The Impact of Rising Fuel Prices on Wages in South Africa: Analysis using the Impulse-Response Function

by

Temitope L.A. Leshoro[*] and Glenda Maluleke[†]

Corresponding author:
Temitope L.A. Leshoro
University of South Africa (UNISA)
Department of Economics
P.O. Box 392
Pretoria 0003
South Africa
Tel: (+27) 12 433 4625
Email**:** lesholat@unisa.ac.za
leshade38@gmail.com

[*] Temitope L.A. Leshoro is an Associate Professor in the Department of Economics, University of South Africa (Unisa); lesholat@unisa.ac.za

[†] Glenda Maluleke is a Lecturer in the Department of Economics, University of South Africa (Unisa); malulg@unisa.ac.za

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Abstract

In this study the impulse-response function of the VAR was used to examine the direct effect of fuel prices on inflation rate and wages and the domestic prices pass-through from fuel prices to wages in South Africa. Quarterly data from 2001Q1 to 2018Q2 was utilized. The empirical results suggested that inflation and wages responded positively to the shock in the fuel price. Furthermore, the results indicated that while wages reacted to an increase in inflation, they responded more directly to changes in fuel prices. This indicates that although wages increased because of a shock in the inflation rate, depicting the pass-through from the fuel price, the fuel price had a more significant and direct impact on wages. The conclusion drawn was that the pass-through effect was not as strong and did not contribute as much as the direct effect from the fuel price. Therefore, the indirect shock of fuel prices, via inflation, does not so much cause an increase in wages as its direct shock.

Keywords: fuel prices, impulse-response function, inflation rate, South Africa, wages

JEL classification: E3, E31

1 Introduction

South Africa, like other developing economies, has not being spared the effects of international oil price shocks. There has been considerable debate and studies on the exchange rate pass-through of the oil price in South Africa, whereby the exchange rate responds to oil price shocks and the inflation rate, in turn, responds to changes in the exchange rate. However, the magnitude of the effect of the oil price shock depends on the degree of dependence of the importing country (Nkomo, 2006). Crude oil is one of the largest commodity imports by South Africa, making up approximately 11 percent of its total imports (South African Market Insights, 2018b). This shows that South Africa is highly dependent on crude oil, having imported over eight billion kilograms of crude oil, to the value of over R54 billion, in the first five months of 2018 alone (South African Market Insights, 2018b).

The aim of this paper is thus to investigate the direct effect of fuel prices on the inflation rate and wages in South Africa, on one hand, and the domestic price pass-through from fuel prices to wages (indirect effect) on the other. South Africa imports the majority of its crude oil from three countries, namely Saudi Arabia, Nigeria and Angola, making up about 84 percent of its total crude oil imports, where different countries charge different amounts. Figure 1 shows the ten largest countries from where South Africa imported crude oil, from January 2010 to June 2017.

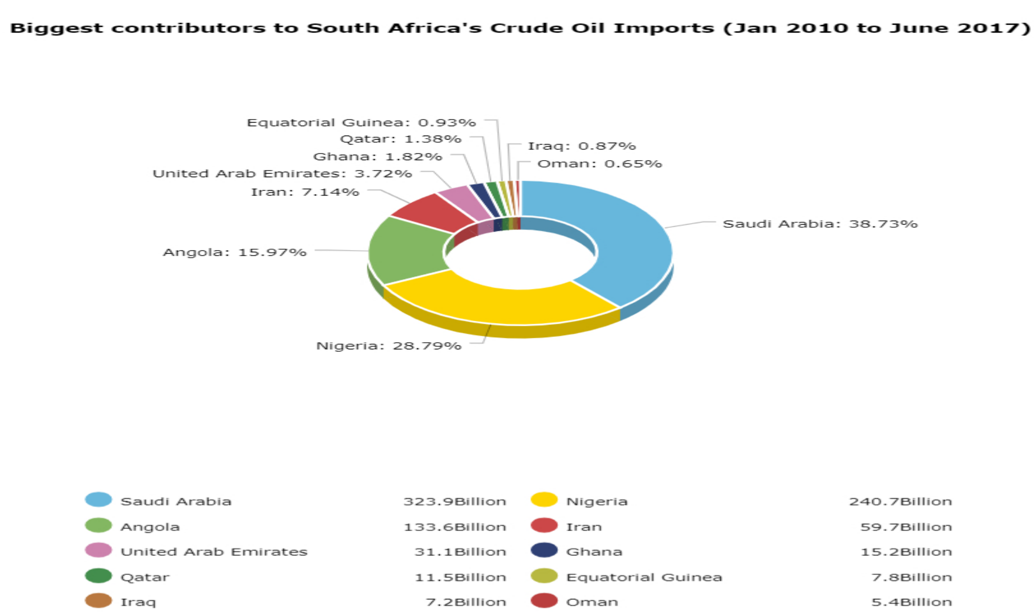

Figure 1: Contributors to South Africa's crude oil imports

Source: South African Market Insights (2018b)

The average increase in the first five months of 2018 compared to the first five months of 2017 was 11.3 percent. The fuel (pump) prices, which are calculated on the basis of the exchange rate, world crude oil prices, costs of shipping, taxes and fuel levies, have been increasing over the years. In South Africa, the fuel levies are in form of two main indirect taxes, namely the general fuel levy and the road accident fund (RAF) levy. These two levies constitute about 35 percent of the petrol price per litre. The petrol price is reviewed and adjusted every month based on the rand/US$ exchange rate and international petrol prices.

According to Automobile Association (2018), the fuel price comprises the following four main components: the general fuel levy, which is the tax charged on every litre of petrol sold; the money collected from the RAF levy is a portion of every litre of petrol sold, and is used to compensate the victims of road accidents. The other two components are the basic fuel price (BFP), which comprises shipping costs, insurance, storage and the costs to harbour facilities when off-loading petroleum products into storage (wharfage), and lastly other costs which include transport costs, customs and excise duties, retail margins paid to fuel station owners and secondary storage costs. The price of a litre of petrol can either increase or decrease, depending on whether any of these elements increases or decreases. According to South African Market Insights (2018a), 50 percent of the petrol price comprises taxes, levies, transport costs and the profit margins of wholesalers and retailers.

Therefore, as international oil prices increase, the resultant rippling effect on the South African economy is vast, given the additional components responsible for the increase in the domestic price. The increased general fuel and RAF levies in April 2019 and additional tax (carbon tax) on the fuel price could see further increases in inflation and thus wage rates. Given that international oil prices are driven by demand and supply, while fuel prices are calculated on the basis of the exchange rate, among other factors, this study therefore departs from the usual studies that examine the exchange rate pass-through of international oil prices to the inflation rate.

Figure 2 shows the trend in the international oil price and the fuel (pump) price in South Africa. It is clear that they both have the same movement, in the sense that as international oil prices increase (or decrease), so do the fuel prices. Although this shows that either of the two could be used, in this study the fuel price was utilised as it has more bearing on consumers' behaviour and reactions. For instance, consumers react more to the announcement of the increase in fuel (pump) price, compared to when there is an increase in the international oil prices.

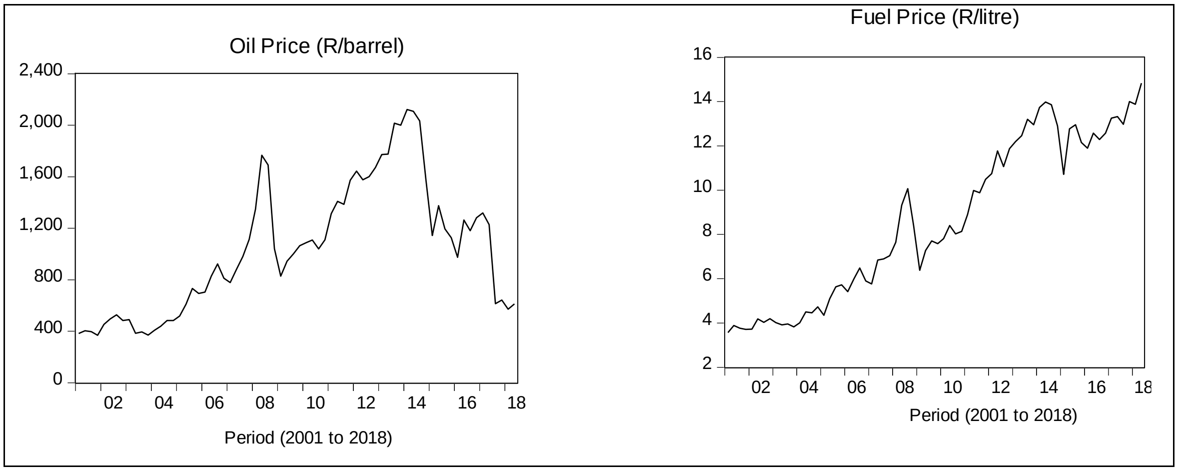

Figure 2: International oil and fuel price trend (2001–2018)
Graph compiled by author
Source: SARB Database (2018) and Department of Energy Database (2018)

Rising fuel prices affect everyone because the price of consumer goods and services purchased also increases, which reflects the underlying increases in production costs as a result of the increased fuel price (StatsSA, 2018). It is therefore important to examine the extent to which the shock in fuel prices affects the economy via the inflation rate and the wage rate. The increase in fuel prices does not only affect the inflation rate, but further filters through to real wages.

The objectives of the study are thus to examine (1) the responsiveness of the inflation rate and wages to an unexpected fuel price shock, and (2) the effect of an unexpected inflation rate shift on domestic wages, using the impulse-response function of the VAR. Although the fuel price in South Africa is linked to the international oil price, while the fuel levies, taxes, etc, do not change significantly in the short run, they do constitute a major portion of the total fuel price. Hence the fuel price is a better reflection of the impact on domestic wages and inflation rates than the international oil price.

2 Literature review

A number of studies have been conducted to investigate the oil price pass-through to inflation in both developed and developing countries. However, no study has observed the fuel price pass-through to real wages in particular. Chen (2009), for instance, investigated the oil price pass-through to inflation of 19 industrialized countries and using a state space approach to estimate time-varying oil price pass-through coefficients. The study found that there was a declining pass-through for almost all of the countries included in the study. According to Chen (2009), the variables that explain the decline in oil pass-through are the appreciation of the domestic currency, a more active monetary policy in response to inflation and a higher degree of trade openness.

Likewise, Álvarez, et al. (2011) assessed the impact of oil price changes on consumer price inflation of the Spanish and Euro area using the Dynamic Stochastic General Equilibrium (DSGE) model. The study found that the inflationary effect of oil price changes in both economies was limited, even though crude oil price fluctuations were a major driver of inflation variability. Using the dynamic error correction model (ECM), Abounoori, et al. (2014) investigated the nature and causes of the oil price pass-through to inflation in the short- and long-run in Iran using monthly data from 2003M3 to 2013M3. The study found that the oil price pass-through to inflation in both the short- and long-run was positive.

Furthermore, Sek, et al. (2015) studied the effects of oil price changes in high and low oil dependency country groups using data from 1980 to 2010. The pass-through equation was modelled in an autoregressive distributed lag (ARDL) format and estimated using the pooled mean group method. The results showed a direct effect of oil price change on domestic inflation in the low oil-dependency group, and an indirect effect in the high oil-dependency countries through changes in the exporter's production cost. They further stated that the higher production cost will then pass-through to domestic price levels and indirectly increase domestic inflation.

Long and Liang (2018) utilised both the autoregressive distributed lag (ARDL) and nonlinear and asymmetric autoregressive distributed lag (NARDL) models to investigate the pass-through effects of the crude oil price on China's producer prices index (PPI) and consumer prices index (CPI). Their results indicated that the impact of global oil price fluctuations on PPI and CPI were asymmetrical in the long-run. The study found that the long-term impacts of the rise in global oil prices on PPI and CPI were greater than the global oil price decline on PPI and CPI.

Živkov et al (2019) investigated the effects of oil price changes on consumer price inflation in eleven Central and Eastern European countries using the wavelet-based Markov switching approach in order to distinguish between the effects at different time horizons. They found that the transmission of oil price changes to inflation was relatively low in these countries because an increase in the oil price of 100% was followed by a rise in inflation of one to six percentage points. Živkov et al. (2019) also found that when oil shocks were transmitted towards inflation, the exchange rate was not a significant factor, except when high depreciation occurred. The countries that were found to have experienced the highest and most consistent pass-through in the study were Slovakia and Bulgaria and this could be due to the fact that these countries have some of the highest oil import/GDP ratios.

However, Peneva and Rudd (2017) assessed how the pass-through of labour costs to price inflation has evolved over time, using a time-varying parameter/stochastic volatility VAR framework. Using USA data, they found little evidence that independent movements in labour costs have had a material effect on price inflation in recent years. By identifying the inflation regimes in Canada after 1961, Faroque and Minor (2009) found that both in- and out-of-sample evidence suggested that wage growth exerts an influence on inflation only during a high-inflation regime, but inflation exerts a more systematic and quantitatively stronger influence on wage growth regardless of the prevailing inflation regime. These results did not support the view of cost-push inflation.

Conflitti and Luciani (2017) estimated the oil price pass-through to consumer prices of the USA and the Euro area by first estimating a Dynamic Factor Model on a panel of disaggregated price indicators, and then using VAR techniques to estimate the pass-through. The results showed that the oil price passes through core inflation only via its effect on the whole economy, and although the pass-through is estimated to be small, it is statistically different from zero and long lasting.

Over the years, there have been numerous attempts to investigate the impact of oil price shocks on a number of macroeconomic variables in South Africa. Some of the studies include the work of

Kohler (2006), Nkomo (2006), Hollander et.al (2018) and Tshepo (2015). For instance, Nkomo (2006) examined the crude oil price movements and their impact on the South African economy. The study found that the country has been shielded from much of the negative impacts of crude oil price increases because of the strong exchange rate between the rand and US dollar, but is still highly dependent on and vulnerable to external sources of oil supply and to increases in international oil prices.

Kin and Courage (2014) investigated the impact of oil prices on the nominal exchange rate in South Africa using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) technique and data from 1994 and 2012. The results indicated that oil prices had a significant impact on nominal exchange rates and an increase in oil prices led to a depreciation of the rand exchange rate.

Dadam and Viegi (2015) analysed the effect of the labour market on the conduct of monetary policy in South Africa by observing the effect of wage inflation on inflation expectations. The study used different econometric techniques such as ordinary least squares (OLS), the dynamic stochastic general equilibrium model and line graphs. Many specifications of the new Keynesian wage Phillips curve and the reduced form traditional Phillips curve were estimated. Their results showed a strong correlation between wage inflation and the inflation expectations of the trade unions. The study thus showed that regulating inflation expectations can control changes in wages.

By contrast, Sibanda et al (2015) examined the impact of the oil price and exchange rate on inflation expectations rather than on the inflation rate. Their study also did not consider the effect of the oil price change on wage rates. They used monthly time-series data spanning 2002M7 to 2013M3, and the vector autoregressive model. Their findings indicated that both oil prices and exchange rates had strong and significantly positive impacts on inflation expectations. Their study further examined the effect of inflation expectations on inflation rates and found a significant one.

More recently, using the vector auto regression and the vector error correction mechanism methods, Sedick (2016) found that the movement in Brent oil prices had a relatively insignificant impact on the movement of the South African rand on a monthly basis. Nzimande and Msomi

(2016) examined the relationship between oil prices and economic activity in South Africa using the asymmetric cointegration approach and data from 1966 to 2014. The results of the study supported the findings of other studies which reported that economic activity responds asymmetrically to oil price shocks, such that an increase in energy prices does not affect economic activity, whereas a decrease in oil prices stimulates economic activity.

Furthermore, Chisadza et al (2016) investigated the impact of the oil supply and demand shocks on the South African economy using a sign restriction-based structural Vector Autoregressive (VAR) model and quarterly data for the period 1975Q1 to 2011Q2. The results of the study indicated that oil supply shock had a short-lived significant impact only on the inflation rate, while the impact on the other macroeconomic variables was statistically insignificant. Chisadza et al. (2016) further stated that the inflation rate and the real exchange rate reacted negatively to an oil-specific demand shock, while output was positively related to unanticipated changes in oil price due to speculations.

Lastly, using the auto regressive distributed lag (ARDL) method of co-integration, Rangasamy (2017) analysed the impact of petrol price movements on inflation outcomes in South Africa after the mid-1970s. The results indicated that petrol prices had a direct impact on the prices of other (non-petrol) commodities in the economy and that increases in the petrol price had a significant bearing on inflation outcomes in South Africa.

The studies reviewed show the impact of oil price shock on inflation via the exchange rate in different countries, using various methodologies. Most of the studies centred around the oil price pass-through to inflation and did not observe the oil price nor fuel price pass-through to wages. Given the above empirical reviews, and according to our knowledge, no study has examined the effects of the fuel price shock directly on the inflation rate and wage inflation in South Africa using the impulse-response function. This is the major contribution of this study to the analysis of fuel price shock.

3 Methodology

3.1 Data source and model specification

The domestic fuel price (FUEL) is the price per litre at the pumps. This was obtained from the Department of Energy database. The input cost variable, labour cost (WAGES), was measured as the remuneration per worker in the nonagricultural sector, at constant prices (2010 = 100). This was obtained from the South African Reserve Bank (SARB) quarterly bulletin via the Econostat database. The consumer price index, measure of inflation rate (INFL) variable was obtained from the International Monetary Fund (IMF/IFS) database. Quarterly data spanning over the period 2001Q1 to 2018Q2 was adopted. These periods covered the post-1970s oil crisis, 1990s and mainly the 2000s oil price shock. The oil price shock of 1990, referred to as “mini oil-shock”, which was the result of increased oil prices and lasted for nine months was excluded from the data. However, the oil crisis in the 2000s witnessed different surges of price shock. The choice of variables was guided by the objectives of the study and their effects on the South African economy.

The model to be estimated is as follows:

$$\overline{W_t} = \alpha_0 + a(L)FUEL_t + b(L)WAGES_t + c(L)INFL_t + \varepsilon_t \qquad \ldots\{1\}$$

where $\overline{W_t}$ is the vector of dependent variables, L is the lag operator and ε_t is the vector of error terms. All the variables are as defined above.

Given South Africa’s dependence on imported crude oil, it is thus exposed to increases in imported inflation as well as possible increases in input cost (real wages in this case). The recent increases in the international oil prices tend to affect domestic prices as a result of an increase in the cost of production and transport costs of the importing country. While fuel price (FUEL) has a direct impact on inflation dynamics and real wages, on the one hand, it has an indirect effect on real wages via inflation rate, on the other. It is therefore necessary to investigate the effects of the direct fuel price shock on real wages and inflation dynamics in South Africa. In addition, the indirect effect of the fuel price shock is equally important by way of a possible price pass-through to wages. This shows how labour reacts to inflation dynamics resulting from the fuel price shock.

3.2 Estimation techniques

Economic time series are generally nonstationary (Johansen and Juselius, 1990; Hjalmarsson and Osterholm, 2007). Hence, before variables can be subjected to cointegration tests, the order of integration must be established. For this purpose, the study utilises the Augmented Dickey-Fuller (ADF), and the Phillips-Perron (PP) tests. If the variables are integrated of order zero, I(0), then a simple vector autoregressive (VAR) technique is used. However, if they are integrated of different orders, their long-run relationship is observed using the appropriate technique.

The estimation procedure is as follows: following the tests of stationarity, depending on the order of integration, the test for cointegration will be applied. The VAR model will be estimated in its reduced-form, followed by the diagnostic test of stability. Finally, the impulse-response function, which is the crux of the study will thus be carried out. Although the ultimate goal of this study is to observe the effect of the shock in domestic fuel price on wages via inflation rate variables, the analysis was started in a VAR system. VAR is a more appropriate technique because it captures the dynamic nature of multiple time-series and provides reliable policy analysis. By applying a VAR technique, which assumes that all the variables are endogenous, the system of equations is such that each variable is determined by other variables (Sims, 1980) (equation 2).

Hence the multivariate linear simultaneous VAR system for domestic price pass-through can be written as follows:

$$FUEL_t = \alpha_0 + \sum_{i=1}^{n1} \alpha_{1t} FUEL_{t-i} + \sum_{t=1}^{n2} \alpha_{2t} WAGES_{t-i} + \sum_{i=1}^{n3} \alpha_{3t} INFL_{t-i} + \mu_t$$

$$INFL_t = \alpha_0 + \sum_{i=1}^{n1} \alpha_{1t} FUEL_{t-i} + \sum_{t=1}^{n2} \alpha_{2t} WAGES_{t-i} + \sum_{i=1}^{n3} \alpha_{3t} INFL_{t-i} + \mu_t$$

$$WAGES_t = \alpha_0 + \sum_{i=1}^{n1} \alpha_{1t} FUEL_{t-i} + \sum_{t=1}^{n2} \alpha_{2t} WAGES_{t-i} + \sum_{i=1}^{n3} \alpha_{3t} INFL_{t-i} + \mu_t \quad \ldots\{2\}$$

Each of the variables in the VAR system is endogenous, except for the constant term.

The lag length at which the VAR will be estimated was first determined, using the Akaike information criterion (AIC), and the stability test will be performed on the estimated VAR. The stability of the VAR roots is the main diagnostic test that has to be passed before continuing the estimation in order to produce reliable, stable and valid results. If the VAR is not stable, results such as the impulse-response and the variance decomposition will be invalid.

The impulse-response function (IRF) and the variance decomposition (VD) within the VAR system use the innovation accounting technique to analyse the dynamic relationship among variables. The IRF gives the interaction and the response between variables, while the VD provides the contribution of each variable to the shock in other variables (Morales, 2003). Thus, this study observes the innovation in the selected macroeconomic variables given a negative shock in the domestic fuel price. The IRF traces the effect of one standard deviation negative shock in the fuel price on both the current and future values of inflation rate and via the inflation rate to wages (equation 2) in the system. The IRF observed how a given variable responds over a specified period of time (the time path), resulting from a one-unit negative shock in the fuel price variable.

The importance of an IRF technique is its applicability to policy analysis because it assists policy makers to observe how macroeconomic variables respond to shocks in a given variable, as well as the duration of the effects of the shocks before they die out (if at all). Consequently, the results obtained from these methods should assist policy makers to observe the variables that are mostly affected as a result of a shock in the domestic fuel price in South Africa (IRF) and the variables that contribute more to the decomposition of the fuel price (VD).

This study uses the generalized impulses decomposition method and Monte Carlo response standard errors of the IRF. Monte Carlo response standard errors decrease the variability in the mean estimate. The generalized impulses decomposition method was chosen because, unlike the Cholesky decomposition method of IRF, whose responses change drastically as the ordering of the variables changes, the generalized impulses decomposition method constructs an orthogonal set of innovations that does not depend on the ordering of the VAR.

4 Results

The simple correlation matrix shows the relationship between each of the variables, fuel price, inflation rate and labour cost. There is a positive but statistically insignificant correlation between the fuel price and inflation rate. The low positive correlation of about 13 percent indicates that the fuel price and inflation rate are positively related, as expected. However, labour cost shows a positive and highly statistically significant correlation with the fuel price. The high positive correlation shows that fuel price and labour cost have a correlation of 95 percent, which supports the *a priori* expectation of a positive relationship. Furthermore, the inflation rate and labour cost have a negative correlation of 1 percent. Table 1 presents the correlation results.

Table 1: Correlation matrix: South Africa, 1990–2018

	FUEL	**INFL**	**WAGES**
FUEL	1		
INFL	0.126	1	
WAGES	0.952***	-0.010	1

Author's analysis
***1%, **5%, *10%

Since all the variables are stationary after the first difference, the study proceeded with the cointegration test. The stationarity test results are presented in Table 2.

Table 2: Stationarity test results

Variables	**LEVELS**		**FIRST DIFFERENCE**		**Conclusion**
	ADF	**PP**	**ADF**	**PP**	
FUEL	-0.486	0.030	-7.865***	-9.695***	I(1)
INFL	-2.948**	-2.873*	-7.451***	-4.366***	I(1)
WAGES	-1.138	-1.138	-10.236***	-10.625***	I(1)

Author's analysis
Critical values: [1% -3.537; 5% -2.908; 10% -2.591]; ***1%, **5%, *10%

Since all the variables are I(1), the study went further to test for cointegration among the variables, using Johansen cointegration technique. However, before testing for cointegration, the study estimated the VAR at the lag length of 2, chosen by Akaike information criterion. The VAR stability test was performed and the VAR roots were found to lie inside the unit circle, which confirms that that VAR is stable (table A1, Appendix A). Johansen test for cointegration found that there is no cointegration among the variables at the chosen lag of 2 (table A2, Appendix A).

The study then observed the effect of the one standard deviation shock in the fuel price on the selected macroeconomic variables, and in order to observe the price pass-through, the one standard deviation shock in inflation rate on the wage rate was examined, using the impulse-response function method. Figure 3 presents the impulse-response results.

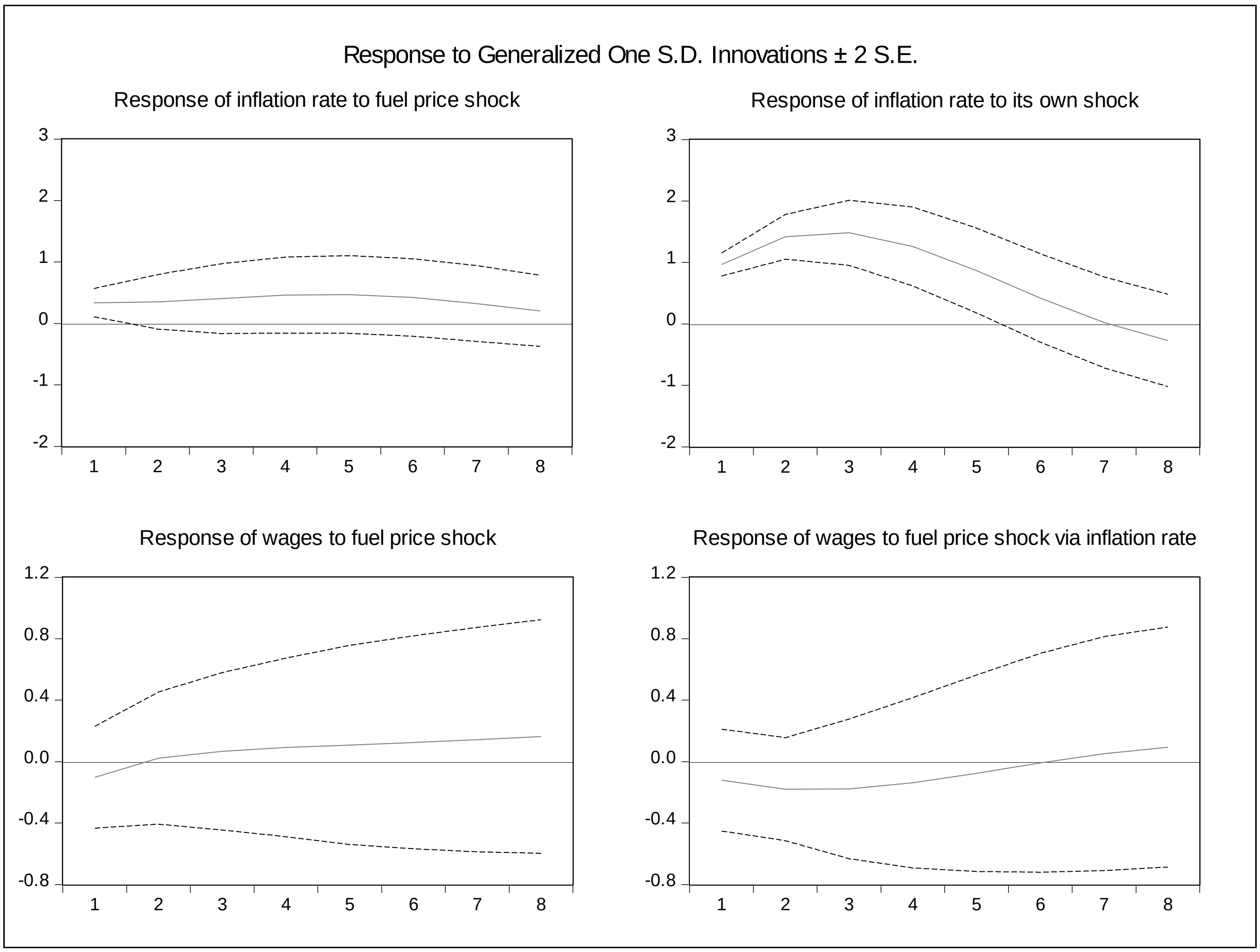

Figure 3: Price pass-through of fuel prices over a two-year period

The results show how each of the variables responded to the shock in another variable over a period of eight quarters (2 years). The Monte Carlo response standard errors show the plus/minus two standard error bands around the impulse response. Although the variables responded as expected, the importance of the impulse-response function goes beyond variables merely meeting expectations, it is also to trace out the duration of a one standard deviation shock in the fuel prices on inflation rate and its pass-through to wages. Given a standard deviation shock in the fuel price, the results show that the inflation rate initially increased after the second quarter up to the fifth quarter before it started to decline.

Generally, in the first year of the shock in the fuel price, that is, in the first four quarters, the inflation rate responded by increasing gradually, and started to decline steadily in the second year (from the sixth to the eight quarter) and settled at a point lower than it was at the onset of the shock. However, there is generally a positive relationship between the inflation rate and fuel price, during the two-year period under investigation. Meanwhile, the wages increased steadily in response to a shock in fuel price, from the first to the eighth quarter. Although the relationship between wages and fuel price started out as negative, it largely depicted a positive relationship during the entire two years.

The price pass-through of the fuel price to wages shows a somewhat interesting picture. While wages responded immediately to a direct shock in fuel prices, it responded more quickly to the shock via inflation rate, but the response was slow. Given a shock in inflation rate, wages increased more steadily, although they initially declined from the first to the third quarter, they picked up and continued to increase until the eighth quarter. There was a negative relationship between wages and inflation rate in the first six quarters as a result of fuel price shock. This changed to a positive relationship after the sixth quarter and continued to remain positive.

While the direct response of wages to the shock in fuel price increased over the entire two-year period, the pass-through effect showed an initial decline and only started increasing after the third quarter. Also, wages responded positively to the shock in the fuel price immediately, and continued to be positively related throughout the eight quarters. Meanwhile, wages initially responded negatively to the shock in the inflation rate before indicating a positive relationship after a year.

This confirms the earlier statement that the fuel price has a greater bearing on the behaviour and reaction of consumers, because they react more to the announcement of the increase in fuel (pump) price. As soon as an increase in the fuel price is announced, consumers expect inflation to increase and they demand higher wages.

The variance decomposition of wages shows the variables that explain its decomposition. The variance decomposition results are presented in Table 3.

Table 3: Two-year (8 quarters) contributions of fuel price and inflation rate to the innovations in wages

Variance decomposition of WAGES				
Period	**S.E.**	**FUEL**	**INFL**	**WAGES**
1	0.965488	0.000000	0.819129	99.18087
		(0.00000)	(3.12355)	(3.12355)
2	1.721546	0.678757	1.713449	97.60779
		(1.76671)	(4.03802)	(4.59568)
3	2.277605	1.401763	2.095174	96.50306
		(3.21015)	(5.01188)	(6.12726)
4	2.610894	1.935739	2.082168	95.98209
		(4.78380)	(5.72334)	(7.54808)
5	2.769587	2.257680	1.847413	95.89491
		(6.03251)	(6.21367)	(8.58529)
6	2.829954	2.456634	1.600119	95.94325
		(7.00286)	(6.69166)	(9.41637)
7	2.859396	2.605421	1.453419	95.94116
		(7.77159)	(7.28125)	(10.1874)
8	2.893688	2.752145	1.418425	95.82943
		(8.41673)	(7.95971)	(10.9458)
Cholesky ordering: FUEL INFL WAGES				
Standard errors: Monte Carlo (100 repetitions)				

Author's analysis

While the contribution from the inflation rate showed a clear contribution to the innovations in wages in the first year of the period under consideration, the fuel price made a stronger, significant and considerable contribution during the second year. This shows that although wages increased as a result of a shock in the inflation rate, depicting the pass-through from the fuel price (this was the case in the first four quarters), the fuel price had a more significant and direct effect on wages, starting from the second year. The longer period of the contributions of these variables are shown in the appendix (table A3, Appendix A).

Therefore, the demand for increased wages is a direct result of the increased fuel prices. Consumers respond more quickly to the increased fuel price than they react to the rise in the inflation rate, to demand higher wages. This also confirms the correlation matrix (table 1), where there was more than a 90 percent correlation between the fuel price and wages.

5 Conclusion

The aim of this study was twofold, namely to (1) observe the responsiveness of the inflation rate and wages to the domestic fuel price shock, and (2) investigate the pass-through effect of the fuel price via the inflation rate to domestic wages. This analysis was conducted using quarterly data over the period 2001Q1 to 2018Q2 and adopting the impulse-response function and variance decomposition techniques. The study found that both the inflation rate and wages responded to the shock in the fuel price as anticipated. The study further showed that the higher percentage variance in wages was the result of the direct change in the fuel price, rather than via the inflation rate.

There was a gradual increase in the inflation rate as a result of an unexpected shock in the domestic fuel price, but this increase was short-lived as the inflation rate gradually declined after about the fifth quarter. However, given an unexpected shock in the fuel price, wages responded directly by increasing steadily for more than a year, while its response to the fuel price shock via the inflation rate was an ephemeral increase, starting with a negative relationship up to the sixth quarter before changing to a positive one, while still increasing.

The results also showed that while wages reacted to the increase in the inflation rate, they responded more directly to the changes in fuel prices. This indicates that although wages increased as a result of a shock in the inflation rate, depicting the pass-through from the fuel price, the fuel price had a more significant and direct effect on wages. While this study does not conclude that there was no price pass-through of the fuel price to wages, it emphasizes that the pass-through effect was not as strong and did not contribute as much as the direct effect from the fuel price.

As shown by the previous studies reviewed, no study has examined the effects of the fuel price shock directly on the inflation rate and wage rate in South Africa using the impulse-response function. Also, many studies have considered the exchange rate pass-through or the effects of the oil price on the inflation rate. It is important to understand the effects of the oil price and fuel prices on the macro economy, especially in a country like South Africa, which faces continuous increases in fuel prices. Further research could be conducted, possibly using different techniques or examine the effects of the fuel price shock on households' consumption expenditure.

Appendix A: Tables

Table A1: VAR roots

Roots of characteristic polynomial
Endogenous variables: FUEL INFL WAGES
Exogenous variables: C
Lag specification: 1 2

Root	Modulus
0.990086	0.990086
0.767547 - 0.367551i	0.851013
0.767547 + 0.367551i	0.851013
0.538708	0.538708
-0.219270	0.219270
0.159395	0.159395

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table A2: Johansen cointegration

Sample (adjusted): 2001Q4 2018Q2
Included observations: 67 after adjustments
Trend assumption: Linear deterministic trend
Series: FUEL_PRICE INFL LBR_COST
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.193419	22.41965	29.79707	0.2758
At most 1	0.095706	8.017968	15.49471	0.4635
At most 2	0.018890	1.277732	3.841466	0.2583

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.193419	14.40168	21.13162	0.3330
At most 1	0.095706	6.740236	14.26460	0.5203
At most 2	0.018890	1.277732	3.841466	0.2583

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A3: Eighteen-quarter contributions of the fuel price and inflation rate to the innovations in wages

Variance decomposition of WAGES				
Period	**S.E.**	**FUEL**	**INFL**	**WAGES**
1	0.965488	0.000000	0.819129	99.18087
		(0.00000)	(3.12355)	(3.12355)
2	1.721546	0.678757	1.713449	97.60779
		(1.76671)	(4.03802)	(4.59568)
3	2.277605	1.401763	2.095174	96.50306
		(3.21015)	(5.01188)	(6.12726)
4	2.610894	1.935739	2.082168	95.98209
		(4.78380)	(5.72334)	(7.54808)
5	2.769587	2.257680	1.847413	95.89491
		(6.03251)	(6.21367)	(8.58529)
6	2.829954	2.456634	1.600119	95.94325
		(7.00286)	(6.69166)	(9.41637)
7	2.859396	2.605421	1.453419	95.94116
		(7.77159)	(7.28125)	(10.1874)
8	2.893688	2.752145	1.418425	95.82943
		(8.41673)	(7.95971)	(10.9458)
9	2.936648	2.922549	1.447182	95.63027
		(8.98397)	(8.60183)	(11.6550)
10	2.976943	3.125184	1.484033	95.39078
		(9.50103)	(9.10753)	(12.2774)
11	3.005004	3.355280	1.495221	95.14950
		(9.98202)	(9.44932)	(12.8050)
12	3.019614	3.599261	1.473238	94.92750
		(10.4302)	(9.65142)	(13.2499)
13	3.025642	3.840153	1.426746	94.73310
		(10.8406)	(9.75244)	(13.6273)
14	3.028897	4.062711	1.368515	94.56877
		(11.2066)	(9.78470)	(13.9475)
15	3.032655	4.256815	1.308269	94.43492
		(11.5265)	(9.77242)	(14.2178)
16	3.037230	4.418518	1.251170	94.33031
		(11.8038)	(9.73686)	(14.4470)
17	3.041467	4.549148	1.199329	94.25152
		(12.0446)	(9.69876)	(14.6471)
18	3.044373	4.653439	1.153601	94.19296
		(12.2545)	(9.67631)	(14.8310)
Cholesky ordering: FUEL INFL WAGES				
Standard errors: Monte Carlo (100 repetitions)				

Author’s analysis

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