SAUDI ARABIA'S ROLE IN THE GLOBAL OIL MARKET

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Abstract

As a leader in global oil production and OPEC, it is conventionally thought that the Kingdom of Saudi Arabia is a swing producer that significantly influences the international oil market and subsequently the global economy by independently adjusting their oil production levels. This paper determines if Saudi Arabia truly does have an active role in the global oil market. A structural empirical method is used to identify shocks to the global market for crude oil, including from Saudi Arabia. The method also allows for shocks to have a permanent or a temporary affect on the level which are important features of the crude oil propagation mechanism. The results indicate that Saudi Arabia has an active role in the global oil market by dampening foreign demand shocks and amplifying foreign supply shocks. The results also suggest that Saudi Arabian intervention is temporary, even in the face of permanent shocks.

Acknowledgements

Thank you to Queen's University and the economics department for welcoming me over the course of five years through an enlightening undergraduate and graduate academic experience. In specific to this research paper, I express great appreciation to my supervisor Dr. Frank Milne for continuously coaching and inspiring my interest in economics. Thank you also to Stephen Snudden who's outstanding knowledge about petroleum economics allowed me to confidently develop my findings throughout this paper. Last but not least, thank you to my family and friends for each supportive step along the way.

Contents

1 Introduction

As a leader in global oil production and OPEC, it is conventionally thought that the Kingdom of Saudi Arabia is a swing producer that significantly influences the international oil market and subsequently the global economy by independently adjusting their oil production levels (Baumeister and Kilian 2015). However, recent history has much to say about Saudi Arabia's behaviour as a defining oil producer. This paper investigates Saudi Arabia's behaviour in the global oil market in order to determine whether the nation has an active role in mitigating volatility, amplifying it, or neither. Saudi's role in the oil market is quantified over recent historical decades to develop this empirical evidence.

The quantitative method is a structural vector auto-regression (SVAR). The SVAR is an appropriate method to structurally model Saudi's small open economy (SOE) and global market for crude oil as motivated by a theoretical model developed by Kilian (2009). Additionally, the SVAR will build on Kilian (2009) and Snudden (2016) for contemporaneous restrictions and ordering reflecting the market framework of a small open economy. Shocks will be identified on foreign (non-Saudi) real GDP, Saudi real GDP, foreign (non-Saudi) crude oil production, Saudi crude oil production, and on the real Brent crude oil price. The impulse-response functions will allow for an observation of Saudi Arabia's role in the global market for crude oil. All identified

shocks are allowed to be either temporary or permanent on the level. Allowing shocks to be either temporary or permanent on the level is a departure from the strictly temporary shocks imposed by other recent empirical models.

This research paper will provide evidence to support that Saudi Arabia has had an active role as a source of price movements and has actively reduced oil price volatility in response to oil price movements driven by international oil demand pressures. This result is consistent with the findings of Mohaddes and Pesaran (2015) and Sudden (2016). The model identifies that Saudi Arabia behaves as a swing producer and OPEC leader. It further provides evidence that Saudi can have a large effect on the global market through its oil supply interventions. Another novel finding is that supply shocks by Saudi Arabia unilaterally changing production takes time to affect the price of oil. Hence, shocks to supply result in a delayed response to oil prices versus a fairly quick response from demand.

This paper begins by first considering the background of Saudi Arabia as a swing producer and OPEC leader. A SVAR is then proposed along with its detailed specification. The motivation of the structural restrictions will be provided. The shocks that will be identified are to foreign oil production, Saudi oil production, real foreign GDP, real Brent crude oil price, and real Saudi GDP. The distinguishing feature of the model employed by this paper is its propagation mechanism. The propagation mechanism contrasts with

previous studies that conventionally used impact elasticities. A more effective approach at interpreting elasticities in the global oil market is to show their evolution over a course of time such as a year. This allows for identification of delayed responses in the oil market. Ultimately, the quantitative analysis will allow for an interpretation of results that explain Saudi Arabia's recent historical role in the global oil market.

2 Literature Review on Saudi Arabia

The Organization of the Petroleum Exporting Countries (OPEC) was established as a permanent intergovernmental organization in 1960 with the objective of stabilizing petroleum prices and exerting collusive control over the petroleum market (OPEC 2016). Saudi Arabia became the leading producer within the cartel, along with its role as the world's largest oil producer. Thus, the survival of the cartel depends on Saudi's ability to portray how important the cooperation is in market volatility control and deriving economic benefits for the cartel members.

Saudi Arabia is a small open economy that is heavily dependent on the oil market. The Kingdom holds 18% of the world's proven petroleum reserves. The oil and gas sector alone account for 50% of the country's gross domestic product and approximately 85% of export earnings (OPEC 2016).

However, Saudi has a limited capacity to actively influence the global market for crude oil. If Saudi is capable of driving certain oil price fluctuations by supply-sided adjustments, it defines their role as a swing producing state.

Using a Global VAR (GVAR) (See Pesaran et al. 2004), Mohaddes and Pesaran (2015) developed an empirical model for 27 countries/regions to depict how oil markets can be used to identify country-specific supply shocks. In their work, Mohaddes and Pesaran (2015) used data over the period 1979Q1 to 2013Q1 that suggested Saudi's role as an OPEC leader was significant in driving oil prices and the global economy under given identified shocks. They asserted that Saudi Arabia was a defining player in the international oil market by historically having the characteristics of what would make it a swing producer [1].

Mohaddes and Pesaran (2015) constructed their GVAR using the variables real GDP, inflation, real exchange rate, short and long-term interest rates and oil production. They concluded that Saudi Arabian crude oil supply shocks resulted in permanent increases in price. Mohaddes and Pesaran's (2015) justification for the given output was that other countries appeared incapable of fully diluting the excess capacity opened up by a Saudi oil supply shock. In turn, prices were increased. Additionally, they concluded that

[1]Recall that a swing producer in the case of Saudi Arabia is referring the the nation as a major crude oil producer capable to exacerbating or dampening certain shocks.

Saudi Arabia does exacerbate supply shocks and dampen demand shocks. Similar empirical results was found by Snudden (2016). When considering Saudi Arabia's role within OPEC itself, Mohaddes and Pesaran (2015) discerned that the Kingdom attempts to fulfil the goals of OPEC when other members are unable. For example, Mohaddes and Pesaran (2015) depict periods in which heavy sanctions were imposed by the United States and Europe on an OPEC member (in this instance Iran) and Saudi reacted by adjusting crude oil exports in order to stabilize the markets and maintain the goals of the OPEC agenda.

Other empirical works have also used a GVAR to model the international crude oil market with slightly differing alterations to the underlying method. For example, Cashin et al. (2014) explores the implications of oil supply shocks on major exporters. Cashin et al. (2014) discriminated between supply-driven and demand-driven oil price shocks which where bounded by price elasticities imposed to both supply and demand.

In this research paper, the model methodology is motivated by the SVAR derived by Kilian (2009). The objective of Kilian's (2009) SVAR was to identify a set of restrictions that recognizes shocks to supply and demand in the oil market. Kilian (2009) imposes a restriction on the SVAR that identifies structural shocks in demand that do not contemporaneously affect supply. Alternatively, this occurs in the long-run as supply factors are capital inten-

sive and altering production capacity is a time consuming process. Kilian (2009) also points out that unanticipated disruptions in crude oil supply have a small effect on the real price of oil. He asserts that the intuition behind the results arises out of supply-sided disruptions that trigger endogenous expansions of crude oil production elsewhere on the global market, offsetting the initial shortfall. This finding will continue to hold in the analysis in this paper. Other authors suggest that this type of market behaviour is common and diminishes OPEC's ability to drive oil prices and control volatility overtime as demand driven factors become more prevalent (See Baumeister and Peersman (2013); Baumeister and Kilian (2015)).

Baumeister and Peersman (2013) developed a TVP-VAR to depict the time-varying parameter of Brent crude oil prices. The TVP-VAR followed the methods of Cogley and Sargent (2005) and Primiceri (2005) to show the stochastic volatility in the innovation process. They did this by identifying three types of structural disturbances associated with innovations in the price of oil and world oil production. All the shocks on oil demand, which included using global economic activity and oil supply, were identified by means of sign restrictions. This allowed for the effect of the shocks on oil prices and production to be immediately absorbed as they changed over time. Baumeister and Peersman's objective was to show how there has been a transition from supply-side factors that once drove the oil markets to now demand-side factors. Their results reveal this transition to have been gradual

and could prove challenging for OPEC and especially Saudi Arabia since a swing producer requires supply to be the main price-driving factor in order to influence the market. Although their core focus is orientated around this market transition over time, they do assert that Saudi may act as a swing producer, but their influential ability has diminished over time. This is an important point to consider as we approach the model specification and results for two reasons. The first is that if oil price movements are becoming more demand driven, this implies and confirms that Saudi Arabia is more dependent on the oil market in which it tries to influence. The second realisation is that the results should reflect that Saudi can still be defined as a swing producer, but greater price innovations are more responsive to shocks in global non-Saudi demand.

Baumeister and Kilian (2015) found that the rise of additional major oil producers over recent decades such as Russia, Canada, China, and especially the United States in developing efficient fracking technologies, has only made it difficult for Saudi Arabia to sustain its market power. This implies that OPEC itself faces coordination problems from a largely demand-driven oil market. Saudi requires cooperation among cartel members in order to achieve certain objectives through price manipulation or volatility control. This will be reflected in the results as elasticities are more sensitive to foreign non-Saudi demand versus foreign non-Saudi crude oil supply or Saudi crude oil supply. The Kingdom requires $100 per barrel of crude oil in order to

balance the nation's fiscal budget (Hulbert and Stevens 2012). This means that OPEC is critical for Saudi Arabia in order to sustain market share and the country's ability to retain itself as a swing producer.

3 Model Specification

The following section outlines the modelling approach for the research question. Its purpose is to motivate the use of selected variables and model selection.

3.1 Brent Oil Benchmark

The logarithms of all major oil price benchmarks are shown in Figure 1. West Texas Intermediate (WTI) is commonly used by Canada and the United States for selling oil to market while Saudi Arabian Light Crude is used by Saudi Arabia, and Brent Crude refers to the benchmark for pricing oil generally extracted from the North Sea and surrounding European countries. The Brent Crude oil market pricing has been selected as the benchmark for this paper. Brent is a widely accepted clearing price index globally and commonly used as the benchmark pricing in academic papers regarding the subject of oil (George and Breul 2014).

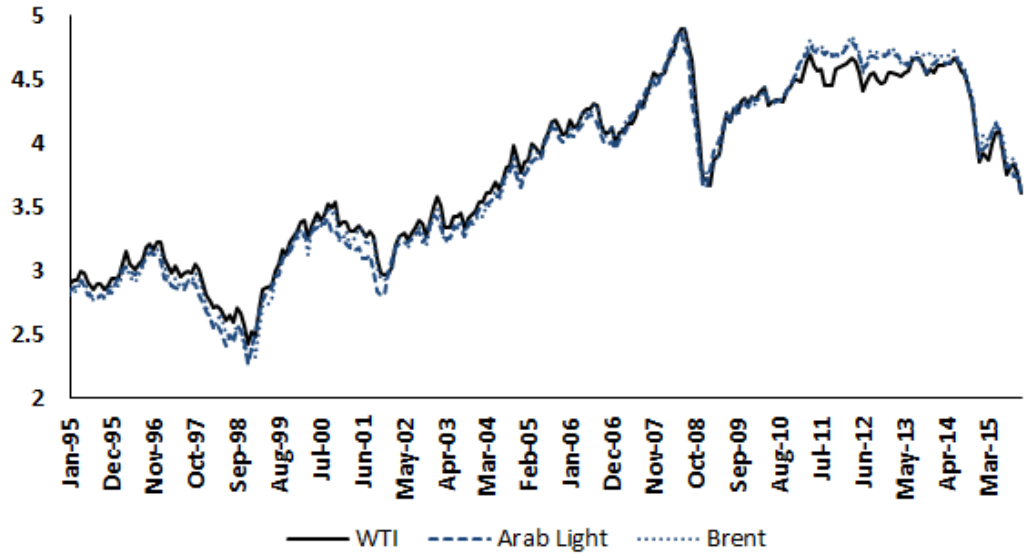

Figure 1: Log-Prices of Oil Benchmarks

3.2 SVAR

The SVAR takes the following form:

$$\mathbf{A}(\mathbf{I}_K - \sum_{i=1}^{p} \mathbf{A}_i L^i)\mathbf{y}_t = \mathbf{B}\mathbf{e}_t$$

where L is the lag operator; $\mathbf{e}_t$ is a $K \times 1$ vector of orthogonal disturbances with $\mathbf{e}_t \sim N(0, I_K)$. Also note that $\mathbf{A}$, $\mathbf{B}$, and $\mathbf{A}_i$ are $K \times K$ matrices of parameters. Specifically, $\mathbf{A}_i$ is a lower triangular matrix with ones along the diagonal, while $\mathbf{B}$ is a $K \times K$ diagonal matrix. Finally, $\mathbf{y}_t$ is a $K \times 1$ vector of endogenous variables.

3.3 Data Selection

The variables are seasonally adjusted foreign real GDP (excluding Saudi), Saudi real GDP, foreign crude oil production (excluding Saudi), Saudi crude oil production, and real Brent crude oil price [2]. Saudi GDP and Foreign GDP are in real US$ terms extracted from the World Bank's Global Economic Monitor. The crude oil production variables are measured in 1000 barrels per day from the Energy Information Administration (EIA). Finally, the Brent crude oil price is in real US$ terms from the Federal Reserve Economic Database (FRED). Given no evidence of co-integration within the dataset, the model has been estimated with all variables in percentage change.

The SVAR is estimated using quarterly data from Q1 of 1995 to Q2 of 2015. The model assumes 4 lags estimated with all variables in period-over-period growth rates. The selection of 4 lags is consistent with the BIC criterion, and thus used for the SVAR as shared by the literature (Mohaddes and Pesaran 2015; Snudden 2016).

[2]Identified in the impulse-response functions as Foreign GDP, Saudi GDP, Foreign Oil Production, Saudi Oil Production, and Brent Crude Oil Price, respectively.

3.4 Identifying Restrictions

The ordering of restrictions is as follows: Foreign Oil Production, Saudi Oil Production, Foreign GDP, Brent Crude Oil Price, Saudi GDP [3]. These contemporaneous restrictions are motivated by Kilian (2009) in which he concludes that supply-side variables go first in the recursive ordering process. This is a result of supply not being contemporaneously affected by the trailing variables in the SVAR ordering. It is also a direct consequence of supply being perfectly inelastic in the first period following all initial demand-sided shocks. Demand follows second in the recursive ordering process due to its greater contemporaneous flexibility in the first period. Innovations in demand as a response to shocks are immediately reflected in the price of oil and economic conditions contemporaneously react to globally significant commodities such as crude oil (Kilian 2009). Finally, the recursive ordering also identifies other demand as represented by the price of oil. Other demand represents other unaccounted demand factors that are composed in the market price of oil. Prices are last in the recursive ordering process as they contemporaneously respond to shocks in supply and demand. This fits the theoretical concept that supply and demand are the contemporaneous drivers of price, but only prices can affect supply and demand with a lag.

Further motivating adjustments to the SVAR framework are derived from

[3]These variables represent foreign crude oil production, Saudi crude oil production, foreign real GDP, real Brent crude oil price, and Saudi real GDP, respectively.

empirical evidence provided by Mohaddes and Pesaran (2015) and Snudden (2016). Saudi Arabia follows foreign crude oil production due to Saudi's excess crude oil capacity (Snudden 2016). This is a concept equally shared by Mohaddes and Pesaran (2015), defining Saudi Arabia as a major crude oil producer that can easily adjust production levels. However, the Kingdom's significantly smaller economy versus the international oil market makes its oil demand inconsequential compared to its oil supply. Saudi Arabia's real GDP follows last. The justification is that since Saudi is a SOE that is heavily dependent on the oil market, it is reasonable that the price of oil has a large impact on the country's economy (Snudden 2016). Following Snudden's (2016) restrictions to reflect Saudi as an SOE, the lags for all periods on Saudi real GDP have been constrained to zero on the real Brent crude oil price, foreign real GDP, and foreign crude oil production. Thus, only the country's crude oil supply is influential to the global market.

3.5 Impulse-Response Function

The impulse-responses will consist of shocks to foreign and Saudi supply, foreign and Saudi demand, and other demand shocks constituted in the price of oil.

The shocks are represented in percentage change. This is so that the impulse-responses have converted the variables back into levels. The figures

are reported with 90% confidence intervals and normalized so that the shocks are 1% on average in the first year [4]. The impulse responses identify structural shocks that may be either permanent or temporary on the level. The discussion will pay close attention to the evolution of the propagation. The annualized elasticities for all shocks will appear in Table 1 with impulse response dynamics for foreign and Saudi real GDP, foreign and Saudi crude oil production, and real Brent oil price shocks revealed in the following sections.

4 Empirical Results

The following subsections layout the results obtained from the SVAR and impulse response functions. Each shock is discussed separately. When reading through the subsections, consider Table 1 along with the impulse-response figures. Section 4.6 discusses the novel propagation method used to achieve results that contribute to the literature.

4.1 Foreign Oil Production Shock

A shock that increases foreign crude oil production by 1% on average in the first year drives a fairly large response from both Saudi crude oil production and the price of oil. Saudi Arabian oil production responds by increasing

[4] See Table 1 and impulse-response figures in the following sections

1.38% while the price of oil drops -3.31%. In the second year the price of oil continues its fall to -7.71% while the increase in Saudi oil production minimizes to 0.70% as it begins normalizing (see Figure 2). Saudi Arabia exacerbates foreign supply shocks. As in Section 4.3, a shock to Saudi oil production moves the price of oil down -1.27% in the second year. We can see how this has an impact on the price of oil in the second year of the foreign oil production shock by the response of Saudi increasing domestic production 0.70% constituting to -0.89% of the -7.65% response in the price of oil. Saudi thus amplifies price decline and volatility [5].

As for foreign GDP and Saudi GDP, the responses in the first year is significant with a rise of 0.04% and 0.08% respectively. In the second year, the average response of foreign GDP and Saudi GDP turns negative with the results -0.01% and -0.23% respectively, with foreign GDP normalizing in the second year.

[5]With reference to Section 4.3, a 1% to Saudi oil production earns a response of -1.27% in the price of crude oil. Multiplying 0.70% to -1.27% we get -0.89% which represents Saudi's production behavioural response to a shock in foreign oil production in Section 4.1.

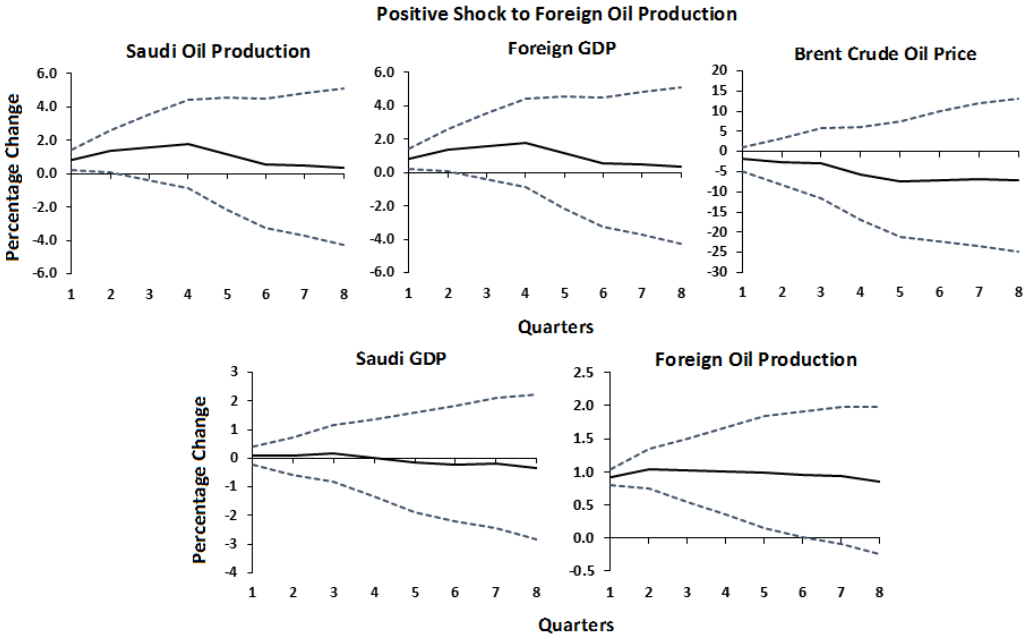

Figure 2: Foreign Oil Supply Shock

The foreign oil production shock forces the price of oil to drop substantially. In order to preserve market share from entrants, Saudi Arabia responds to the foreign oil production shock by increasing domestic crude oil production at a rate exceeding that of the initial shock. This reveals Saudi's aggressive measure to preserve market share within the first year. This strategic behaviour could be considered as predatory as the country attempts to block new entrants from profitably entering the market or to induce production cutbacks for high marginal cost producers. This strategy leads to consequences in the long-term in the second year. As prices continue their decline from the foreign supply shock, the results show a reduction from

the initial response of Saudi Arabian crude oil production. This means that while the foreign shock is permanent, the supply response from Saudi Arabia is temporary. This is important because the preservation of market share by Saudi is only temporary.

4.2 Foreign GDP Shock

A demand shock that increases foreign GDP 1% on average in the first year exerts significant upward pressure on the price of oil at 12.13%. What follows are increases in Saudi oil production, Saudi GDP, and foreign oil production with 1.09%, 0.88%, and 0.38%, respectively. In the second year the average response of price to a positive 1% shock in foreign GDP relaxes to 9.49%. As for Saudi oil production and Saudi GDP, they continue growth to 1.77% and 1.16%, respectively as Saudi oil production begins to show signs of normalizing around halfway through the second year. Similar can be said about foreign oil production as it increases during the first year and normalizes throughout the second.

In Section 4.3, a Saudi oil production shock in the positive direction results in a decrease of -1.27% in the price of oil on average in the second year. This suggests that during the historical time frame of this model, Saudi Arabian oil production in the second year of the shock to foreign GDP deducted -2.25% from the increasing price of oil. Otherwise, instead of a 9.49% growth

in the price of oil in the second year, it would have been 11.74% without Saudi's historically dampening affect.

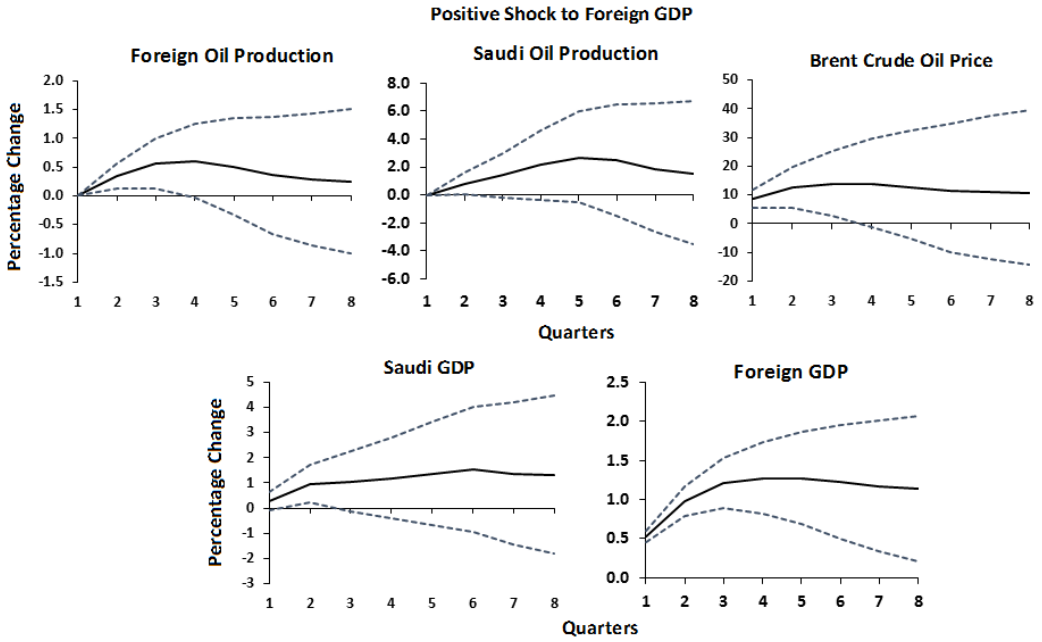

Figure 3: Foreign GDP Shock

A foreign GDP shock has a sizeable impact on foreign oil production, Saudi oil production, Saudi GDP, and especially on the price of oil. Interestingly, since the change in foreign oil production is less than the demand shock, this exerts upward pressure on the price of oil in the first year. The cause of this may be due to capacity constraints on many high marginal cost foreign producers trying to increase supply to meet demand (Mohaddes and Pesaran 2015). However, Saudi Arabia being a producer with excess capac-

ity is capable of dampening the demand shock in the first year by increasing production. This dampening of the demand shock by Saudi Arabia smooths the price volatility over the 2 years in the model as Saudi continues to expand its oil supply.

The results also show that the Saudi economy benefits by reducing the price volatility over the 2 year period with domestic GDP rising from an average increase of 0.88% in the first year to 1.16% in the second. The likely cause of this arises out of Saudi's increased oil production and increased crude oil prices over the 2 years. Evidence to further support this finding from a foreign demand shock can be seen in Sections 4.3 and 4.5. Section 4.3 reveals that a positive shock to Saudi oil production drives a 0.38% response in Saudi GDP in the second year. This constitutes to 0.67% of the 1.16% response from Saudi GDP in the second year of the foreign GDP shock [6]. Section 4.5 reveals that a 1% shock to oil price results in a 0.05% increase in Saudi GDP in the second year. This means that a 9.49% response in oil price in the second year to a shock in foreign GDP constitutes to 0.47% of the 1.16% increase in Saudi GDP [7]. Adding the results together, it totals 1.14% of the 1.16% response in Saudi GDP during the second year of a shock to foreign GDP.

[6]Referring to Section 4.3, a 1% shock to Saudi oil production earns a response of 0.38% from Saudi GDP. Multiplying 0.38% to 1.77% (the response of Saudi oil production to a shock in foreign GDP in the second year) gives the result 0.67%.

[7]Here we are multiplying 0.05% (Saudi GDP response to shock in oil price) to 9.49% which is the response of oil prices to a shock in foreign GDP.

4.3 Saudi Oil Production Shock

A shock to Saudi oil production represented by a 1% increase on average in the first year is associated with a price increase of 0.56% while Saudi GDP increases 0.23%, foreign oil production decreases -0.01% and no change in foreign GDP. In the second year, the foreign oil production decrease remains consistent at -0.01% as it normalizes while foreign GDP moves downwards to -0.09%. Saudi GDP continues its increase to 0.38%. However, there is a reversal for oil prices in the second year. From its average of 0.56% in the first year, the oil price response reverses to an average of -1.27% in the second. The delay in the response of pricing innovations to a shock in Saudi crude oil production depicts how changes in Saudi oil production take time to be fully reflected in the price of oil.

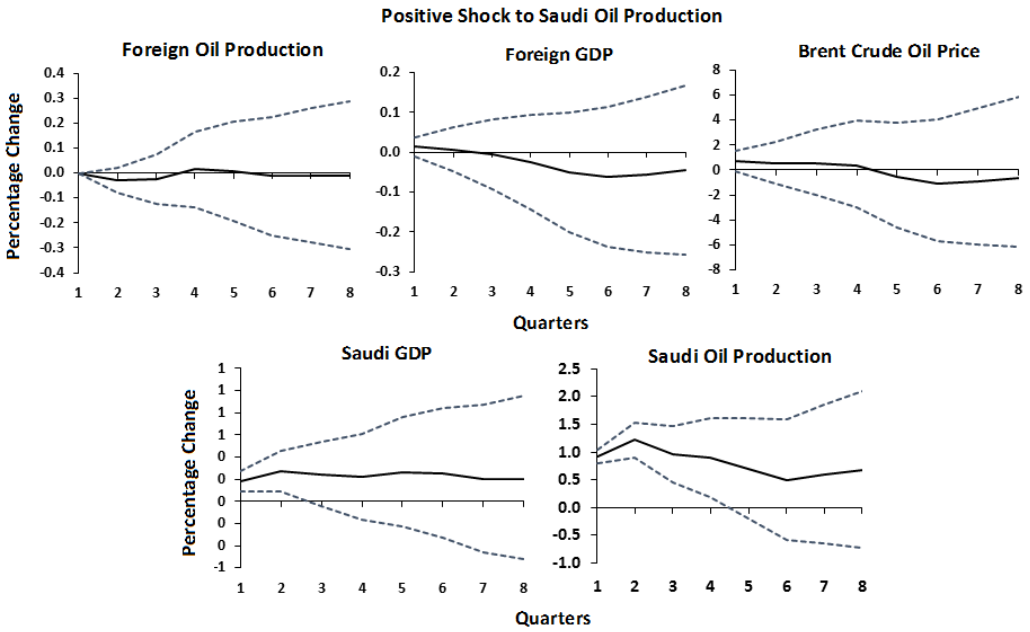

Figure 4: Saudi GDP Shock

A 1% supply-sided shock to Saudi oil production results in an impact on the price of oil and Saudi GDP in the first year. The shock does not have an effect on foreign GDP and only a negligible influence on foreign supply. What is interesting however, is how the shock to Saudi oil production also drives up the price of oil in the first year. In turn, this inevitably increases Saudi GDP as well. According to standard economic theory, it would be expected that an increase in supply is associated with a decrease in price, ceteris paribus. In the case for a Saudi Arabian crude oil supply shock, this does not appear to hold true in the first year. Furthermore, the increase in oil price from the Saudi supply shock also cannot be explained by foreign

GDP since this demand variable had no response. It can be implied that this theoretical anomaly is associated with market participant expectations. Granted that Saudi's position as an OPEC leader and recognized largest international producer of crude oil, they attain a lot of publicity. Hence, when Saudi announces an increase in production or publishes higher crude oil output, market participants trading spot oil contracts may initially be under the impression that Saudi is producing more to dampen an anticipated global demand shock that may dramatically increase the price of oil as in the case of a foreign GDP shock (see Section 4.2). Hence, expectations are that oil prices will go up. It is thus likely to do with speculation in spot contracts trading rather than economic growth. Baumeister and Peersman (2013) discuss the rise of spot contracts in the oil market that has allowed expectations and speculation to become greater drivers of oil prices. Conversely, the second year depicts what can be considered a correction from initial price expectations as a more theoretically sound equilibrium takes hold. In the second year the price of oil has corrected by decreasing to -1.27% which more accurately reflects the positive shock to Saudi oil supply.

4.4 Saudi GDP Shock

A demand shock that increases Saudi GDP 1% on average in the first year results in little response among all other variables as intended by the model specification. The most responsive out of the variables is Saudi oil produc-

tion which increases 0.115% in the first year. In the second year, Saudi oil production continues its increase to 0.21%. At the same time, the price of oil begins to react in what appears was a delayed response. In the first year, Brent crude oil prices dropped very slightly by -0.016%, but extends the decline further to -0.178% in the second year. This reflects the novel conclusion from Section 4.3 on Saudi oil production shocks. In this case, a shock to Saudi GDP drives an increase in Saudi oil production as a response. As in Section 4.3, an increase in Saudi oil production is followed by an average decrease in the price of oil in the second year. Thus, for a shock on Saudi GDP, a responding slight increase in Saudi crude oil production is associated with a slight decrease in the price of oil in the second year.

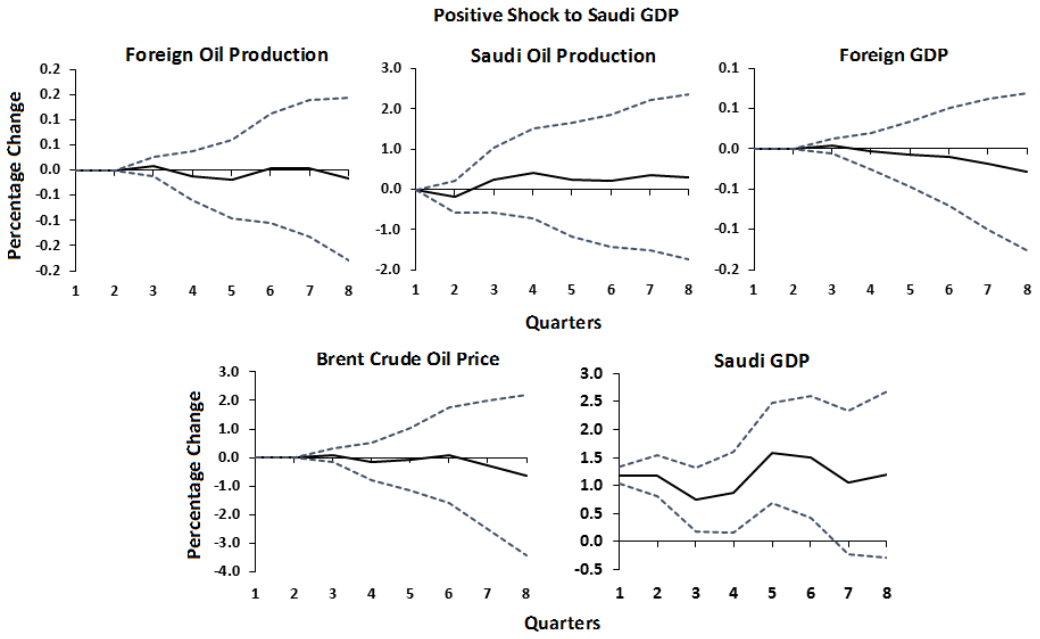

Figure 5: Saudi GDP Shock

For a shock on Saudi GDP, Section 3.4 on model specification indicates that Saudi real GDP is not a major driver of foreign crude oil production, foreign real GDP, nor oil prices due to its small open economy (Snudden 2016). However, a shock to Saudi real GDP does have somewhat of an influence on domestic crude oil production. The rising Saudi GDP over the 2 years reflects Saudi Arabia's dependence on the oil market. The intuition is that positive innovations in domestic economic performance are associated with a response in increased national crude oil supply. This is likely to supplement the growing economy's increasing demand for oil as fuel for continued economic growth.

4.5 Other Demand Shocks

As revealed in the section on model specification, the model shows that the price of oil is not a driver of demand or supply, but is instead almost fully influenced by them. This is reflect in the near nil response from all variables regarding the other demand shock represented by the Brent crude oil price.

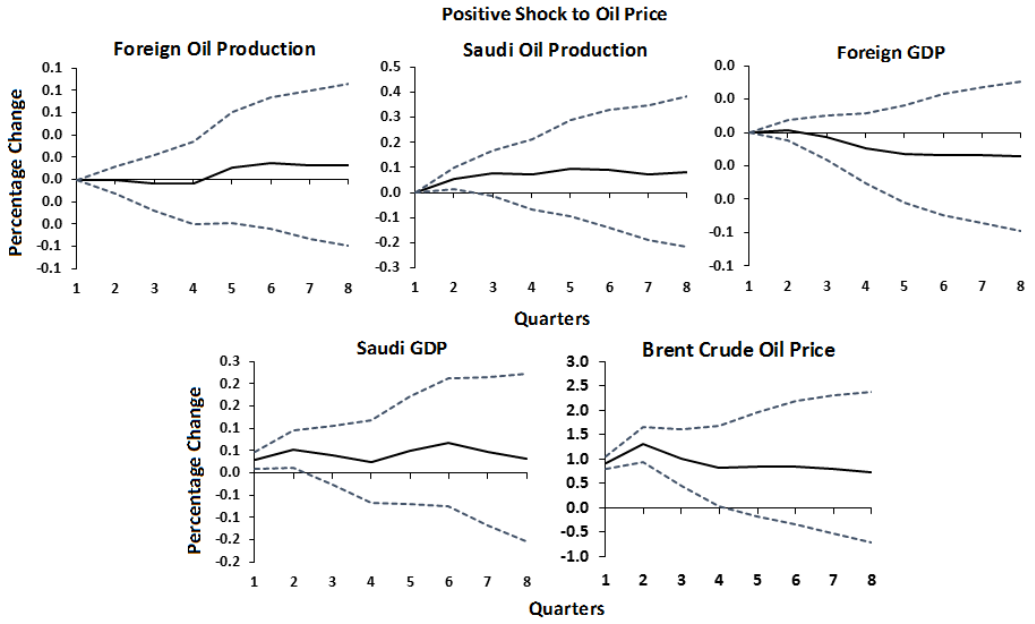

Figure 6: Brent Crude Oil Price Shock

4.6 Propagation Mechanism

Early in this paper, it is introduced that the propagation mechanism is different from other traditional empirical approaches. Conventionally, research focuses on the impact elasticities within short time periods versus interpreting the results as average evolutions over a long term horizon. The latter approach has been preferred in this paper as it appropriately reflects the delayed responses that may result from immediate innovations in the global crude oil market. Additionally, having used percentage change in the model, it has allowed shocks to have a permanent affect on the level, but not excluding that shocks may only just have temporary affects on the level.

Table 1 reveals the yearly average innovations versus the immediate innovations that were displayed in the impulse-response function figures. It is still critical to use the impulse response function figures as we can determine whether or not shocks have a permanent affect on the level, or instead just a temporary affect allowing the response to normalize over time. This is especially the case when reviewing the novel finding that shocks to Saudi Arabia's crude oil production take over a year to be fully reflected in the price of oil (see Section 4.3). Another novel finding was that over the historical time frame of the model, Saudi Arabia responds temporarily to foreign oil production shocks since domestic oil production normalizes in the second year (see Section 4.1). Thus, the impulse response figures allowed for interpretation of immediate short-term transitions in innovations as the yearly averages

in Table 1 give observational clarity to aggregate affects over a specified time horizon.

First Year					
Impu./Resp.	Foreign Oil Prod.	Saudi Oil Prod.	Foreign GDP	Brent Oil Price	Saudi GDP
Foreign Oil Prod.	1.00*	1.38	0.04	-3.31	0.08
Saudi Oil Prod.	-0.01	1.00*	0.00	0.56	0.23
Foreign GDP	0.38*	1.09	1.00*	12.13*	0.88
Brent Oil Price	0.00	0.05	0.00	1.00*	0.04
Saudi GDP	-0.001	0.115	0.000	-0.016	1.00*
Second Year					
Impu./Resp.	Foreign Oil Prod.	Saudi Oil Prod.	Foreign GDP	Brent Oil Price	Saudi GDP
Foreign Oil Prod.	1.00	0.70	-0.01	-7.65	-0.23
Saudi Oil Prod.	-0.01	1.00	-0.09	-1.27	0.38
Foreign GDP	0.29	1.77	1.00*	9.49	1.16
Brent Oil Price	0.01	0.09	-0.01	1.00*	0.05
Saudi GDP	-0.01	0.21	-0.012	-0.178	1.00*

Annual averages. Sample period: 1995q1 - 2015q2. * represents significance at the 90 percent significance level. Saudi Supply is domestic crude oil supply, Foreign Supply is foreign crude oil supply, Saudi GDP is domestic real GDP, Foreign GDP is foreign real GDP, Brent Oil Price is real price of Brent crude oil. Rows are shocks, columns are responses.

Table 1: Annual I-R Averages

The construction of Table 1 in averaging impact elasticities also allowed for quantifying average response compositions from certain shocks. For example, let us consider the case in Section 4.1 of a shock to foreign oil production and the response from oil prices in the second year. Table 1 was used to determine how the response was exacerbated by Saudi oil production when considering shocks to Saudi oil production and the response from the price of oil in the second year. Subsequently, the contributions to the literature in the subsections of Section 4 have been dramatically enhanced by the use of impulse-response figures and annual impulse-response averages in Table 1.

5 Concluding Remarks

Saudi Arabia's active role in the global oil market is characterized by exacerbating foreign crude oil production (supply) shocks and dampening foreign GDP (demand) shocks. However, it is the new insight into how Saudi Arabian crude oil production temporarily responds to foreign supply and demand shocks that has been this paper's main contribution to the literature.

The model developed within this paper was a SVAR that's use of contemporaneous restrictions reflected Saudi Arabia as a small open economy and major producer in the global oil market (Kilian 2009; Snudden 2016). Departing from the conventional focus on impact elasticities, this paper took an alternative approach. Shocks were allowed to be identified as either temporary or permanent by estimating all variables in percent change. In other words, shocks were not only permanent, but perhaps temporary on the level.

As a consequence of the model specification defined within this paper, two significant findings were a result. The first is how impulse-response functions quantified Saudi Arabia's response to foreign demand and supply shocks. The impulse response functions revealed that Saudi Arabia not only portrayed the behaviour of a swing producer and role as an OPEC leader

in response to foreign demand and supply shocks, but also by how much they contributed to the price movements. The novel results find that Saudi responds temporarily to foreign supply shocks and hence, only temporarily makes attempts to preserve market share.

The empirical evidence supports that Saudi Arabia behaves as a swing producer and OPEC leader. However, to what extent and how effective Saudi Arabia is a swing producer cannot be exactly defined within the confines of this paper. In future research, this may be determined by use of a historical decomposition that could pinpoint specific events at which Saudi Arabia has influenced the oil market. Therefore, it is concluded that Saudi Arabia takes an active role in the global oil market on which it is dependent on by historically adjusting crude oil production in response to foreign supply and demand shocks.

6 References

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