

Does the source of oil price shocks matter for South African stock returns? A structural VAR approach*

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Abstract

In this paper, we investigate the dynamic relationship between different oil price shocks and the South African stock market using a sign restriction structural vector autoregression (VAR) approach for the period 1973:01 to 2011:07. The results show that for an oil-importing country like South Africa, stock returns only increase with oil prices when global economic activity improves. In response to oil supply shocks and speculative demand shocks, stock returns and the real price of oil move in opposite directions. The analysis of the variance decomposition shows that the oil supply shock contributes more to the variability in real stock prices. The main conclusion is that different oil price shocks affect stock returns differently and policy makers and investors should always consider the source of the shock before implementing policy and making investment decisions.

JEL classifications: C32, C58, G1, Q43

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1. Introduction

As an oil-importing emerging economy, South Africa is exposed to developments in the global market for crude oil. The recent increases in the global oil price affected the South African economy through a number of channels including the transfer of wealth to oil-exporting countries, increased costs of domestic production, inflationary pressures and financial markets – through volatility in the equity market. An extensive macroeconomic literature suggests a strong negative link between oil prices and real variables, especially for oil-importing countries (see e.g. Hamilton, 1983; Hamilton 2003; Hooker, 1996; Eltony and Al-Awadi, 2001 and Keane and Prasad, 1996, amongst others). Hamilton (1983) points out that 10 of the 11 postwar economic downturns have been immediately preceded by a significant rise in oil prices. The literature on the impact of oil prices on macroeconomic activity has been widening in recent years, with the focus shifting to variables such as inflation, interest rates, labour markets, exchange rates and stock prices. Chisadza *et al.* (2013) assesses the impact of different shocks that influence the global oil market on the South African economy. They focus on the exchange rate, output, inflation and interest rates channels. In this paper, we focus on the relationship between the global oil market shocks and the South African stock returns. It is crucial to investigate the determinants of stock price behavior not only because stock prices act as leading indicators for domestic economic activity (Gupta and Hartely, Forthcoming, Stock and Watson, 2003 and Forni *et al.*, 2003) but also because they reflect the expected earnings of companies. For South Africa, Aye *et al.* (2012) investigate the existence of spillovers from stock prices onto consumption and the interest rate. Their findings suggests that there are important spillover effects emanating from stock returns to the real economy, emphasizing the importance of financial markets.

The existing literature has so far mainly concentrated on assessing the impact of global oil market shocks on the stock returns of developed economies (see Aktham, 2004; Ono, 2011; Kilian and Park, 2009; Park and Ratti, 2007; Guntner, 2011; Apergis and Miller, 2008; Al-Fayoumi, 2009). In general, there has been no consensus about the relationship between oil price shocks and stock returns. Chen *et al.* (1986) and Jones and Kaul (1996) conclude that oil price changes have no effect on asset prices. On the other hand, Kaul and Seyhun (1990), Sadorsky (1999), Papapetrou (2001), Hong *et al.* (2002), O’Neil *et al.* (2008) and Park and Ratti (2008) generally found a negative relationship between oil price shocks and stock returns for advanced economies. In contrast, Gogineni (2007) and Yurtsever and Zahor (2007) showed that oil prices are positively associated with stock prices if oil prices reflect changes in aggregate demand. There have been some studies that focused on this relationship for emerging markets, and in these studies, there has also been no consensus on the impact of oil price shocks on stock returns of these economies. Ono (2011) assessed the impact of the oil price shock on the BRIC¹ economies, and found that this shock has a positive impact on the Indian and Russian real stock returns, while no impact was observed for the

¹ Brazil, Russia, India and China.

Brazilian and Chinese stock returns. Cong *et al.* (2008) concluded that the supply shock has no impact on stock markets for India, Russia and China; and Fang (2010) found that such an impact exists for these countries.

Kilian (2009) has criticized most of the earlier conventional studies because the research tends to treat all oil price shock as exogenous. There have been studies arguing that oil prices respond to factors also affecting stock prices and as a result, the aggregate oil price shock should be decomposed (Barsky and Kilian, 2004; Hamilton, 2003; Kilian, 2009). Following Kilian and Park (2009) and Kilian and Murphy (2013), we distinguish between three types of shocks to the global oil market. First, an oil supply shock which reflects an unexpected changes in the physical volume of oil. Second, an aggregate demand shock which corresponds to changes in the demand for industrial commodities that are driven by fluctuations in the global business cycle. Third, a speculative demand shock which captures changes in oil prices driven by speculative motives and forward-looking behavior. Kilian and Park (2009) found that US stock prices react negatively only to oil prices increases driven by speculative demand, while oil production disruptions have no significant impact on the US stock market. Oil price shocks due to an overall improvement in global real economic activity have a persistent positive effect on stock prices. Apergis and Miller (2008) concluded that although global stock returns do not respond in a large way to oil market shocks, different oil-market structural shocks play a significant role in explaining the adjustments in stock returns. For emerging markets, Fang (2010) investigates how explicit structural shocks that characterize the endogenous character of oil price changes affect stock returns for Brazil, China, India and Russia. Fang (2010) shows that the different oil shocks have no significant impact on India's stock market, while for Russia, both global and oil-specific demand shocks have significantly positive effects on the stock price.

We assess the impact of different oil price shocks on South African stock returns by using an improved methodology proposed in Kilian and Park (2009). Unlike in previous studies that only look at the demand and supply shocks to the global oil market; we also add oil inventories to our analysis. Following Kilian and Murphy (2013), oil inventories are used as a tool to identify the forward-looking element of the real price of oil. The idea is to separate the speculative component of the real price of oil from the components driven by demand and supply flows and to characterize the relative importance of each type of oil demand and supply shock and for changes in oil inventories. Further, we consider both dynamic and static restrictions. We select our model using short run oil demand elasticity in use. The choice to investigate the South African case is based on the familiarity with the structure of the economy and the considerable lack of such literature.

According to our knowledge, this is the first study to assess the relationship between different global oil market shocks and the South African stock returns using a sign restriction VAR model specification (which combines static and dynamic sign restrictions) that explicitly allows for shocks to the speculative demand for oil and the flow demand and supply shocks. Our results show that

stock returns are positively influenced by developments in the aggregate demand. An unexpected increase in aggregate demand will result in a positive and persistent reaction of stock returns. The flow supply shock and the speculative demand shock affect stock returns negatively. The variance decomposition analysis shows that an oil supply shock tends to drive the behavior of stock returns much more than the other two shocks. The explanation power of different global oil shocks for the stock returns also increases with the horizons.

The paper proceeds as follows. Section 2 deals with the data and the methodological issues. Section 3 presents the empirical results, while the conclusion of the research is provided in Section 4.

2. The VAR model

Following the recent literature (Kilian and Park, 2009; Kilian and Murphy, 2012; Kilian and Murphy, 2013; Baumeister and Peersman, Forthcoming (a,b); amongst others), we base our analysis on a dynamic simultaneous equation model in a form of a structural VAR (including five variables). The model specified in our analysis improves the model presented in Kilian and Park (2009) in that it includes oil inventories used to capture possible shocks to expectations in the global oil market. Let z_t be a vector of endogenous variables included in the analysis – the percent change in global crude oil production, a measure of global real activity expressed in percent changes, the real price of crude oil, the change in crude oil inventories and per cent changes in real stock prices.

Data description

We estimate a 5 variable structural VAR model using monthly data for the period 1973:01 to 2011:07. For the global oil market variables, we include the price of crude oil based on the US refiners' acquisition cost for imported crude oil obtained from the US Department of Energy starting from 1974:01. Following Barsky and Kilian (2002) the data for the price of crude oil has been extrapolated back to 1973:01 and was deflated using the US consumer price index (CPI) inflation. We also obtained the data for the global oil production measured in millions of barrels of oil – expressed in per cent changes. As described in Kilian and Murphy (2013), we use the data for US crude oil inventories provided by the Energy Information Administration (EIA). These data are scaled by the ratio of Organisation for Economic Co-operation and Development (OECD) petroleum stocks over US petroleum stocks for each time period. The data provided by the EIA includes crude oil (including strategic reserves) as well as unfinished oils, natural gas plant liquids, and refined products. The data, however, does not provide petroleum inventory data for non-OECD countries. The data for the OECD countries is therefore used as a proxy for global petroleum inventories. Since the EIA data for petroleum stocks is not available prior to 1987:12, the per cent change in the OECD inventories is extrapolated backwards at the growth rate of U.S. petroleum inventories. We define the resulting proxy for global crude oil inventories in changes rather than percent changes. Expressing oil inventories as changes is required to compute the

correct oil demand elasticity as this computation is not feasible when using percentage changes. To measure global real economic activity we rely on an index constructed by Kilian (2009). The global activity index is constructed by cumulating average rates of increase in dry cargo ocean shipping freight rates. The series is deflated using the US CPI inflation². The index is stationary by construction – since the fluctuations in real activity are measured in per cent deviation from the trend. Finally, we measure the variable of interest as the Johannesburg Securities Exchange Allshare Index – which is the main index of the South African share market. The index is made out of the top 40 shares by market capitalization and another 22 shares across all industries and sectors. The variable of interest is deflated using South African CPI inflation. The first difference of the natural logarithm is obtained to allow for stationarity in the series.

The structural VAR model

In line with Kilian and Murphy (2013), and Kilian (2009), our reduced-form structural VAR model allows for 24 months lags to adequately capture the transmission of oil price shocks. The structural VAR model is specified as:

$$A_0 z_t = \alpha + \sum_{i=1}^{24} A_i z_{t-i} + \varepsilon_t \quad (1)$$

where ε_t denotes the vector of serially and mutually uncorrelated structural innovations, α denotes a constant and $A_i, i = 0, \dots, 24$, denotes the coefficient matrices. The ε_t are grouped into two blocks where the first block consist of a global crude oil market model, while the second block comprises of the variable of interest – South African stock returns. Following the intuition in Kilian and Murphy (2012), ε_t in the first block consists of a shock to the flow of the production of oil (flow supply shock). A shock to the flow demand for oil and other industrial commodities (flow demand shock) captures unexpected movements in the global business cycle. A shock to the demand for oil inventories arising from forward-looking behavior (speculative demand shock) is designed to capture innovations to the oil demand, reflecting revisions to expectations about future demand and supply rather than current demand and/or supply flows. We also include a residual shock in the first block that captures all structural shocks not otherwise accounted for and has no direct economic interpretation. The second block contains only one structural innovation - an innovation to real stock returns not necessary driven by shocks in the first block.

Restrictions imposed on the VAR model

Following Baumeister and Peersman (Forthcoming, a) and Kilian and Murphy (2013) we identify our model by imposing a combination of static and dynamic sign restrictions, contemporaneous

² For a detailed discussion of the data sources and construction of the variables refers to Kilian (2009).

zero restrictions and boundary restrictions on the impact price elasticities of oil supply and oil demand. Each set of restrictions is discussed below.

Impact sign restrictions

The first sets of restrictions that we impose are the static sign restrictions which are derived from simple theoretical supply-demand model of the global oil market. The identification that we use combines sign restrictions in the oil market block with contemporaneous zero restrictions on the domestic variable. Using both sign restrictions and contemporaneous zero restrictions on selected impact responses allows us to improve identification of the structural shocks and thus to enhance the interpretation of the respective impulse response functions by exploiting additional information (Kilian and Murphy, 2012). The impact sign restrictions on the responses of the five endogenous variables are reported in Table 1 below.

Table 1: Sign restrictions on impact responses in the VAR model

	Oil supply shock	Aggregate demand shock	Speculative demand shock
Oil price	-	+	+
World oil production	+	+	+
World activity	+	+	-
Inventories	?	?	+
Stock returns	?	?	?

Our model assumes that the real price of oil is determined by the current demand and supply flows for oil as well as expectations about future demand and supply conditions. Global oil production measures the flow supply of oil such that an unexpected disruption in oil production will increase the real price of oil. This will in turn cause global real activity to weaken. For inventories we do not restrict the impact effect of an oil supply shock a priori because the response can go either way. Unexpected fluctuations in global real activity (flow demand) lead to shifts in the demand for oil associated with the global business cycle. This means that an unanticipated improvement in the global real activity will result in higher oil prices, stimulating global production. As in the case of the oil supply shock, the impact on inventories is left unrestricted.

Since oil is storable, the real price may also be determined by demand for inventories. Any information regarding future oil supply or oil demand will influence the current quantity of inventories and as a result, affect the current price of oil. This means that an upward revision to expected future demand for oil will increase the demand for oil inventories in the current period, resulting in an increase in the real price of oil. This shock is expected to negatively affect global real

activity and increase global oil production – these effects are indirect and most likely to be small in nature. Given that the effect of the different types of oil price shocks on real stock returns is the key object of interest, the response is not constrained.

For the stock price shock, we impose contemporaneous zero restrictions and assume that domestic stock price changes do not immediately affect variables in the first block. These zero restrictions are imposed on impact only. The results for this shock are not reported in this study because the focus is on the oil price impact on domestic stock returns rather than how the global market change given fluctuations in the domestic stock market.

Dynamic sign restrictions

In line with Kilian and Murphy (2013) we impose dynamic sign restrictions after an oil supply shock. We assume that the response of the real price of oil to a negative oil supply shock must be positive for at least twelve months after the impact period. As shown in the literature, a positive response of the real price of oil tends to be accompanied by a persistently negative response of oil production. This means that after we impose the first dynamic restrictions, we must also ensure that global real activity responds negatively to oil supply shocks. Basically, the set of dynamic restrictions are such that the responses of oil production and global real activity to an unanticipated oil supply disruption are negative for the first twelve months, while the response of the real price of oil is positive during the same period.

Bounds on the impact price elasticity of oil supply and the short run oil demand elasticity in use

Following Kilian and Murphy (2012, 2013), we impose an upper bound on the impact oil supply elasticity. There is a consensus in the literature that this short-run price elasticity of oil supply is close to zero (Hamiltom, 2009; Kilian, 2009) and ignoring this restriction will imply an impact oil supply elasticity that is far too large to be economically plausible. Using historical episodes of well-defined and exogenous oil price shocks, Kilian and Murphy (2013) show that this elasticity is around 0.025. We impose this upper bound on impact price elasticity of oil supply in selecting a set of admissible models in our analysis.

Given that the impact elasticity of oil supply is based on a shift of the oil demand curve along the supply curve, we can compute the oil supply elasticity after a speculative demand shock and after a flow demand shock.

Following Kilian and Murphy (2013) we select our surviving model using the short-run oil demand elasticity in use. This elasticity is based on the change in the quantity of production and the depletion of oil inventories. The model is specified as:

$$U_t = Q_t - \Delta S_t$$

where U_t represents the amount of oil used in period t , Q is the quantity of oil produced in the same period and ΔS_t is the oil that is added to the stock of inventories. This means that the change in oil used over time equals the change in oil production minus the change in the addition to inventories stocks:

$$\Delta U_t = \Delta Q_t - \Delta^2 S_t$$

The price elasticity of demand in use is therefore given by:

$$\eta_t^{use} = \frac{\% \Delta U_t}{\% \Delta P_t} = \frac{\frac{\Delta Q_t - \Delta^2 S_t}{Q_{t-1} - \Delta S_{t-1}}}{\% \Delta P_t}$$

where Δ denotes changes and $\% \Delta$ indicates percentage changes in response to an oil supply shock in period t , while P_t represents the real price of oil. We also define the following terms:

\tilde{B}_{11} = impact response of the per cent change in oil production to an oil supply shock.

$\Delta Q_t = Q_{t-1} \times \tilde{B}_{11}/100 - Q_{t-1} = Q_{t-1} \times \tilde{B}_{11}/100$, the implied change in oil production.

$\Delta^2 S_t = \Delta S_t - \Delta S_{t-1} = \overline{\Delta S} + \tilde{B}_{41} - \overline{\Delta S} = \tilde{B}_{41}$, where the change in oil inventories in response to the oil supply shock equals the impact response \tilde{B}_{41} and before the shock, the change in oil inventories is equal to its mean $\overline{\Delta S}$ and is observable.

\tilde{B}_{31} = impact per cent change in the real price of oil in response to an oil supply shock.

Given the above terms, the demand elasticity in use can be formulated as:

$$\eta_t^{use} = \frac{\frac{(Q_{t-1} \times \tilde{B}_{11}/100) - \tilde{B}_{41}}{Q_{t-1} - \overline{\Delta S}}}{\tilde{B}_{31}/100}$$

Since the elasticity in use is time varying as it depends on Q_{t-1} , we report the average oil demand elasticity in use over the sample period.

Implementation of the identification procedure

Given the set of identifying restrictions and consistent estimates of the reduced-form VAR model, the construction of the set of admissible structural models follows the standard approach on VAR models identified based on sign restrictions. Imposing these restrictions to our VAR model we follow Uhlig (2005). Consider equation (1) as a reduced form:

$$A(L)z_t = e_t \tag{2}$$

Where $A(L)$ is a finite-order autoregressive lag polynomial. The construction of structural response functions require an estimate of the $N \times N$ matrix \tilde{B} in $e_t = \tilde{B}\varepsilon_t$.³ Because in our case we impose zero restrictions on the stock price shock, we only rotate the 4×4 submatrix instead of the entire $N \times N$ matrix. Let $\Sigma_{e_t} = P\Lambda P'$ and $B = P\Lambda^{0.5}$ such that B satisfies $\Sigma_{e_t} = BB'$. This means that $\tilde{B} = BD$ also satisfies $\tilde{B}\tilde{B}' = \Sigma_{e_t}$ for any orthonormal 4×4 submatrix D . We examine a wide range of possibilities for \tilde{B} by repeatedly drawing at random from the set D of orthonormal rotation matrices and discarding candidate solutions for \tilde{B} that do not satisfy a set of priori restrictions on the implied impulse response functions.

The basic idea is to firstly draw a 4×4 submatrix K of $NID(0,1)$ random variables and then derive the QR decomposition of K such that $K = Q \cdot K$ and $QQ' = I_4$. We let $D = Q'$ and compute impulse responses using the orthogonalisation $\tilde{B} = BD$ and only retain D if all the implied impulse response functions satisfy the identifying restrictions, otherwise discard D . We repeat this 1 million times and stored impulse response functions corresponding to each D that satisfied the restrictions. The resulting \tilde{B} comprises the set of admissible structural VAR models. In our analysis, only 25 candidate models satisfy all identifying restrictions. To select one model that yields an impact price elasticity of oil demand in use closest to the posterior median of this elasticity, we rely on a procedure described in Kilian and Murphy (2013)⁴. This can be done without loss of generality since the other admissible models yield virtually similar response estimates.

3. Empirical results

Impulse response functions

The results obtained from using the structural VAR model specified in section 3 are presented in Figure 1. The responses of the real price of crude oil, world oil production, global real economic activity, crude oil inventories and South African stock returns after the three structural shocks are shown in Figure 1 (together with the corresponding pointwise 16 per cent and 84 per cent posterior quantiles). The oil supply shock has been normalized to present a negative shock, whereas the aggregate demand shock and oil-market specific demand shock have been normalized to represent positive shocks such that all three shocks would tend to increase the real price of oil.

Figure 1 shows that one model lies outside the confidence bands (the response of the real priced of oil to an oil supply shock and for only the first four months). This can be explained by the fact that the pointwise 16 per cent and 84 per cent posterior quantiles are constructed slightly different from the final model presented in Figure 1. The first difference is the selection of the models. The

³ For a detailed review of the construction of these structural impulse responses, please refer to Fry and Pagan (2005, 2011).

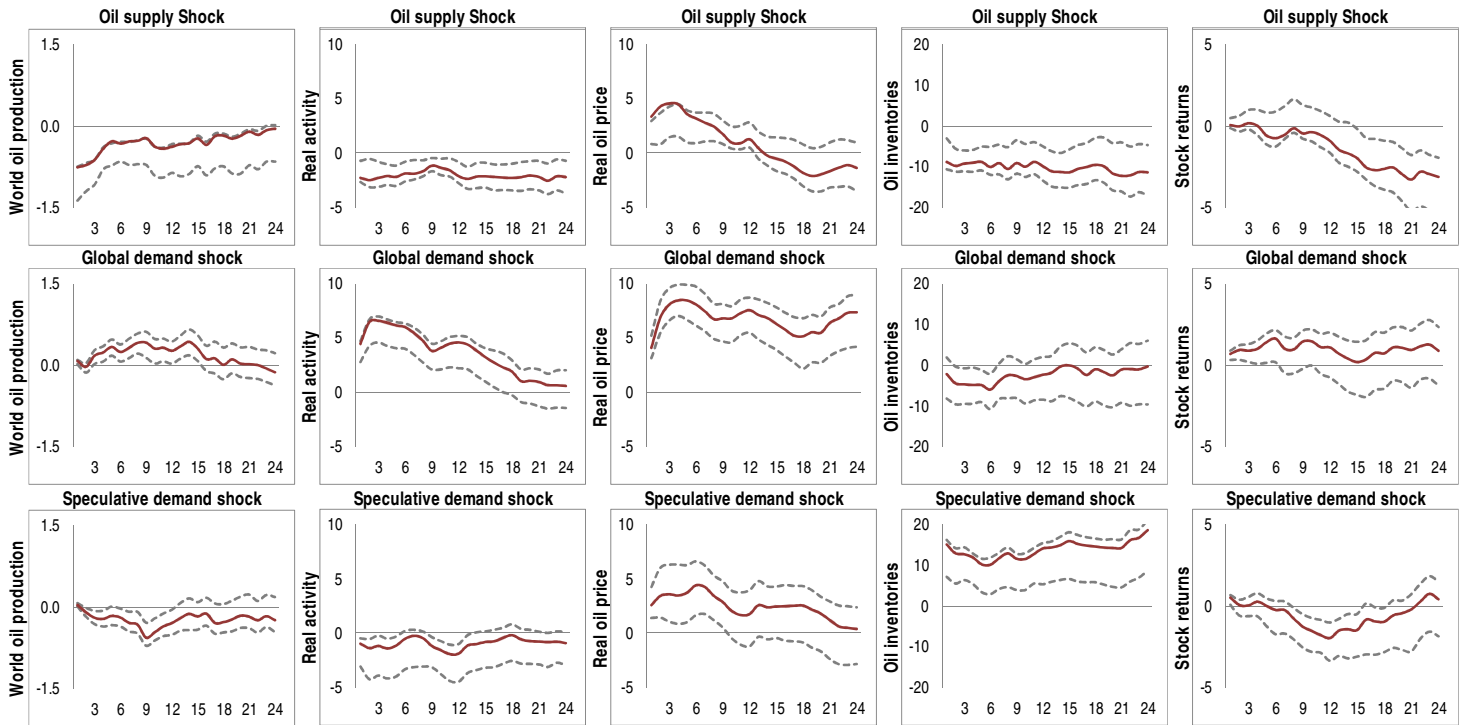
⁴ For a detail description of this procedure, the reader is referred to Kilian and Murphy (2013).

surviving model is selected based on the point estimates of the reduced form VAR model. The one standard deviation error bands are, however, selected by drawing from the posterior. All the models used for both cases satisfy all the restrictions (dynamic and static) that we impose and the boundary restrictions on the impact price elasticities of oil demand and oil supply. As discussed earlier, to select the surviving model, we rely on the procedure proposed Kilian and Murphy (2013) and we use the short-run oil demand elasticity in use, while for the 68 per cent posterior confidence bands, we use pointwise error bands. There has been a number of criticism again using pointwise error bands (see Fry and Pagan, 2011; Inoue and Kilian, 2011). Firstly, pointwise 68 per cent posterior error bands provide little protection against mischaracterising the impulse response dynamics. This is the case in Figure 1 as two models lie outside the constructed confidence bands (although not for the entire horizon). Secondly, pointwise intervals tend to understate the estimation uncertainty compared with credible sets that capture the joint uncertainty over all impulse response functions. Nonetheless, this methodology is still used widely and we also construct our error bands using pointwise error bands.

An oil supply shock

The first row of Figure 1 shows the response to a negative oil supply shock which results in a decline in oil production of 0.8 per cent, decreases global real activity by 2.3 per cent and drives real oil prices higher by 3.4 per cent. Oil inventories decline following the shock which implies that consumers start drawing down oil inventories to make up for the loss in production. An increase in the oil price emanating from an unfavourable oil supply shock results in a general decline in the South African stock returns over the medium- to longer-term horizon. This outcome is in line with findings from a number of studies. Kilian and Park (2009) found a similar reaction for the US stock returns. Ghorbel and Younes (2010) assess the impact of an oil supply shock on 27 countries and find that for some countries the impact is negative, especially for oil importing countries. Park and Ratti (2007) conclude that an unfavourable oil supply shock has a negative impact of stock returns for oil importing countries. An increase in the real price of oil due to oil supply disruptions has a negative effect on consumer income and wealth, resulting in a fall in stock returns. The findings in these studies are in contrast with some of the literature on emerging markets and what we find in the short-run. Aktham (2004) similar to our results in the short term finds that oil shock have no significant impact on stock returns in emerging markets suggesting that stock market returns do not rationally signal shocks in the crude oil market.

Figure 1: Impulse Response Functions



Note: the solid line represents the results of the admissible structural model with an impact price elasticity of oil demand in use closest to the posterior median of that elasticity. The gray lines show pointwise 16 per cent and 84 per cent posterior quantiles based on 204 admissible draws from the posterior. Oil production and oil inventories refer to the cumulative per cent change in oil production and oil inventories.

An aggregate demand shock

The second row of Figure 1 shows that an unexpected increase in demand for crude oil driven by an improved global activity will result in higher oil prices, increased global real activity and rising world oil production. The real oil price increases significantly in response to a global demand shock, especially within the first 5 months of the shock and is relatively persistent over the response horizon— although moderating. As envisaged, an unexpected increase in global demand for all industrial commodities will lead to higher and sustained global real activity. This shock presents a significant improvement in the world economic activity and remains positive for the entire horizon, although gradually approaching zero. The increased demand for commodities, followed by higher oil prices is likely to influence producers to increase their oil production to take advantage of the higher returns emanating from higher oil prices. As presented in Figure 1, an aggregate demand shock will result in an increase in global oil production. The positive impact, however, only lasts for up to 20 months and becomes negative thereafter. The unexpected increase in aggregate demand will result in lower inventories for the first 15 months before gradually recovering. Not surprisingly, oil inventories will be utilized to sustain the rapid demand in the global market, thereafter, inventories buildups will take place. The global demand shock has a positive and lasting effect on stock returns

over the horizon although the impact is only significant in the shorter horizon. The South African stock returns reaction is in line with the results obtained by Kilian and Park (2009) for the US economy. South Africa is a commodity exporting economy and an improvement in global demand means rising exports demand and commodity prices. This will result in higher income into the country – increasing household incomes and company profits – thereby increase the wealth which will translate into higher stock returns. Fang (2010) finds a similar reaction for the Russian stock returns. Although Russia is an oil exporting country, while South Africa exports platinum, gold and other mining products, the general increase in global commodity prices following a positive global demand shock results in the same effects for these two countries.

A speculative demand shock

An unfavourable speculative demand shock will result in a general decline in world oil production, a fall of 0.9 per cent in real global activity and an overall decline in the stock returns although positive for the first five months. Only the price of oil (2.6 per cent) and inventories (15.1 per cent) will increase following such a shock. The rationale for the reaction of these variables to a speculative shock is as follows. If there is a belief that oil prices will change in the future, then the current flow demand and supply will be affected by the speculation. Assuming that investors believe that the demand for oil will increase in period $t + 1$ then the current price of oil will increase, while both the global real activity and the world oil production will decrease. As expected, current oil inventories will increase on speculation about future developments in the market for crude oil. Similar findings are reported in Kilian and Murphy (2013) where they show that inventories react positively to a speculative demand shock and the impact is persistently positive over 15 months. Although the impact is positive for the first five months, the overall impact of a speculative demand shock is negative on stock returns in South Africa. This is because a speculative demand shock will result in higher oil prices, with no increase in the prices of other global commodities. This effect will be inflationary in South Africa, thereby reducing household wealth. Not surprising, the results are in line with recent literature for oil importing countries. Guntner (2011) finds that stock returns of oil importing countries are negatively affected by a speculative demand shock. Kilian and Park (2009) present the same results for the US as a net oil importing economy.

Variance decomposition

Table 2 presents the variance decomposition of real oil prices and the real stock prices due to oil supply shock, aggregate demand shock and speculative demand shock. The figures quantify the importance of the global oil market shocks that we have identified on the real oil price and real stock prices. The data is presented for 1 month, 12 months and 24 months horizons. On impact, 46 per cent of the variability in the real price of oil can be explained by an aggregate demand shock, 31 per cent of the variability is explained by an oil supply shock, while only 18.3 per cent of variability on impact is explained by a speculative demand shock. At the medium horizon (12 months), an

aggregate demand shock explains above 50 per cent of the variability in the real oil price, while the contribution of both the oil supply shock and the speculative demand shock moderates (27.7 per cent and 17.7 per cent, respectively). At a long horizon (24 months) the ratio of contributions remains unchanged, although the percentage contribution of the oil supply shock rises marginally and for the other two shocks, the contributions moderate. These results suggest that, on average, fluctuations in the real oil price mainly reflect developments in the global activity, but there are also elements of production smoothing and speculation. Our results are also in line with findings in Baumeister and Peersman (Forthcoming, a) as well as Kilian (2008 and 2009), showing that demand increases rather than supply reductions drive global oil prices.

Table 2: Percentage contribution of global oil market shocks to the variability of real price of oil and the South African real stock returns

	Horizon		
	1 Month	12 Months	24 Months
	Impact on the real price of oil		
Oil supply shock	31.0	27.7	28.8
Aggregate demand shock	46.0	50.2	48.6
Speculative demand shock	18.3	17.7	17.0
Other shocks ¹	4.7	4.4	5.6
	Impact on the real stock returns		
Oil supply shock	0.0	24.9	36.9
Aggregate demand shock	2.1	17.2	21.9
Speculative demand shock	1.2	12.0	12.0
Other shocks ¹	96.7	45.9	29.2

¹ Shocks that are not captured by global oil market developments

Table 2 also shows that on impact, the effect of the identified global oil market shocks is negligible on South African real stock returns, with only 3.3 per cent of the variability in real stock returns associated with shocks that drive the global oil market. The explanation power increases significantly in the medium horizon (12 months), with global oil market shocks accounting for 54.1 per cent of the variability in the domestic real stock returns – with the oil supply shock exhibiting the largest contribution of close to 25 per cent. For the long horizon, the contribution increases further to 70.8 per cent, with the oil supply shock maintaining the largest contribution. In contrast to the findings in Kilian and Park (2009), the variability in South African real stock returns in the medium to long horizons is driven by oil supply shocks, followed by aggregated demand shocks, while speculation only accounts for 12 per cent.

4. Conclusion

We added to the limited literature that assesses the relationship between stock returns and different oil market shocks by improving on Kilian and Park (2009) methodology of disaggregating the effects of oil market shocks on South African (as an oil-importing emerging economy) stock returns by distinguishing between flow demand, flow supply and speculative demand shocks. For the speculative demand shock, we rely on the help of oil inventories. To do this, we rely on a structural VAR model specification with both static and dynamic sign restrictions using monthly data from 1973:01 to 2011:07. We further construct a variance decomposition to assess the impact of oil shocks on stock returns over time.

The results show that South Africa's stock returns react differently to oil shocks, depending on the underlying causes of the increase in the oil price. An unexpected positive aggregate demand shock has a positive impact on stock returns. This evidence is also presented in the historical decomposition since the relative contribution of the aggregate demand shock seems to be more pronounced than for the other two shocks – suggesting that the aggregate demand shock is more important for understanding changes in South African stock returns. Our results are in line with some of the findings in the literature that suggests a positive relationship between oil price shocks due to aggregate demand and stock returns and a negative relationship for the other shocks. The negative relationship emanated from the fact that South Africa is an oil-importing emerging market. The variance decomposition analysis shows that South African stock returns are mostly driven by an oil supply shock since this shock contributes more than the other shocks to the variability of stock returns. Our results propose that policy makers and investors should consider the source of the oil price shock before implementing policies or make investment decisions. Future research may be aimed at assessing how this relationship has changed over time, using a TVP-VAR model combined with sign restrictions along the lines proposed in Baumeister and Peersman (forthcoming, a,b).

References

- Agusman, A. and Deriantino, E. 2008. Oil Prices and Industry Stock Returns: Evidence from Indonesia. *21st Australian Finance and Banking Conference Paper*, Available at SSRN: <http://ssrn.com/abstract=1253904>.
- Aktham, M. 2004. Oil Price Shocks and Emerging Stock Markets: A Generalized VAR Approach. *International Journal of Applied Econometrics and Quantitative Studies*, 1(2): 2–27.
- Al-Fayoumi, N.A. 2009. Oil Prices and Stock Market Returns in Oil Importing Countries: The Case of Turkey, Tunisia and Jordan. *European Journal of Economics, Finance and Administrative Sciences*, 16: 87–98.
- Anoruo, E. and Mustafa, M. 2007. An Empirical Investigation into the Relation of Oil to Stock Market Prices. *North American Journal of Finance and Banking Research*, 1(1): 22-36.
- Apergis, N. and Miller, S.M. 2004. Consumption Asymmetry and the Stock Market: Further Evidence. *University of Connecticut, Department of Economics, Working Paper No 2004-19*.
- Apergis, N. and Miller, S.M. 2005a. Consumption asymmetry and the stock market: New evidence through a threshold adjustment model. *University of Connecticut, Department of Economics, Working Paper No 2005-08*.
- Apergis, N. and Miller, S.M. 2005b. Resurrecting the Wealth Effect on Consumption: Further Analysis and Extension. *University of Connecticut, Department of Economics, Working Paper No 2005-57*.
- Apergis, N. and Miller, S.M. 2006. Consumption asymmetry and the stock market: Empirical evidence. *Economics Letters*, 93(3): 337-342.
- Apergis, N. and Miller, S.M. 2008. Do Structural Oil-Markets Shocks Affect Stock Prices? *University of Connecticut, Department of Economics, Working Paper No 2008-51*.
- Aye, G.C, Gupta, R. and Modise, M.P. 2012. Do Stock Prices Impact Consumption and Interest Rate in South Africa? Evidence from a Time-Varying Vector Autoregressive Model. *University of Pretoria, Department of Economics, Working Paper No 201224*.
- Barsky, R.B and Kilian, L. 2004. Oil and the Macroeconomy Since the 1970s. *Journal of Economic Perspectives, American Economic Association*, 18(4): 115-134.
- Barsky, R.B. and Kilian, L. 2002. Do We Really Know that Oil Caused the Great Stagflation? A Monetary Alternative. *NBER Macroeconomics Annual 2001*, 137-183.
- Baumeister, C. and Peersman, G. Forthcoming(a). The Role of Time-Varying Price Elasticities in Accounting for Volatility Changes in the Crude Oil Market. Forthcoming in the *Journal of Applied Econometrics*.
- Baumeister, C. and Peersman, G. Forthcoming(b). Time-Varying Effects of Oil Supply Shocks on the US Economy. Forthcoming in the *American Economic Journal: Macroeconomics*.
- Bjørnland, H. 2008. Oil Price Shocks and Stock Market Booms in an Oil Exporting Country. *Norges Bank Working Paper*, No 2008/16.
- Chen, N.F., Roll, R. and Ross, S.A .1986. Economic Forces and the Stock Market. *Journal of Business*, 59(3): 383-403.
- Chisadza, C., Dlamini, J., Gupta, R. and Modise, M.P. 2013. The Impact of Oil Shocks on the South African Economy. Forthcoming in *Energy Sources, Part B: Economics, Planning, and Policy*.

- Cong, R., Wei, Y., Jiao, J. and Fan, Y. 2008. Relationships between oil price shocks and stock market: An empirical analysis from China. *Energy Policy*, 36(9): 3544–3553.
- Eltony, N. and Al-Awadi, W. 2001. Oil price Fluctuations and their Impact on the Macroeconomic Variables of Kuwait: a Case Study Using a VAR Model. *International Journal of Energy Research*, 25(11): 939-959.
- Fang, C. 2010. The impact of oil price shocks on the three BRIC countries' stock prices. *Department of Economics, National Cheng-Chi University, Taiwan*.
- Forni, M., Hallin, M., Lippi, M. and Reichlin, L. 2003. Do Financial Variables Help Forecasting Inflation and Real Activity in the Euro Area? *Journal of Monetary Economics*, 50(6): 1243–1255.
- Fry, R. and Pagan, A. 2005. Some Issues in Using VARs for Macroeconometric Research. *Centre for Applied Macroeconomic Analysis, Australian National University, Working Paper No. 19*
- Fry, R. and Pagan, A. 2011. Sign Restrictions in Structural Vector Autoregressions: A Critical Review. Forthcoming in *Journal of Economic Literature*.
- Ghorbel, A. and Younes, B. 2010. Response of international stock markets to oil price shocks. *Department of economics in university of SFAX-TUNISIA*.
- Gjerde, O. and Sættem, F. 1999. Causal Relations among Stock Returns and Macroeconomic Variables in a Small, Open Economy. *Journal of International financial market, Institutions and Money*, 9(1):61-74.
- Gogineni, S. 2007. The Stock Market Reaction to Oil Price Changes. *Working Paper, University of Oklahoma*.
- Guntner, J.H.F. 2011. How do international stock markets respond to oil demand and supply shocks? *Universitat Magdeburg, Working Paper No 28/2011*.
- Gupta, R. and Hartley, F. Forthcoming. The Role of Asset Prices in Forecasting Inflation and Output in South Africa. *Forthcoming in Journal of Emerging Market Finance*.
- Hamilton, J.D. 1983. Oil and the macroeconomy since World War II. *Journal of Political Economy* 91(2): 228-248.
- Hamilton, J.D. 2003. What is an Oil Shock? *Journal of Econometrics*, 113(2): 363-398.
- Hamilton, J.D. 2009. Causes and Consequences of the Oil Shock of 2007-08. *Brookings Papers on Economic Activity*, 1 (Spring): 215-261.
- Hamilton, J.D. and Herrera, A.M. 2004. Oil Shocks and Aggregate Economic Behavior: The Role of Monetary Policy. *Journal of Money, Credit and Banking*, 36(2): 265-286.
- Hong, H.W.T. and Valkanov, R. 2002. Do Industries lead the Stock Market? Gradual Diffusion of Information and Cross-asset Return Predictability. *Working Paper, Stanford University and UCLA*.
- Hooker, M. 1996. What Happened to the Oil Price–Macroeconomy Relationship. *Journal of Monetary Economics*, 38(2): 195–213.
- Huang, B., Hwang, M. and Hsiao-Ping, P. 2005. The Asymmetry of the Impact of Oil Price Shocks on Economic Activities: An Application of the Multivariate Threshold Model. *Energy Economics*, 27(3):445-476.
- Inoue, A and Kilian, L.. 2011. Inference on Impulse Response Functions in Structural VAR Models. *Forthcoming in Journal of Econometrics*.

- Jones, C. and Kaul, G. 1996. Oil and the Stock Markets. *Journal of Finance*, 51(2): 463-491.
- Kaul, G. and Seyhun, N. 1990. Relative Price Variability, Real Shocks, and the Stock Market. *Journal of Finance*, 45: 479-496.
- Keane, M. and Prasad E. 1996. The Employment and Wage Effects of Oil Price Changes: A Sectoral Analysis. *The Review of Economics and Statistics*, 78: 389-400.
- Kilian, L. 2008. The Economic Effects of Energy Price Shocks. *Journal of Economic Literature*, 46(4): 871-909.
- Kilian, L. 2009. Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. *American Economic Review, American Economic Association*, 99(3): 1053–1069.
- Kilian, L. and Murphy, D.P. 2012. Why agnostic sign restrictions are not enough: understanding the dynamics of oil market VAR models. *Journal of the European Economic Association*, 10(5): 116–1188.
- Kilian, L. and Murphy, D.P. 2013. The Role of Inventories and Speculative Trading in the Global Market for Crude Oil. Forthcoming: *Journal of Applied Econometrics*.
- Kilian, L. and Park, C. 2009. The Impact of oil price shocks on the US stock market. *International Economic Review*, 50(4): 1267–1287.
- Lettau, M. and Ludvigson, S.C. 2001. Consumption, aggregate wealth, and expected stock returns. *Journal of Finance*, 56(3): 815– 849.
- Lettau, M. and Ludvigson, S.C. 2004. Understanding Trend and Cycle in Asset Values: Reevaluating the Wealth Effect on Consumption. *American Economic Review*, 94(1): 276-299.
- Lettau, M., Ludvigson, S.C. and Steindel, C. 2002. Monetary Policy Transmission Through the Consumption-Wealth Channel. *FRBNY Economic Policy Review*,
- O’ Neil, T.J.J.P and Terrell, R.D. 2008. The Role Higher Oil Prices: A Case of Major Developed Countries. *Research in Finance*, 24: 287-299.
- Ono, S. 2011. Oil Price Shocks and Stock Markets in BRICs. *The European Journal of Comparative Economics*, 8(1): 29-45.
- Papapetrou, E. 2001. Oil price Shocks, Stock Market, Economic Activity and Employment in Greece. *Energy Economics*, 23(5): 511-532.
- Park, J. and Ratti, R. 2008. Oil Prices and Stock Markets in the U.S. and 13 European Countries. *Energy Economics*, 30(5): 2587–2608.
- Pavlidis, I.E., Peel, D. and Spuru, A. 2009. Bubbles in House Price and their Impact on Consumption: Evidence for the US. *Lancaster University Management School Working Paper No.* 2009/025.
- Peersman, G. & Van Robays, I. 2009. Oil and the Euro Area Economy. *Economic Policy*, 24(60): 603–651.
- Rapach, D. and Strauss, J.K. 2006. The long-run relationship between consumption and housing wealth in the eighth district states. *Federal Reserve Bank of St. Louis Regional Economic Development*, 2: 140-147.

- Rapach, D. and Strauss, J.K. 2007. Habit Formation, Heterogeneity, and Housing Wealth Affects Across U.S. States. *Missouri Economics Conference*.
- Sadorsky, P. 1999. Oil Price Shocks and Stock Market Activity. *Energy Economics*, 21(5): 449-469.
- Stock, J.H. and Watson, M.W. 2004. Combination Forecasts Of Output Growth in A Seven-Country Data Set. *Journal of Forecasting*, 23(6): 405–430.
- Uhlig, H. 2005. What are the effects of monetary policy on output? results from an agnostic identification procedure. *Journal of Monetary Economics*, 52 (2): 381-419.
- Wakeford, J.J. 2006. The impact of oil price shocks on the South African macroeconomy: History and prospects. *South African Reserve Bank Conference Paper*.
- Yurtsever, C. and Zahor, T. 2007. Oil Price Shocks and Stock Market in the Netherlands. *Working Paper, University of Groningen*.