crucial and relevant when fuel prices have reached record highs amid global oil price variations and exchange rate variations. Also, higher fuel prices devastate households, businesses, and the economy. The following section reviews the theoretical and empirical literature on the influence of international and domestic factors on the overall fuel price.

2. Literature Review

The availability of fuel remains a fundamental factor in the supply chain of every economy. However, its pricing and cost impact cannot be overlooked since its pricing unravels a chain reaction in aspects outside the economic space. With the global pandemic pronouncing causality of an economic surge in global economies, fuel prices are among the numerous factors affected by the pandemic. Thus, its scrutiny remains vital in understanding its economic impact on households and businesses. In South Africa, the fuel price is determined by numerous factors subject to economic shocks and political occurrences. The fuel price in South Africa encompasses five elements, namely, the General Fuel Levy (GFL), which accounts for 31%. The Road Accident Fund levy (18%), the Basic Fuel Price (freight and insurance costs, cargo dues, storage, and financing), wholesale and retail margins, as well as distribution and transport costs (Automobile Association, 2021). The prices are based on 93 Octane petrol (inland) and 95 Octane petrol (coastal) pricing structure. The Basic Fuel Price (BFP), in particular, is primarily determined by the exchange rate and price of brent crude oil. Apart from the elements mentioned above, other macroeconomic factors indirectly influence the price of petrol, such as the strength of monetary and fiscal policy. For example, changes in the interest rate and political instability affect the exchange rate and, consequently, the price of petrol. Along the same line, the government may shift the burden of increased expenditure and higher interest payments to taxpayers through increases in several tax rates, including fuel levies. Figure 1 illustrates the composition of fuel prices in South Africa. The Department
of Energy (2021) provides a complete list of all the components that make up the fuel pricing structure, including international and domestic factors.

![Petrol Pump Price Diagram](image)

**Figure 1.** South African petrol pricing structure

International factors pertain to the introductory fuel price, determined mainly by the Brent crude oil, the South African exchange rate to the US dollar, and freight and insurance costs. Freight cost refers to the transport costs of refined petroleum from the export refinery centres to the South African ports (DoE, 2021). The government has no control over the costs mentioned above but instead influences selected components such as the exchange rate. On the one hand, domestic components include inland transport costs, government levies, customs, and excise levies collected in agreement with the Southern African Customs Union. RAF is a government levy collected to compensate third-party victims of road accidents. Other components include wholesale and retail margins, which are set and fixed by the DoE based on the actual costs incurred by the service station operator in selling petrol and marketing petroleum activities. Lastly, other levies include pipeline levy, slate levy, equalization levy, and DSML.

It is worth noting that DSML only applies to 95 unleaded fuels and is aimed at curbing the demand for 95 octanes to avoid unnecessary octane waste, given its dire economic consequences (DoE, 2021). The slate levy is imposed to balance the slate account provided the daily calculation of fuel is lower than the introductory fuel price reflected in the fuel price structure at that time.

With the recent fuel price hike, it has been noted that the determinants of fuel prices can explain the price increase. This pertains to the unstable nature of these determinants with specific reference to the exchange rate and Brent crude oil. The Automobile Association (2021) states that motorists are paying high fuel prices due to a weak rand, economic policy, and poor management of the country's fiscal affairs. Though the state does not control these fuel prices, it is worth bearing in mind that they influence the exchange rate, fuel levies, and fiscal policy. All of which directly and indirectly determine the price of fuel. Figure 2 below illustrates the trends in Brent crude oil prices and the exchange rate as international influences on the introductory fuel price. Herein, the two factors display an inverse relationship. That is, when the rand is strong against the US dollar, and the price of crude oil is low, the price of essential fuel becomes relatively cheaper, whereas a weaker rand and higher crude oil prices would result in relatively higher basic fuel prices.
Nonetheless, the price of crude oil averaged US$62.1 per barrel in March 2007 before accelerating to a record high of US$132.7 per barrel in August 2008 amid the emergence of the 2008 global financial crisis and subsequent disruptions in global supply chains. As the 2008 global financial crisis intensified, the average price of crude oil fell sharply to US$40 in December 2008. During this time, the rand was trading at R9.95c to the US dollar while the domestic price of primary fuel was R3.65c. This illustrates that the combination of a stronger rand and lower brent crude oil price results in lower basic fuel prices.

![Graph: Trends in average crude oil price and exchange rates](image)

Source: Author’s computations using data from DEMR (2021)

**Figure 2.** Trends in average crude oil price and exchange rates

It is worth noting also that a more substantial and has the potential to partially offset the effects of higher crude oil prices on the introductory fuel price. For example, in March 2012, the average price of crude oil stood at US$125.5 per barrel while the corresponding US$/ZAR exchange rate stood at R8.01. During this period, the price of essential fuel amounted to R12 per litre. However, one could have expected the introductory fuel price to be relatively higher due to higher crude oil prices. The Covid-19 pandemic likewise had devastated effects on the average price of crude oil and the strength of the rand against the US dollar. During March 2020, the price of brent crude oil reached a record low as the price of brent crude oil stood at US$18.3 per barrel, while the rand depreciated against the US dollar to reach R15. However, this provided much-needed financial relief to households and businesses as the primary fuel price stood at R4.79 per litre. However, the total fuel pump price stood at R15.84, given the number of levies that feed into the fuel pump price. There has been a growing concern recently over the alarming increase in fuel levies that have increased yearly over the last decade. According to the Organisation Undoing Tax Abuse OUTA (2022), fuel levies and taxes make up 65% of the fuel price (see Figure 3). In 2004, the fuel price was below R5 per litre. However, past this period, fuel prices have been relatively high, given the gradual increase in fuel levies and taxes. By 2021, fuel taxes and levies constituted up to 65% of the total fuel pump price.
Furthermore, Mabungu, Chitiga, and Amusa (2009) echo that the government has been increasing fuel levies and taxes, albeit overlooking the tax base in which the taxes are collected and a clear rationale for the increment of taxes and levies on fuel prices. These irrational fuel tax hikes have been given policy significance since August 2006 (Mabungu et al., 2009). To reiterate, Ncanywa and Mgwangqa (2018) advise that the general increase in fuel taxes and levies breeds a negative economic relationship that hampers the production costs of petroleum products while decreasing priority expenditure and increasing unemployment over time—considering the niche that robust tax collection should be underpinned by strong economic growth. Another rationale justifying the excise fuel tax applies to the promotion of using public transport and lift clubs to mitigate the effects of air contamination and achieve cost-saving strategies (Ncube, Shimeles, and Verdier-Chouchene, 2012). However, the rationale counters the current tax base of the country, where taxpayers are less than grant recipients. Newbery (2005) further highlights that most fuel taxes are excise taxes that burden producers, while the standard argument suggests that levies should be concentrated on the final consumption. The most illogical justification for these taxes was to fill fiscal deficits where the tax system has shortfalls. At the same time, a close emphasis is placed on the political unwillingness to pronounce effective policy reform on fuel taxes (Newbery, 2005).

Concerning fiscal policy and its equal importance to fuel prices. A study by Mabungu, Ribichaud, Masonnave, and Chitiga (2013) signals the relationship between the 2008 economic crisis and an unsustained fiscal policy. Nevertheless, in 2008 the country saw a significant fiscal consolidation. In this case, Burger and Chitiga (2020) mirror the same situation at the height of the pandemic, where there was higher adjusted spending on government expenditure than the estimated budget following the February 2020 budget presented by former minister Mboweni. State expenditure amounted to R145 billion net addition, contouring the R36 billion budgeted, leaving a difference of R109 billion in unintended state expenditure (Burger & Chitiga, 2020). Though the latter suffices in times of a national state of disaster, an unintended impact of poor fiscal policy emerges in the long run (Mabungu et al., 2013). The latter is further discouraged by Keynes’s economic theorization in that, in times of economic difficulties, the state should adjust its taxes and spending and plunge the finances back into the economy to achieve and maintain good fiscal and monetary policy (IMF, 2014).

Consequently, such an inverse relationship between deficits and surplus yields a poor economic outlook without any sign of fiscal consolidation, especially with a shrinking tax base in the country.
Therefore, it can be argued that, though the 2008 fiscal woes were consolidated within a short period, the latter does not project quick swift fiscal consolidation. The attribution is dedicated to weak economic growth in preceding years. As a way of maintaining revenue collection, there has been a general increase in fuel taxes to expand revenue collection amid an economic contraction in the past decade.

According to the Keynesian taxation theory developed in the 1940s, no industry should be left to function on a free market basis, but rather, the government should play an active role in regulating and influencing the market. The latter assumes that economic growth is achieved through an effective fiscal and monetary policy where excise taxes and levies should be collected on the basis that it is suitable for full employment in the state (IMF, 2014). On the contrary, Keynes argued that fiscal policy should play a significant role in times of economic crisis by introducing tax rebates. In contrast, the surplus collected during an economic boom should cover the state expenditure (IMF, 2014). The logic suggests that when people pay lower taxes during an economic crisis, they have more money to spend and invest, yielding demand. Also, economic expansions and employment are known as a positive feedback loop. However, the illustrations in the case of South Africa show the direct opposite. Fuel levies have been increasing steadily despite the economic climate.

Of equal importance, the exchange rate remains a significant factor that determines fuel prices. Bloomberg (2017) reveals that the vulnerability of the exchange rate is due to its intricate link to politics. This talks about factors of political stability, sovereign debt, trade terms, political upheavals, and elections. The uncertain nature of the above factors leaves the exchange rate in a highly vulnerable position of dependence. Ngwakwe and Sebola (2019) noted a specific time in the political space of South Africa when the government's administrative capacity resulted in policy uncertainty (Lalbahaudue, 2017). To illustrate, there was a sharp fall in the value of R16 to the dollar due to an unforeseen cabinet reshuffle (Krabodia & Soni, 2016). Moreover, the cabinet reshuffles of 2017 did not only weaken the rand but downgraded the country's sovereign credit rating. These reshuffles can be attributed to policy uncertainty, thus, making the rand unstable.

The fuel price response was R13, 40 (93 octanes) and 13,54 (95 octanes) per litre (Rossous, 2017; SAPIA, 2022). The worst was seen during the July unrest and lootings triggered by the incarceration of former president Zuma. The rand responded by R17, 13 to the dollar, while petrol prices spiked to R17,30 (93 octanes) and 17,39 (95 octanes) per litre. Though the lootings signalled an entrenched socio-economic and inequality woe, the trigger to these remains’ political factors (IFRC, 2012). Due to the negative relationship between the exchange rate and fuel price, the response has been adverse, especially with the current economic state of South Africa. Despite all discussed, the sole aim is to find practical solutions to these hiccups. The Automobile Association has proposed practical ways in which the government can reduce the price of fuel. The first step is to scrutinize the current pricing structure while auditing and recalculating the existing elements and clarifying their relevance. The reduction of the RAF levy by improving its management and governance and maximizing road safety and semi-privatization of RAF should be considered.

3. Method

This section describes the research methodology and approach executed to estimate the response of petrol prices to domestic and international components. The study employed monthly time series data ranging from 2002M1 to 2021M12. The data was obtained from the Department of Energy and Mineral Resources archives. The methodology was guided by earlier studies, e.g., Hartley and Medlock (2013), Berument et al. (2014), and Kargbo (2018).

The model for basic petrol prices can be specified mathematically as follows:

\[ y_t = \beta_0 + \beta_1 BC_{t} + \beta_2 EXR_{t} + \epsilon_t \]  (1)
Where:

\( y_t \) is the dependent variable represented by the introductory petrol price. This includes both 95-octane and 93-octane.

\( BCO \) is the average brent crude oil price

\( EXR \) is the exchange rate used to import petroleum products

\( \varepsilon_t \) is the idiosyncratic error term

It is sufficient to note that the basic petrol price is largely determined by the brent crude oil price and the prevailing market exchange rate. The second model, which encompasses domestic factors, can be expressed mathematically as:

\[
 y_t = \alpha_0 + \alpha_1 BPP_t + \alpha_2 X_t + \varepsilon_t
\]  

(2)

Where:

\( y_t \) is the dependent variable represented by the petrol pump price. This includes both 95-octane and 93-octane.

\( BPP \) is the basic petrol price consisting of the brent crude oil price and exchange rate

\( X_t \) is a vector of domestic factors that make up the petrol pump price, including fuel taxes, customs duties, Road Accident Fund levy, inland transport costs, wholesale margins, retail profit margins, pipeline taxes, equalization fund, and slate and pipeline levies.

\( \varepsilon_t \) is the idiosyncratic error term

The study employed a multiple regression analysis. Several pre-estimation tests were conducted prior to the regression analysis. This included an informal overview of the variables and unit root analysis. The variables were examined for unit root utilizing the Augmented Dickey-Fuller unit root test (Dickey & Fuller, 1979). Following this, the study employed the structural Vector autoregression (SVAR) given the structural breaks in the data. The optimal lag length was identified utilizing a standard VAR. Given that the study's objective was not to estimate the impact of petrol prices but rather the response of petrol prices to shocks in the energy market, the impulse response function and variance decomposition were executed utilizing structural VAR. The last point of analysis involved examining the estimated residuals for autocorrelation and heteroskedasticity.

4. **Results and Discussion**

The findings of the study are discussed in this section. This includes an overview of the data, stationarity analysis, structural VAR estimation, impulse responses, and variance decomposition. The section begins with an overview of the data presented in Figure 4.
From the overview above, basic fuel prices, including Octane (95), Octane (93), and diesel (0.005 sulfur), have increased sharply between 2000M1 and 2021M12. Also, the prices appear to move in the same direction as the average crude oil price. On the one hand, the exchange rate has been constant over time except for a significant deviation in 2001M6. Domestic factors that feed into the fuel pump price, including fuel taxes, transport costs, wholesale margin, retail margin, and customs and excise, have likewise steadily increased over time except for customs and excise, which remained fixed at 0.40c throughout the entire period. As a result, the variable was dropped as it resulted in a substantial serial correlation. The next point of analysis involved examining the variables for unit root utilizing the Augmented Dickey-Fuller unit root test. The results are presented in Table 1.

Table 1. Unit root analysis

| Variable              | Level  | 1st Diff  | 2nd Diff | Outcome |
|-----------------------|--------|-----------|----------|---------|
| Basic Petrol Price (95)| -2.29  | -12.19*   |          | D(1)    |
| Basic Petrol Price (93)| -2.29  | -12.23*   |          | D(1)    |
| Crude Oil Price       | -2.57  | -10.90*   |          | D(1)    |
| Exchange rate         | -15.22*| -12.24*   |          | D(0)    |
| Petrol Pump Price (93)| -0.55  | -11.97*   |          | D(1)    |
| Petrol Pump Price (95)| -0.81  | -11.94    |          | D(1)    |
| Fuel Tax              | 0.91   | -1.96     | -31.99*  | D(2)    |
| Transport Cost        | 1.20   | -18.38*   |          | D(1)    |
| Wholesale margin      | -2.11  | -15.92*   |          | D(1)    |
| Retail margin         | 1.30   | -16.82*   |          | D(1)    |

Source: Author’s computations
4.1. **International Components**

International components that make up the basic petrol price include brent crude oil and the exchange rate. Although relatively small, other components include freight and insurance costs. The response of basic petrol prices (95 octanes) to shocks in brent crude oil and the exchange rate is illustrated in Figure 5 below.

![Accumulated Response to Structural VAR Innovations ± 2 S.E.](image)

**Figure 5.** Accumulated response of basic petrol price (95 octanes)

The impulse response function revealed that basic petrol prices (95 octanes) respond positively to their short, medium, and long-run innovations. Similarly, basic petrol prices respond positively to crude oil prices' shocks throughout the period. Hartley and Medlock (2011) likewise found that basic fuel and crude oil prices move in the same direction, at least in the short run. It is worth noting that the response of basic petrol prices to their innovations and shocks in crude oil prices was found to be substantial in size. In contrast, the response of basic petrol prices to shocks in the exchange rate appears neutral in the short and medium term, albeit the response becomes negative in the long run.

![Accumulated Response to Structural VAR Innovations ± 2 S.E.](image)

**Figure 6.** Accumulated response of basic petrol price (93 octanes)

Basic petrol prices (93 octanes) follow a similar trend to basic petrol prices (95 octanes). For example, in the short and long run, basic petrol prices (93 octanes) respond positively to shocks in the average brent crude oil price. On the contrary, the response of basic fuel prices to shocks in the exchange rate is muted in the short run and harmful in the long run, albeit the magnitude is relatively small. These findings are in line with Berument et al. (2014), who found that the response of basic fuel prices to changes in brent crude oil is relatively more significant than the response of basic fuel prices to changes in the exchange rate. The variance decomposition was employed to estimate the forecast errors of each
variable concerning its shock. The findings are summarised in Table 2 below. In the short run (1-3 years), shocks in basic petrol prices (95 octanes) are explained mainly by their innovations, whereas, in the medium term (4-6 years), shocks in basic petrol prices (95 octanes) are explained by 42% of their innovations and 58% by innovations in the brent crude oil price. Furthermore, shocks in the basic petrol price (95 octanes) are explained by 38% of their innovations and 62% by innovations in the brent crude oil price in the long run (7-10 years). To a small extent, shocks in the basic petrol price (95 octanes) are explained by 0.15% of innovations in the exchange rate, at least in the long run.

Table 2. Variance Decomposition of Basic Petrol Price (95)

| Period | S.E. | Shock1 | Shock2 | Shock3 |
|--------|------|--------|--------|--------|
| 1      | 0.08 | 100.00 | 0.00   | 0.00   |
| 2      | 0.13 | 75.52  | 24.39  | 0.08   |
| 3      | 0.18 | 54.69  | 45.23  | 0.08   |
| 4      | 0.21 | 48.51  | 51.42  | 0.07   |
| 5      | 0.23 | 47.31  | 52.63  | 0.07   |
| 6      | 0.24 | 46.17  | 53.77  | 0.07   |
| 7      | 0.25 | 44.14  | 55.79  | 0.07   |
| 8      | 0.26 | 41.87  | 58.05  | 0.08   |
| 9      | 0.27 | 39.91  | 59.98  | 0.11   |
| 10     | 0.28 | 38.24  | 61.61  | 0.15   |

Factorization: Structural

The variance decomposition was likewise carried out for basic petrol prices (93 octanes), and the results were not far different from those obtained for basic petrol prices (95 octanes). As seen in Table 3, in the short run, shocks in basic petrol prices (93 octanes) are explained by 54% of its shocks, (46%) by shocks in brent crude oil prices, and 0.8% by shocks in the exchange rate. In the long run, however, shocks in basic petrol prices (93 octanes) are explained by 43% of their innovations, 57% by shocks in brent crude oil prices, and 0.8% by shocks in the exchange rate.

Table 3. Variance Decomposition of Basic Petrol Price (93)

| Period | S.E. | Shock1 | Shock2 | Shock3 |
|--------|------|--------|--------|--------|
| 1      | 0.08 | 100.00 | 0.00   | 0.00   |
| 2      | 0.14 | 75.23  | 24.68  | 0.08   |
| 3      | 0.18 | 54.16  | 45.76  | 0.08   |
| 4      | 0.21 | 47.82  | 52.09  | 0.08   |
| 5      | 0.23 | 46.42  | 53.50  | 0.07   |
| 6      | 0.24 | 45.15  | 54.78  | 0.07   |
| 7      | 0.25 | 43.12  | 56.81  | 0.07   |
| 8      | 0.26 | 40.89  | 59.03  | 0.08   |
| 9      | 0.27 | 38.96  | 60.92  | 0.10   |
| 10     | 0.28 | 37.33  | 62.52  | 0.14   |

Factorization: Structural
The estimated structural VAR model was analysed for residual diagnostics. This includes the autocorrelation and heteroskedasticity tests. The results are provided in Table 4 below. The autocorrelation test revealed that residuals in both models (93 and 95 octanes) do not suffer from autocorrelation. This is evidenced by the probability values above the 5% significance level. The probability value for the basic petrol price (95 octanes) was 94%, while the probability value for the basic petrol price (93 octanes) was 91%.

Table 4. Residual analysis

|                      | Autocorrelation | White Heteroskedasticity |
|----------------------|-----------------|--------------------------|
| Basic Petrol price (95) | 0.94            | 0.06                     |
| Basic Petrol Price (93)  | 0.91            | 0.07                     |

Source: Author’s computations

Furthermore, the White heteroskedasticity test revealed that the models do not suffer from heteroskedasticity, given that the probability values are above the 5% significance level. The following subsection details findings from domestic components.

4.2. Domestic Components

This subsection highlights findings on the response of the fuel pump price to variations in domestic components, including basic petrol price, fuel tax, road accident fund levy, transport costs, and wholesale and retail margins.
The fuel pump price (95 octanes) response to its shocks was positive and significant throughout the period. Similarly, fuel pump prices respond favourably to shocks in basic petrol prices, transport costs, and wholesale and retail margins in the long run, albeit the response is neutral in the short to medium term. The response of fuel pump prices to innovations in fuel taxes was muted throughout the entire period. On the downside, the response of fuel pump prices (95 octanes) to road accident fund levy was found to be harmful in the short and long run.

A summary of findings on the response of fuel pump prices (93 octanes) to domestic components is provided in Figure 8. Similarly, the response of fuel pump prices (93 octanes) to internal components is no different from that of fuel pump prices (95 octanes). This is mainly because 95 and 93-octane prices differ by a relatively small margin. Nonetheless, fuel pump prices (93 octanes) respond positively to shocks in the basic petrol price, transport costs, and wholesale and retail margins but respond negatively to shocks in the road accident fund levy. In addition, the response of fuel pump prices (93 octanes) to shocks in fuel taxes is somewhat neutral throughout the entire period. On the downside, we fail to compare our findings on the influence of domestic components with earlier studies, given that research in this field is scant in South Africa.

The variance decomposition analysis, which measures the forecast error of one standard deviation, was performed for fuel pump prices (95 octanes). The results are provided in Table 5 below.

Figure 7. Accumulated response of fuel pump price (95 octanes)

Accumulated Response to Structural VAR Innovations ± 2 S.E.

Accum Response of Petrol Pump Price (93) to Shock 1
Accum Response of Petrol Pump Price (93) to Shock 2
Accum Response of Petrol Pump Price (93) to Shock 3
Accum Response of Petrol Pump Price (93) to Shock 4
Accum Response of Petrol Pump Price (93) to Shock 5
Accum Response of Petrol Pump Price (93) to Shock 6
Accum Response of Petrol Pump Price (93) to Shock 7

Source: Author’s computations

Figure 8. Accumulated response of fuel pump price (93 octanes)
The findings in respect of the petrol pump price were quite interesting, in that shocks in the fuel pump price are explained mainly by their innovations in the short and long run. For example, in the short run (1-3 years), 98% of the variations in the fuel pump price are seemingly explained by its innovations. Also, in the long run (7-10 years), shocks in the fuel pump price are explained by 94% of its innovations, (0.7%) by shocks in the basic petrol price, (0.1%) fuel taxes, (0.9%) road accident fund levy, (3.28%) transport costs, (2.63%) wholesale margins and (1.26%) retail margins. The results in respect of petrol pump price (93 octanes) are presented in Table 6 below.

### Table 6. Variance Decomposition of Petrol Pump Price (93)

| Period | SE   | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|--------|------|--------|--------|--------|--------|--------|--------|--------|
| 1      | 0.05 | 100.00 | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   |
| 2      | 0.09 | 98.88  | 0.63   | 0.03   | 0.01   | 0.00   | 0.44   | 0.01   |
| 3      | 0.10 | 98.56  | 0.46   | 0.02   | 0.24   | 0.22   | 0.44   | 0.07   |
| 4      | 0.11 | 97.99  | 0.39   | 0.02   | 0.38   | 0.78   | 0.37   | 0.06   |
| 5      | 0.12 | 97.15  | 0.39   | 0.03   | 0.51   | 1.37   | 0.41   | 0.14   |
| 6      | 0.12 | 95.99  | 0.53   | 0.03   | 0.62   | 1.87   | 0.63   | 0.33   |
| 7      | 0.13 | 94.72  | 0.66   | 0.03   | 0.69   | 2.33   | 0.99   | 0.58   |
| 8      | 0.13 | 93.47  | 0.71   | 0.04   | 0.76   | 2.73   | 1.46   | 0.84   |
| 9      | 0.13 | 92.29  | 0.71   | 0.05   | 0.81   | 3.05   | 2.03   | 1.06   |
| 10     | 0.14 | 91.22  | 0.69   | 0.05   | 0.85   | 3.28   | 2.63   | 1.26   |

Factorization: Structural

Source: Author’s computations

In the short run, 98% of the shocks in the petrol pump price are explained by its innovations. In the long run, 92% of the variations in the petrol pump price are explained by its shocks, 0.7% by shocks in the basic petrol price, (0.1%) fuel taxes, (0.8%) road accident fund levy, (3.3%) transport costs, (2.7%) wholesale margins and 1.3% by retail margins. The last point of analysis involved examining the residuals. The results are summarised in Table 7 below.
Table 7. Residual analysis

|                      | Autocorrelation | Heteroskedasticity |
|----------------------|-----------------|--------------------|
| Petrol Pump Price (95) | 0.99            | 0.62               |
| Petrol Pump Price (93)  | 0.99            | 0.69               |

Source: author’s computations

The autocorrelation and heteroskedasticity tests confirmed that the estimated residuals do not suffer from autocorrelation and heteroskedasticity. The probability values confirmed this above the 5% significance level in both models. As a result, the null hypothesis of autocorrelation and heteroskedasticity was rejected against the alternative hypothesis.

5. Conclusion and Recommendations

The study’s primary goal was to investigate the response of petrol prices to variations in domestic and international components. Monthly time series data from 2002M1 to 2021M12 was analysed using econometric modelling, including the structural Vector autoregression—the first point of analysis involved examining the variables for stationarity utilizing the ADF unit root test. The basic petrol price, average crude oil price, petrol pump price, transport costs, and wholesale and retail margins were stationary after first differencing. In contrast, the exchange rate, on the contrary, was found to be stationary at level. Fuel taxes were neither stationary at level nor first difference but somewhat after second differencing. Following this, the structural VAR technique was carried out to estimate the response of petrol prices to changes in their components. The structural impulse response function indicated that basic petrol prices respond positively to shocks and shocks in brent crude oil prices, and this response was found to be substantial in size.

In contrast, basic petrol prices respond negatively to shocks in exchange rates, albeit the response is small in size. The variance decomposition revealed that variations in basic petrol prices are primarily explained by their shocks in the short run and by shocks in brent crude oil prices in the long run. Domestically, petrol pump prices respond positively to shocks in basic petrol prices, inland transport costs, and wholesale and retail profit margins. On the contrary, the response of petrol pump prices was found to be hostile towards shocks in the road accident fund levy and muted towards shocks in fuel taxes. Given the rise in crude oil prices, the government can consider reviewing the current fuel structure and suspending several fuel levies indefinitely to provide much-needed financial relief to households and businesses.

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Bagaimana Harga Bensin Menanggapi Variasi Minyak Mentah dan Nilai Tukar? Bukti dari Afrika Selatan

Abstrak
Studi ini menyelidiki respon harga bensin terhadap variasi komponen domestik dan internasional. Data deret waktu bulanan dari 2002M1 hingga 2021M12 dianalisis menggunakan pemodelan ekonometrik, termasuk autoregresi Vektor struktural. Fungsi respons impuls struktural menunjukkan bahwa harga dasar bensin merespons guncangan dan guncangan harga minyak mentah brent secara positif, dan respons ini ternyata berukuran besar. Sebaliknya, harga dasar bensin merespons guncangan nilai tukar secara negatif, meskipun responsnya kecil. Dekomposisi varian mengungkapkan bahwa variasi harga bensin dasar terutama dijelaskan oleh guncangannya dalam jangka pendek dan oleh guncangan harga minyak mentah brent dalam jangka panjang. Di dalam negeri, harga pompa bensin merespons secara positif guncangan harga dasar bensin, biaya transportasi darat, dan marjin laba grosir dan eceran. Sebaliknya, respon harga SPBU ternyata tidak bersahabat terhadap guncangan pada pungutan dana kecelakaan lalu lintas dan diredam terhadap guncangan pada pajak bahan bakar. Mengingat kenaikan harga minyak mentah, pemerintah dapat mempertimbangkan untuk meninjau kembali struktur bahan bakar saat ini dan menangguhkan beberapa pungutan bahan bakar tanpa batas waktu untuk memberikan bantuan keuangan yang sangat dibutuhkan oleh rumah tangga dan bisnis.

Kata kunci: harga bahan bakar, nilai tukar, minyak mentah, Afrika Selatan
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