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US shale oil and the behaviour of commodity prices

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Abstract

The US is committed to technological improvements in horizontal drilling and hydraulic fracturing in its drive of toppling the world's leading oil producers by the mid-2020s and evolving into a net oil exporter by 2030. Consequently, the technological innovations revolutionised the US oil sector and the international oil market with increasing relevance of the shale oil and attendant shock spill overs to financial and commodity markets. Upon these attractions and consistent with evidence in the literature, we trace the oil price and commodity price dynamics to the shale revolution using a recursive structural VAR model of the shale supply shocks. In line with the standard practice of ensuring sensitivity of results, we also conduct analyses such as impulse responses, forecast-error variance decomposition and historical decompositions for the total US oil production shocks. We show that the shale revolution, rather than the total US oil supply shocks, is associated with the recent oil price plunge while both oil supply shocks are associated with mild shock spill over to all- and nonfuel- commodity prices.

Key words: US, Shale revolution, oil shocks, commodity prices, SVAR

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1.0 Introduction

Due to unabated reliance of the world's economy on energy in the face of sustained energy demand worldwide, the shale revolution came about through advances in horizontal drilling and hydraulic fracturing, a technological leap heralding improvement in exploration, extraction, processing, and drilling oil and gas from previously nonrecoverable sources (shales) (see Wakamatsu and Aruga, 2013; Melikoglu, 2014; Bilgili et al., 2016; Zendehboudi, 2017). The technological developments use these techniques to facilitate the extraction of oil and gas from shales in economically viable quantities. The process of hydraulic fracturing involves pumping water, sand and chemicals at high pressure to fracture the shale formation and create artificial permeability to release the oil and gas from shale erstwhile trapped in tight formations (Ansari, 2017; Zendehboudi, 2017). Interestingly, the process allows for long term production given opportunity for large-scale exploitation of existing shale wells (see Middleton et al., 2017).

In addition, the shale revolution represents a giant step in the goal of making the United States the world's leading crude oil producer, ahead of the top OPEC producer, Saudi Arabia, by the mid-2020s and evolving into a net oil exporter by 2030 (see International Energy Agency projection of 2012). In this vein, the technological change in the oil and gas extractive industry has sped-up the rate of production in the US; has seen the US domestic oil production surged from 5 million barrels per day in 2008 to over 9 million barrels per day in recent months; responsible for about half of US total crude oil production in 2015 and reduced the US oil imports from OPEC to a 28-year low (see Bataa et al., 2017; Khan, 2017). It has also engendered cheaper energy prices for residential, commercial, and industrial consumers (due to relative lower cost of shale production in the US relative to most of rest of the world) and improved target to meet domestic consumption. Thus, with the US hedging closer to energy independence coupled with ability to wrestle power with OPEC, the shale revolution could represent an additional win for the US in the global hegemony. These came with consequences for oil-dependent economies like Yemen, Egypt, Qatar, Saudi, Nigeria and Algeria who once enjoyed heavy patronage from the United States energy supply needs, but now grapples with lower prices (see Khan, 2017 for more).

In the literature, studies on shale oil revolution as well as the possible spillover effects are gradually emerging. The few related empirical papers are those conducted by Mănescu and Nuño (2015), Bilgili et al. (2016), Ansari (2017), Bataa and Park (2017) and Monge et al. (2017) and their findings offer some insightful motivations for further empirical inquiry. For instance, Bataa and Park (2017) and Monge et al. (2017) find that the shale oil revolution has a greater potential to influence global oil price. On the other hand, Mănescua and Nuño (2015) reveal that the impact of the shale oil revolution on the GDP is more likely to be minimal given that the consequences of the expected increases in US oil supply due to the shale oil revolution filter through (consumer) prices. These evidences point to the possible connection of shale oil revolution with oil and consumer markets and their price evolution. We therefore extend the literature further to capture the probable response of the commodity market to shocks due to the US shale oil. This exercise is borne out of the established nexus between the international crude oil and commodity markets in the extant literature.

Theoretically, the connection between oil price changes and commodity market stems from: one, the increasing evidence of swings in international oil prices and global commodity prices; two, the evidence of volatility spillover from oil market to non-energy commodity markets in recent times; three, the liberalization of capital flows stimulating increased integration between commodity markets so that commodity prices tend to response to the same shock; and four, the financialization and integration of commodity markets exposing it to potential contagion risks (see Ji and Fan, 2012; Hegerty, 2016; Bastianin, et al. 2016; Algieri and Leccadito, 2017). Empirically, the nexus has been largely limited to the interaction between energy and agricultural commodity markets. Studies such as Liu, (2014); Wang et al. (2014); Chen, (2015); Fernandez-Perez et al., (2016); Lucotte, (2016); Pal and Mitra, (2017) report either direct impact of crude oil or comovements with the commodities and also, there are corroborative evidences suggesting that some economic policies or energy developments can buffer the interdependence between oil price and world commodity prices (for example Natanelov et al., 2011; Paris, 2018).

The foregoing is insightful for the present study. Although further empirical motivation for the present study is bared in the succeeding section, we argue here on the basis of the previous argument that the US energy development policy in the form of shale revolution could influence the oil-commodities dynamics. The focus of the present paper therefore is to trace the shale oil shocks through oil and commodity price indices. The rest of the paper is structured as follows. The next section motivates the study further. Section 3.0 describes the research methodology. Section 4.0 presents the preliminary analysis of results before the main discussion of results in Section 5.0. Section 6.0 concludes the paper.

2.0 Motivation for studying shale oil - commodity prices volatility nexus

The empirical analysis of the shale oil-commodity prices contagion has remained unexplored in the extant literature despite arguments of contagion spill overs from the conventional oil market to other non-energy markets. There are however evidences to show that the impact of the shale revolution can be felt in the real economy (see for example Mănescu and Nuño, 2015; Bilgili, et al. 2016). Mănescu and Nuño, (2015) analyse the impact of the shale oil revolution on oil prices and economic growth with a general equilibrium model of the world oil market. Results suggest that most of the expected increase in US oil supply due to the shale oil revolution has already been incorporated into prices and that it will produce an additional increase of 0.2% in the GDP of oil importers in the period 2010–2018. Further, Bilgili, et al. (2016) examine the impacts of shale gas revolution on industrial production in the US. The dynamic ordinary least squares estimator explores that shale gas production has positive effect on industrial production. Asides that, evidence from the Granger causality test show that shale gas production Granger causes industrial production in the US.

Other empirical evidences in the extant literature address the impact of conventional oil market to other financial and commodity markets. In terms of volatility spillover to financial markets, considerable works have been done in the past to connect oil price changes with stock price/returns (for example Hamilton, 1996; Sadorsky, 1999; Kilian, 2008; Nandha and Faff, 2008; Miller and Ratti, 2009; Chen, 2009; Aloui, et al. 2013; Salisu and Oloko, 2015). More recently, Bastianin et al. (2016) study the effects of oil price shocks on the stock market volatility of the G7 countries. Findings show that stock market volatility does not respond to oil supply shocks but rather demand shocks. Mohaddes and Pesaran, (2017) confirm unstable relationship between oil and equity prices over the 1946–2016 period. Further, Nadal, et al. (2017) investigates the time-varying impacts of demand and supply oil shocks on correlations between changes in oil prices and stock markets returns. The findings indicate that demand shocks positively affect the correlations between oil prices and stock market returns during and after the 2007/08 financial markets volatility and at the height of uncertainties about the Chinese growth in 2015.

Away from oil price volatility spillover to financial markets, considerable attention has been paid to contagion effects of conventional oil market to non-financial commodities markets. One of these is Nazlioglu et al. (2013) who examine volatility spillover between oil prices and the prices of agricultural commodities (prices corn, soybeans, wheat and sugar), conducting analysis for the periods before and after food crisis. The findings show evidence of no volatility spillover between oil market and agricultural commodities markets in the pre-crisis period but establish interdependence between the markets afterwards. With structural breaks cointegration and nonlinear causality tests, Fowowe (2016) also shows that agricultural commodity prices in South Africa are neutral to global oil prices. Like Nazlioglu et al. (2013), Wang et al. (2014) also find that oil shocks explain marginal variations in agricultural commodity price before the food crisis in 2006-2008, whereas in post-crisis period their explanatory abilities become much higher. In the light of the present study, Ji and Fan, (2012) examine the influence of oil market on non-energy commodity markets before and after the 2008 financial crisis. The results reveal that the oil market exert significant volatility spillover effects on non-energy commodity markets, which demonstrates its core position among commodity markets. This position is also in tune with Algieri and Leccadito, (2017) who show that commodity markets generate contagion risks which are mainly triggered by financial factors for energy market and that there are spillovers from energy to food markets.

3.0 Methodology

We adopt a structural VAR model consisting of three endogenous variables; the growth rate of US oil supply (divided into total oil production and shale oil production), the growth rate of international oil price, and the growth rate of commodity prices (divided into all-commodity and nonfuel-commodity prices) of the form:

$$\Pi_0 y_t = \sum_{j=1}^{p} \Pi_j y_{t-j} + \varepsilon_t \tag{1}$$

where y_t is a 3 X 1 column vector of endogenous variables, y_{t-j} is the vector of lagged values of endogenous variables up to lag order p, and ε_t is a vector of serially and mutually uncorrelated structural shocks of variances of US oil supply, oil price, all-commodity price, and nonfuel-commodity price such that:

$$y_t = (USoil_t, oilp_t, comp_t)^I \tag{2}$$

$$\varepsilon_t = (\varepsilon_{USoil,t}, \varepsilon_{oilp,t}, \varepsilon_{comp,t})^I ;\ E(\varepsilon_t \varepsilon_t) = \Sigma \tag{3}$$

Π_j is a 3 X 3 matrix of the SVAR parameters and Π_0 is a triangular matrix of recursive short run impulse response designated as:

$$\Pi_0 = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \tag{4}$$

The specification above is standing on a recursive model such that the growth rate of US oil supply comes first in the SVAR structure. This construction allows us to trace the contemporaneous relationship among the variables in terms of the transmission of shocks emanating from shale oil supply (and or the US total oil output) across oil and commodity prices.[1]

4.0 Data and Preliminary Analyses

The shale revolution being the centrepiece of this paper necessitates need for data on US shale oil production. We utilize monthly data set on shale oil production across the seven US oil-rich regions; Anadarko region, Appalachia region, Bakken region, Eagle Ford region, Haynesville region, Niobrara region and Permian region. This data allows us to explore the probable effects of shocks due to (shale) oil supply following the revolution in the energy sector. Also, to probe the shocks due to total US oil supply for robustness, we utilize data on total US oil production. These were with the view to analyse the impacts of these shocks on oil and commodity prices given prior hint in the literature that the shocks have perceptible influence on energy and nonenergy prices. Consequently, we sought data on oil price (Western Texas Intermediate) and commodity price indices (all components and non-fuel, excluding energy fuel component). The data scope spans from 1st Jan 2007 to 31st December 2017, yielding exactly 132 observations for each series (see Table 1). The intuition behind this scope is that it captures the start date of shale oil production in commercial quantities as one of the institutional responses to the global financial crisis at that time.

[1] Our theoretical specification of the relationship is firmly rooted in the literature (see Kilian, 2007, 2009; Wang, et al. 2014; Baumeister and Kilian, 2016; Mohanddes and Raissi, 2015; Mohanddes and Pesaran, 2016; Khan, 2017; Algieri and Leccadito, 2017; Bataa and Park, 2017).

Table 1: Data Scope

Variables	Start Date	End Date	No.
Shale oil production	01/1/2007	31/12/2017	132
Total US oil production	01/1/2007	31/12/2017	132
WTI	01/1/2007	31/12/2017	132
Commodity Price Index (all)	01/1/2007	31/12/2017	132
Commodity Price Index (non-fuel)	01/1/2007	31/12/2017	132

It is customary in empirical studies of this nature to explore the historical information of the series from statistical and graphical perspectives to provide insights into the nature and distribution of the series individually as well as understand the likely co-movements or divergence among the variables of interest. In essence, we assess the descriptive statistics of the series of interest including the mean, standard deviation, skewness and kurtosis (see Table 2) and also provide the graphical analyses (see Figures 1.1 to 1.6), as a foundation to build our study. Based on the descriptive statistics, all the series are widely spread given the standard deviation values with respect to the mean values. Commonplace also, the series, with the exception of nonfuel commodity price index deviate from normal distribution. A salient observation here however is the observed difference in the distributions between all commodities price index and nonfuel commodities price index. This indicates that the analysis based on the two series may differ given that the price index excluding energy components is positively skewed and almost normally distributed while the all-commodities price index behaves otherwise.

Table 2: Summary Statistics

Variables	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
US oil production	6981.732	1747.499	0.253165	1.407737	15.3541*** (0.00046)
Shale oil production	3386923.	1779642.	0.209151	1.357023	15.808*** (0.00369)
WTI	75.98227	23.90436	0.014113	2.020951	5.2763* (0.07149)
Commodity prices (all)	149.9644	35.29284	-0.039890	1.702526	9.2939*** (0.00959)
Commodity prices (non-fuel)	153.1948	21.26639	0.249284	2.636638	2.09331 (0.351109)

Note: values in "()" parenthesis are probability values associated with the respective statistics. *** indicates 1% level of significance.

In Figures 1.1 & 1.2 and 1.3 & 1.4, we plot total US oil production and shale oil production against the two price indices, all-and non-fuel commodity price index respectively. As common with inflation measures, commodity prices witness spikes while on the other hand, oil productions appear to soar over time while the two series appear to converge around 2014 – 2016. This observation is in agreement with positions in the literature that the oil supply shocks may actually have a hand in the oil price plunge of that period (see Hamilton, 2014; Arezki and Blanchard, 2015; Mănescu and Nuño, 2015; Baumeister and Kilian, 2016; Bataa, et al. 2017; Ansari, 2017; Kilian 2017; Khan, 2017). This is however to the extent that energy price is a true representation of total commodity prices. Also in support of conclusions in the extant literature that suggest a link between prices and economic activity, with the role of oil in the production process of commodities, the graphical analysis (see Figures 1.5 and 1.6) show distinct pattern of co-movement between the commodity price indices and oil price over time.

Fig 1.1: Trends in US oil production and all commodity prices

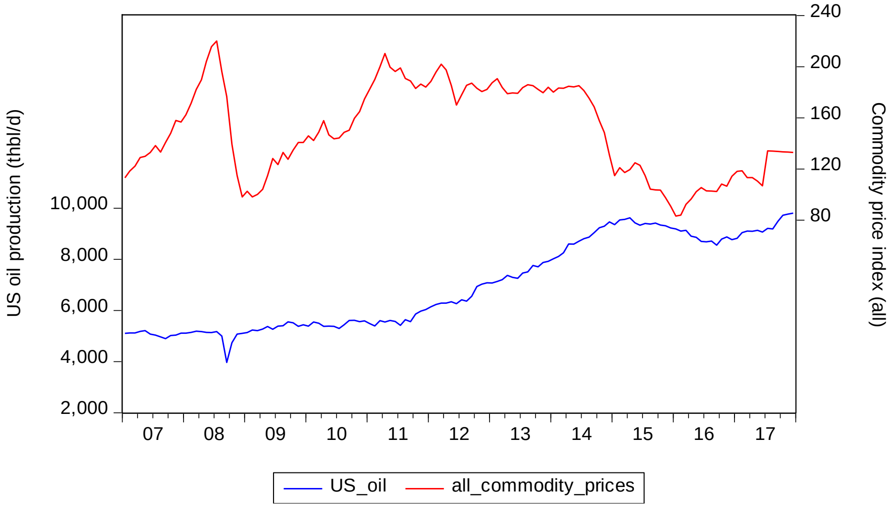


Fig 1.2: Trends in US oil production and nonfuel commodity prices

Fig. 1.3: Trends in ShaleOil Production and Commodity Prices

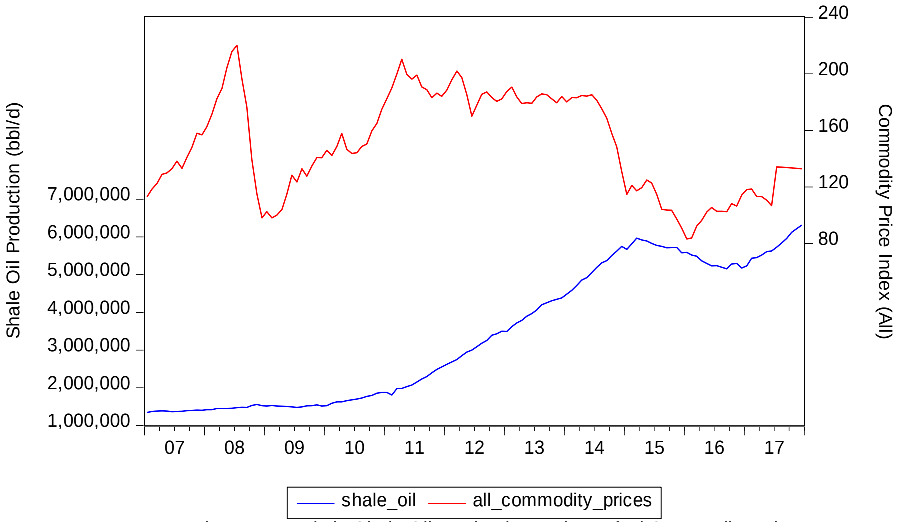


Fig. 1.4: Trends in Shale Oil Production and Non-fuel Commodity Prices

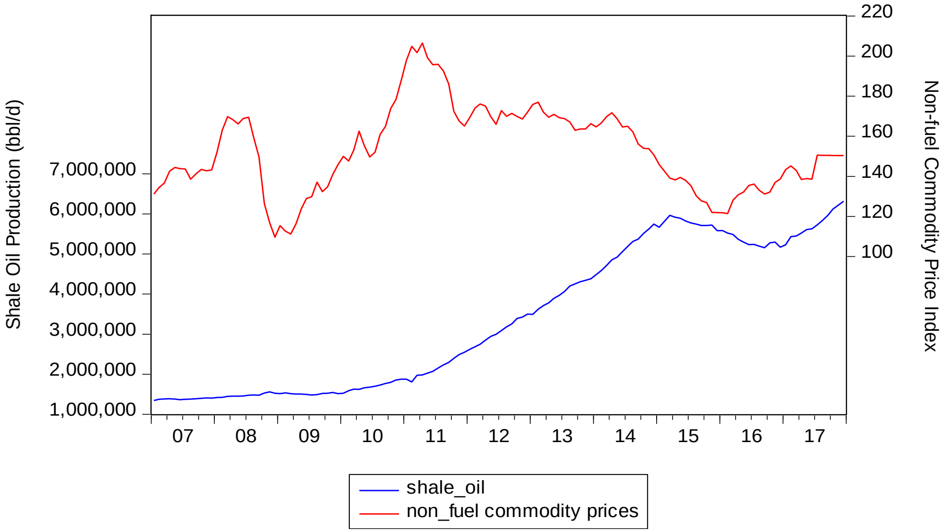


Fig 1.5: Trends in oil and all-commodity prices

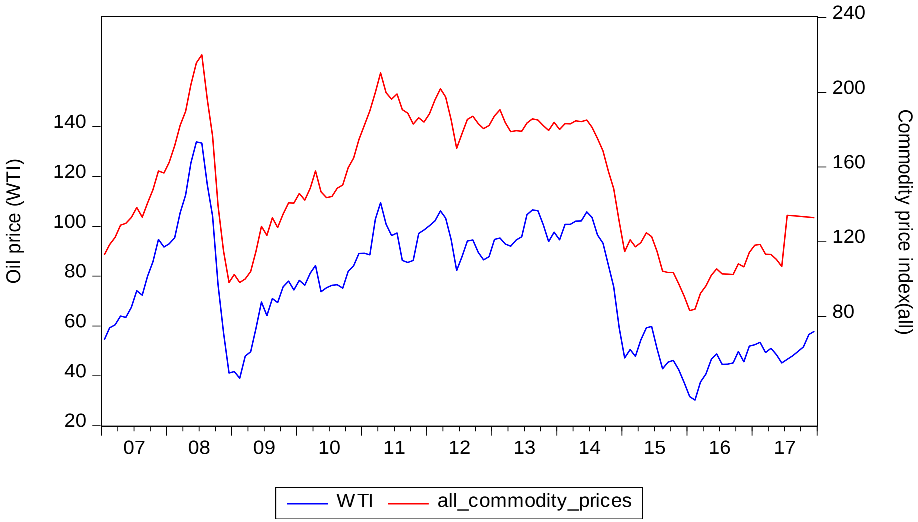
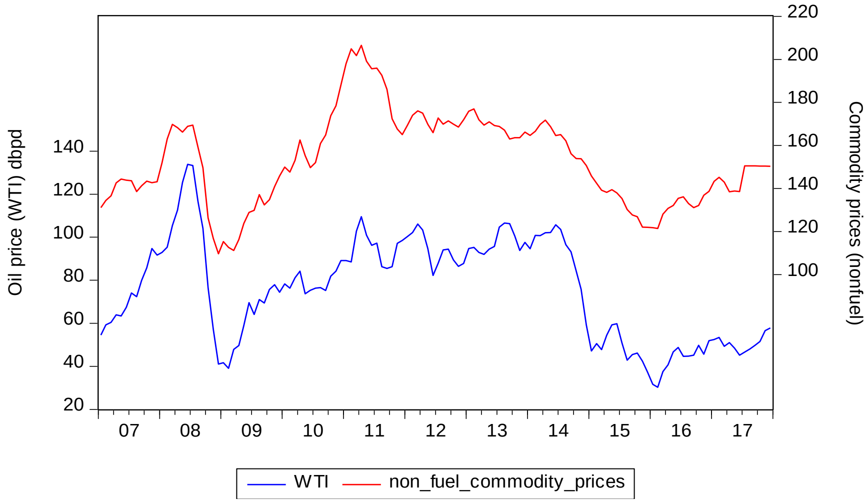


Fig 1.6: Trends in oil and nonfuel commodity prices



To be properly guided in the estimation process, we examine the time series properties of the series, individually and collectively. The individual analysis entails testing for nonstationarity; that is, the presence of unit root in the series employing the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (see Table 3a). These are confirmed with Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (see Table 3b) which specifically tests for stationarity in the series. Collectively, in case the series are nonstationary, there is need for a cointegration analysis to reveal evidence of long run relationship among the series. Results from the analyses reveal that although the ADF test appear to be inconsistent, the PP test indicates rejection of nonstationarity null hypotheses after first difference showing that the series could be integrated of order one. In the same vein, with results from the KPSS tests, we could not reject the null of stationarity for the series at first difference. Hence, the PP and KPSS tests point to the stationarity of the series at first difference. Jointly, the Johansen cointegration test results (see Table 4) indicate evidence of long run relationship among the series, even as findings reveal evidence of one cointegrating equation among the variables.

Table 3a: Unit Root Tests (ADF & PP)

Series	**ADF**						**PP**						**I(d)**
	Level			**1st Difference**			**Level**			**1st Difference**			
	None	Intercept	Intercept & trend	None	Intercept	Intercept & trend	None	Intercept	Intercept & trend	None	Intercept	Intercept & trend	
US_oil	1.8386	-0.36785	-2.57280	-13.10***	-13.46***	-13.44***	2.5033	-0.08817	-2.44960	-13.10***	-13.95***	-13.96***	I(1)
	(0.9840)	(0.9101)	(0.2935)	(0.0000)	(0.0000)	(0.0000)	(0.9971)	(0.9475)	(0.3526)	(0.0000)	(0.0000)	(0.0000)	
Shale_oil	1.8174	-0.5869	-2.1431	-1.5630	-2.4192	-2.4094	3.8475	-0.3185	-1.3574	-8.0751***	-9.9931***	-9.9749***	I(1)
	(0.9832)	(0.8684)	(0.5166)	(0.1107)	(0.1385)	(0.3730)	(1.0000)	(0.9179)	(0.8687)	(0.0000)	(0.0000)	(0.0000)	
WTI	-0.2207	-2.35470	-2.84373	-7.6272***	-7.5973***	-7.5795***	-0.1277	-2.1901	-2.6742	-7.7018***	-7.6726***	-7.6569***	I(1)
	(0.6050)	(0.1568)	(0.1846)	(0.0000)	(0.0000)	(0.0000)	(0.6379)	(0.2109)	(0.2491)	(0.0000)	(0.0000)	(0.0000)	
CPI_all	-0.0296	-2.1851	-2.4538	-7.2945***	-7.2662***	-7.2567***	0.0622	-2.1147	-2.3944	-7.2945***	-7.2662***	-7.2567***	I(1)
	(0.6711)	(0.2128)	(0.3505)	(0.0000)	(0.0000)	(0.0000)	(0.7009)	(0.2393)	(0.3807)	(0.0000)	(0.0000)	(0.0000)	
CPI_non_fuel	0.0832	-2.3337	-2.3570	-7.0293***	-7.0037***	-6.9855***	0.1746	-2.2244	-2.2490	-7.0464***	-7.0216***	-7.0057***	I(1)
	(0.7074)	(0.1631)	(0.4002)	(0.0000)	(0.0000)	(0.0000)	(0.7353)	(0.1988)	(0.4583)	(0.0000)	(0.0000)	(0.0000)	

Table 3b: Stationarity Test (KPSS)

	KPSS				
	Level		**1st Difference**		**Decision**
	Intercept	Intercept & trend	Intercept	Intercept & trend	
US_oil	1.350261**	0.16360**	0.152523	0.123784	I(1)
	[0.463000]	[0.14600]	[0.739000]	[0.216000]	
Shale_oil	1.372468**	0.176341**	0.207247	0.207630	I(1)
	[0.463000]	[0.14600]	[0.739000]	[0.216000]	
WTI	0.478032**	0.211011**	0.089136	0.047344	I(1)
	[0.463000]	[0.14600]	[0.739000]	[0.216000]	
CPI_all	0.341923	0.218906**	0.104958	0.058784	I(1)
	[0.463000]	[0.14600]	[0.739000]	[0.216000]	
CPI_non_fuel	0.217528	0.210417**	0.083240	0.053484	I(1)
	[0.463000]	[0.14600]	[0.739000]	[0.216000]	

Note: all series are expressed in natural logarithm. ADF, PP and KPSS denote the Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin tests respectively. Values in "()" parenthesis are probability values of the ADF and PP statistics. Values in "[]" parenthesis are the critical values for the KPSS statistics. *,** and *** indicate 10%, 5% and 1% levels of significance respectively.

Table 4: Johansen cointegration test

Test Null Hypothesis	Trace statistics	Decision	Maximum Eigen statistics	Decision
CE = 0	97.76291*** (63.87610)	Reject the null	57.07160*** (32.11832)	Reject the null
CE = 1	40.69131 (42.91525)	Do not reject the null	23.72444 (25.82321)	Do not reject the null
CE = 2	16.96687 (25.87211)	Do not reject the null	13.82033 (19.38704)	Do not reject the null
CE = 3	3.146538 (12.51798)	Do not reject the null	3.146538 (12.51798)	Do not reject the null

Note: The null tests the number of cointegrating equation(s) (CE). Values in "()" parenthesis are the associated 5% critical values of the respective statistics. *** indicates 1% level of significance.

5.0 Discussion of Results

In this study, we are concerned with the analysis of the US energy and commodity markets dynamics where we subject the ensuing multivariate model to oil production shocks; namely shocks from total and shale oil production. We adopt the structural VAR (SVAR hereinafter) framework to trace the shock transmission mechanism from these sources of oil supply shocks through oil price fluctuations to commodity prices (all-commodity and nonfuel-commodity prices). As instructed in Breitung, (1998), we are guided by relevant theoretical constructs in our specification of the SVAR model dynamics. In essence, we dealt with a recursive SVAR where we impose relevant restrictions to trace the source, put differently, the cause of the shock in the VAR system to oil supply shocks. Based on the instantaneous impacts associated with the interrelationship between oil supply and oil price and the direct spill over to commodity prices, we work with a short SVAR, where current values of the variables affect each other to show contemporaneous effects of the shock passthrough.

Our VAR model is therefore a recursive dynamic structural model where commodity prices depend on oil price and oil supply shocks in that order. In line with the extant literature in this area (for example Kilian, 2007; Edelstein and Kilian, 2009; Kilian, 2011; Innoue and Kilian, 2012; and others), we apply the SVAR methodology to achieve three major feats. First, we produce the graphical representations of the impulse response functions (hereafter, IRFs) to show the average responses of the target variables (oil price and commodity prices) to structural shocks from oil production. Second, we construct forecast error variance decompositions (hereafter, FEVDs) to measure the average contribution of the structural shock across the system. Third, we generate historical decompositions (hereafter, HDs) to determine the cumulative contribution of the structural shocks to the evolution of the target variables over time. We focus on shale supply shocks and follow it up with total oil production shocks for robustness. We attend to the foregoing in the listed order in subsequent sections.

5.1 The Impulse Response Functions

We begin the analysis by assessing the tools that tell us how the oil supply shocks reverberate through the SVAR system. The IRFs partly assist in this regard (see Figures 2.1 to 2.6). In simple language, the IRFs measure the effects of these oil supply shocks on the other endogenous (target) variables. More technically, the IRFs show the effect of these (oil production) shocks on the adjustment path of the target variables. The IRFs capturing the total oil supply shock transmission are contained in Figures 2.1 to 2.3 while Figures 2.4 to 2.6 capture the IRFs for shocks emanating from shale oil revolution. The impacts of the two shocks on the target variables differ; the effects of the shale supply shocks stayed longer before dying out and it is more lasting on nonfuel commodity prices than the commodity price with energy component. Another major difference is that the total US oil supply shock evoke instant negative then positive responses from the international oil price and subsequently depresses both all-commodity and nonfuel-commodity prices before dying out around 6th and 7th period. On the other hand, the US shale oil production shock to induce negative responses of almost equal magnitude from both oil price and all-commodity price while nonfuel-commodity prices receive greater and more lasting negative response from the shale structural shock. The foregoing reveals the strength of the US energy sector in transmitting shocks that could alter the world oil price; but the shale revolution, rather than the conventional US oil supply, is responsible for the oil price plunge. We seek further insights from the forecast error variance decompositions in the next section.

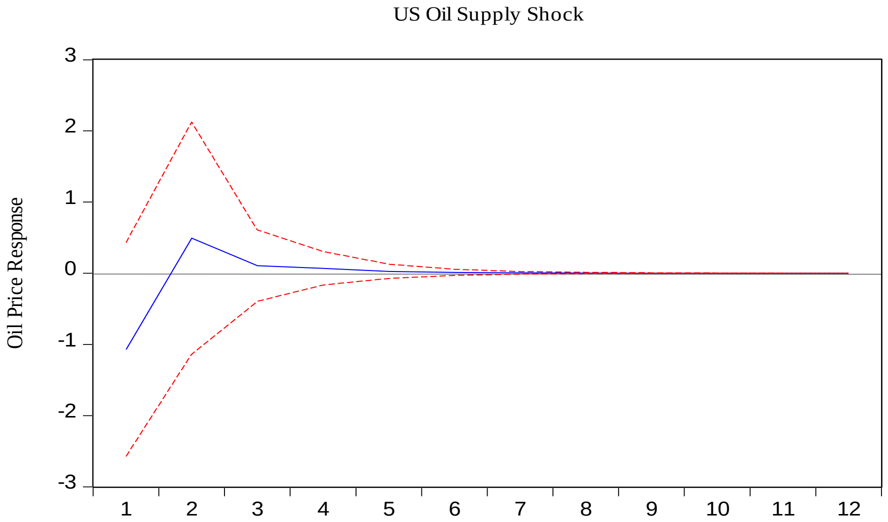


Figure 2.1: Oil price response to US oil supply shocks

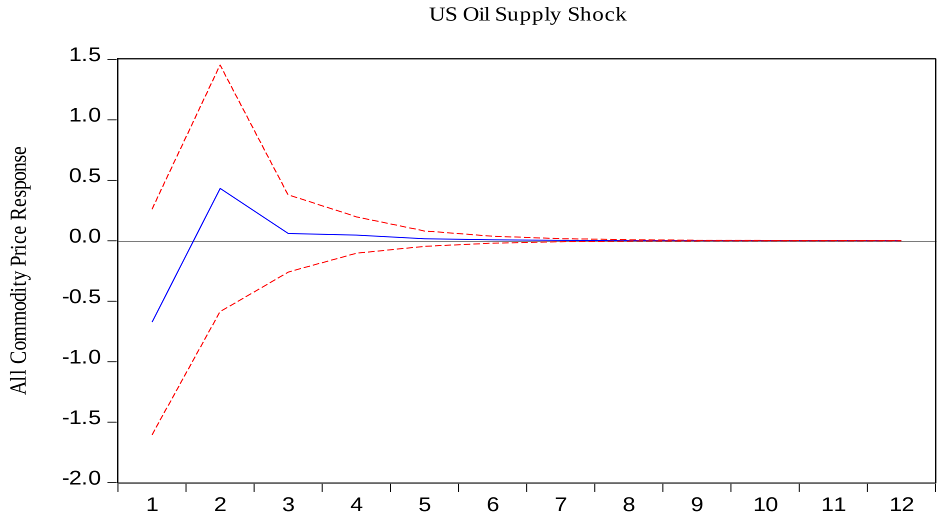


Figure 2.2: All commodity price response to US oil supply shocks

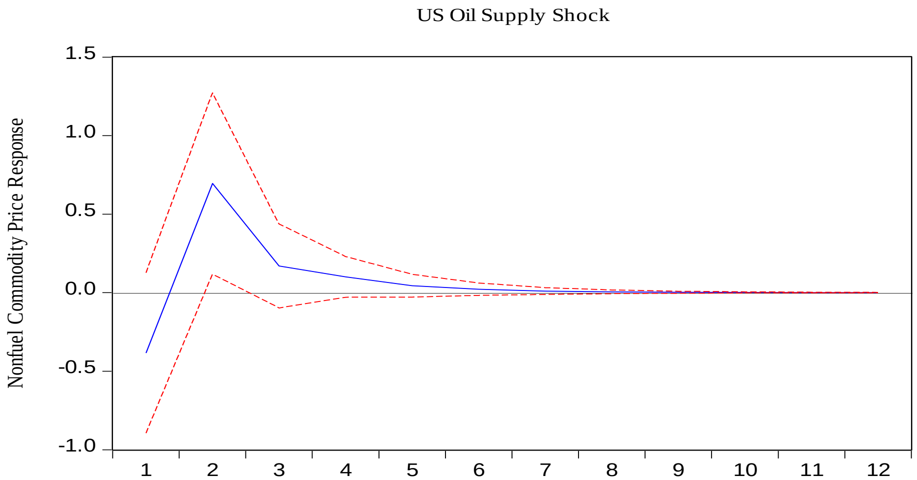


Figure 2.3: Nonfuel commodity price response to US oil supply shocks

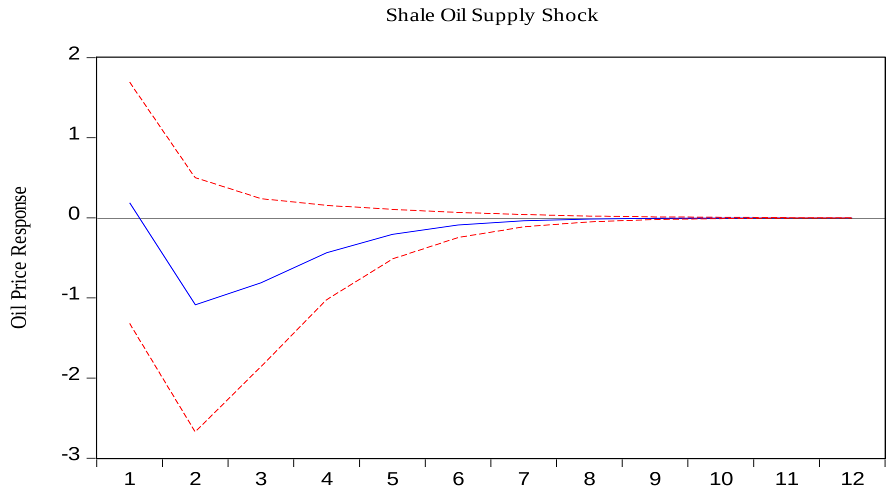


Figure 2.4: Oil price response to US shale supply shocks

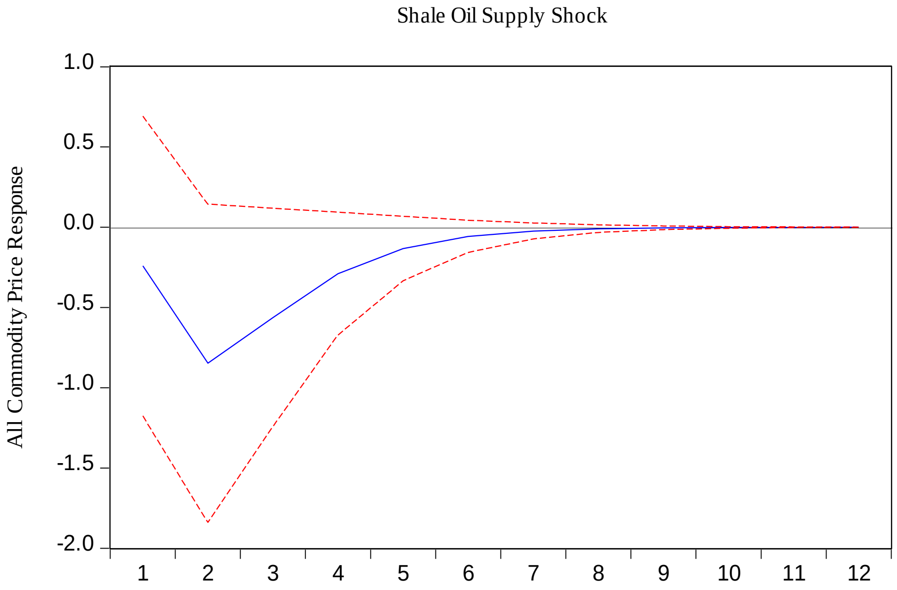


Figure 2.5: All commodity price response to US shale supply shocks

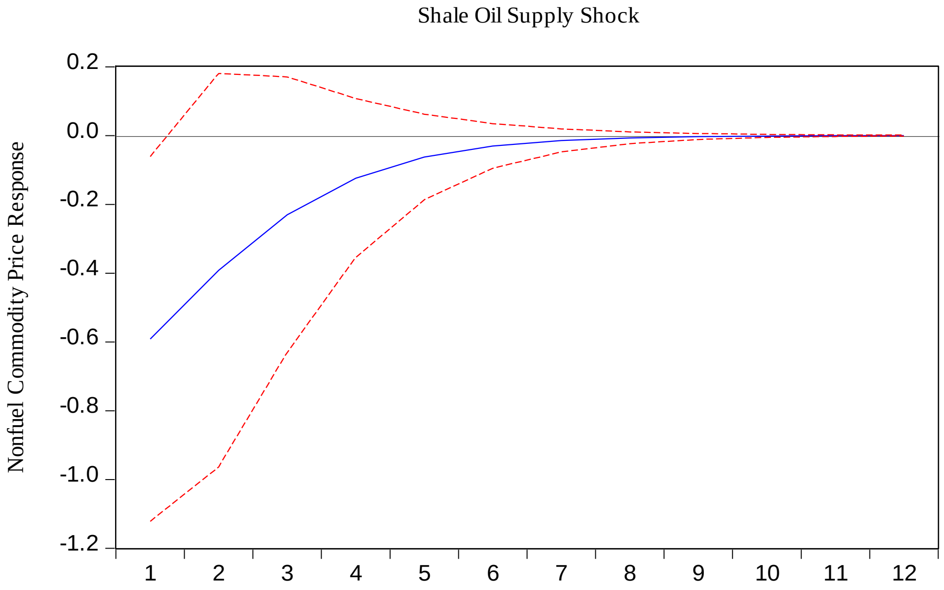


Figure 2.6: Nonfuel commodity price response to US shale supply shocks

5.2 The forecast error variance decompositions

To further shed light on the total and shale oil supply shocks transmission, we turn to the FEVDs (see Tables 5a,b & 6a,b). Like the IRFs, the FEVD serve as a supporting tool to assess the shock transmission through the VAR system. In our specific case, the FEVD measures the contribution of the orthogonal (uncorrelated) forecast error variance of the oil supply shocks attributable to itself or to the other variables (oil price and commodity prices). Table 5 a & b represents the FEVDs results for the transmission of shocks emanating from US oil supply shock through oil price to all-commodity price and nonfuel-commodity price respectively. These results show that conventional oil shock accounts for predominant variation of own shock with infinitesimal spill-over to either oil price or commodity prices. Also, results from Tables 6 a & b show overwhelming prevalence of own shock in the variance decomposition of shale oil supply shock. The implication of these results is that oil shocks are only slightly transmitted to the international oil price and commodity prices.

Table 5a: Variance decomposition of shock transmission from oil supply to oil price and all commodity prices

Period	S.E.	Shock1 (US Oil)	Shock2 (Oil price)	Shock3 (ComP_all)
1	3.074889	100.0000	0.000000	0.000000
2	3.127409	99.62445	0.337854	0.037697
3	3.128956	99.59839	0.356106	0.045507
4	3.129123	99.59100	0.361819	0.047181
5	3.129141	99.58985	0.362667	0.047483
6	3.129145	99.58963	0.362835	0.047539
7	3.129145	99.58959	0.362864	0.047549
8	3.129146	99.58958	0.362870	0.047551
9	3.129146	99.58958	0.362871	0.047551
10	3.129146	99.58958	0.362871	0.047551
11	3.129146	99.58958	0.362871	0.047551
12	3.129146	99.58958	0.362871	0.047551

Table 5b: Variance decomposition of shock transmission from oil supply to oil price and nonfuel commodity prices

Period	S.E.	Shock1 (US Oil)	Shock2 (Oil price)	Shock3 (ComP_nonfuel)
1	3.067442	100.0000	0.000000	0.000000
2	3.127108	99.31972	0.263660	0.416621
3	3.128579	99.24886	0.297438	0.453700
4	3.129016	99.22720	0.307783	0.465013
5	3.129093	99.22257	0.310079	0.467347
6	3.129112	99.22147	0.310631	0.467901
7	3.129116	99.22121	0.310759	0.468028
8	3.129117	99.22115	0.310789	0.468058
9	3.129117	99.22114	0.310796	0.468065
10	3.129117	99.22114	0.310798	0.468066
11	3.129117	99.22114	0.310798	0.468067
12	3.129117	99.22113	0.310798	0.468067

Table 6a: Variance decomposition of shock transmission from shale oil supply to oil price and all-commodity prices

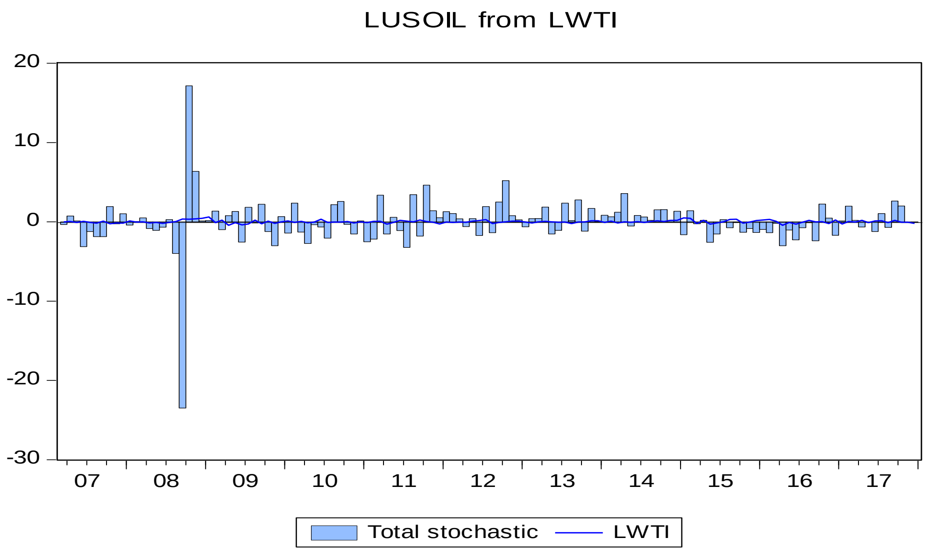
Period	S.E.	Shock1 (Shale Oil)	Shock2 (Oil price)	Shock3 (ComP_all)
1	1.706561	100.0000	0.000000	0.000000
2	1.776945	99.73143	0.055640	0.212930
3	1.782369	99.64030	0.093865	0.265838
4	1.782802	99.61867	0.106329	0.275003
5	1.782847	99.61431	0.109284	0.276407
6	1.782854	99.61352	0.109874	0.276610
7	1.782856	99.61338	0.109980	0.276638
8	1.782856	99.61336	0.109997	0.276642
9	1.782856	99.61336	0.110000	0.276643
10	1.782856	99.61336	0.110000	0.276643
11	1.782856	99.61336	0.110000	0.276643
12	1.782856	99.61336	0.110001	0.276643

Table 6b: Variance decomposition of shock transmission from shale oil supply to oil price and nonfuel-commodity prices

Period	S.E.	Shock1 (Shale Oil)	Shock2 (Oil price)	Shock3 (ComP_nonfuel)
1	1.708363	100.0000	0.000000	0.000000
2	1.777296	99.89912	0.078716	0.022164
3	1.782503	99.86815	0.106168	0.025681
4	1.782880	99.86212	0.112042	0.025839
5	1.782906	99.86106	0.113104	0.025840
6	1.782909	99.86086	0.113287	0.025851
7	1.782909	99.86082	0.113318	0.025857
8	1.782909	99.86082	0.113324	0.025859
9	1.782909	99.86082	0.113325	0.025860
10	1.782909	99.86082	0.113325	0.025860
11	1.782909	99.86082	0.113325	0.025860
12	1.782909	99.86082	0.113325	0.025860

5.3 The historical decompositions

Building on the previous discussions, which situate shale revolution as a relevant shock in the evolution path of oil and commodity prices, we extend our analysis to cover information provided by the historical decompositions (as obtained in Figures 3.4 and 3.6). for robustness, we are also concerned with the historical decompositions emanating from the total oil shock (see Figures 3.1 to 3.3). By definition, the historical decompositions show the extent to which the structural shocks (either from the total US oil production or the shale revolution) explains the historical fluctuations in the endogenous variables (oil price and the all- and nonfuel-commodity prices). In other words, we use the HD to trace the genesis of the shock impacts on the endogenous variables and therefore provide information on the cumulative effect of the shale oil supply shock on each of the endogenous variables. Findings appear to corroborate FEVDs where the oil shocks explain marginal fluctuations in the international oil price and commodity prices.


LUSOIL from LWTI
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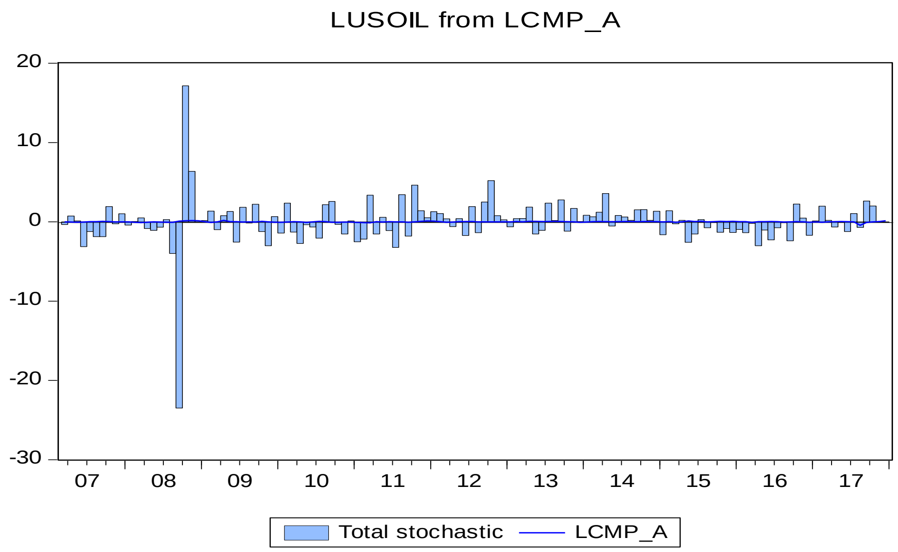
07 08 09 10 11 12 13 14 15 16 17
Total stochastic
LWTI


LUSOIL from LCMP_A
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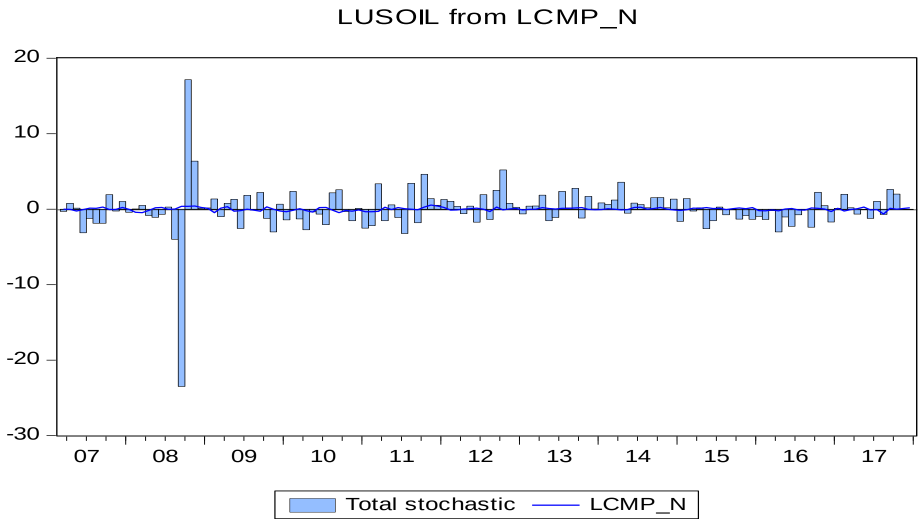
Total stochastic
LCMP_A


LUSOIL from LCMP_N
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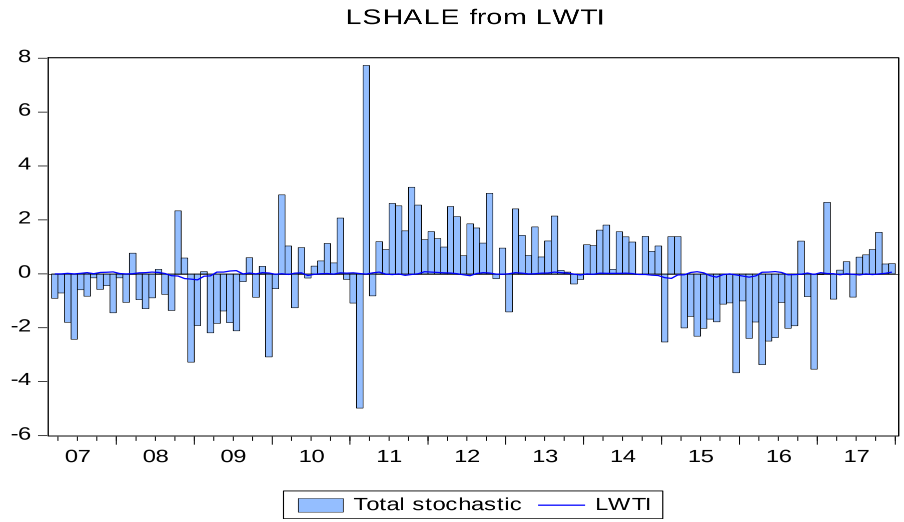
07 08 09 10 11 12 13 14 15 16 17
Total stochastic
LCMP_N


LSHALE from LWTI
8
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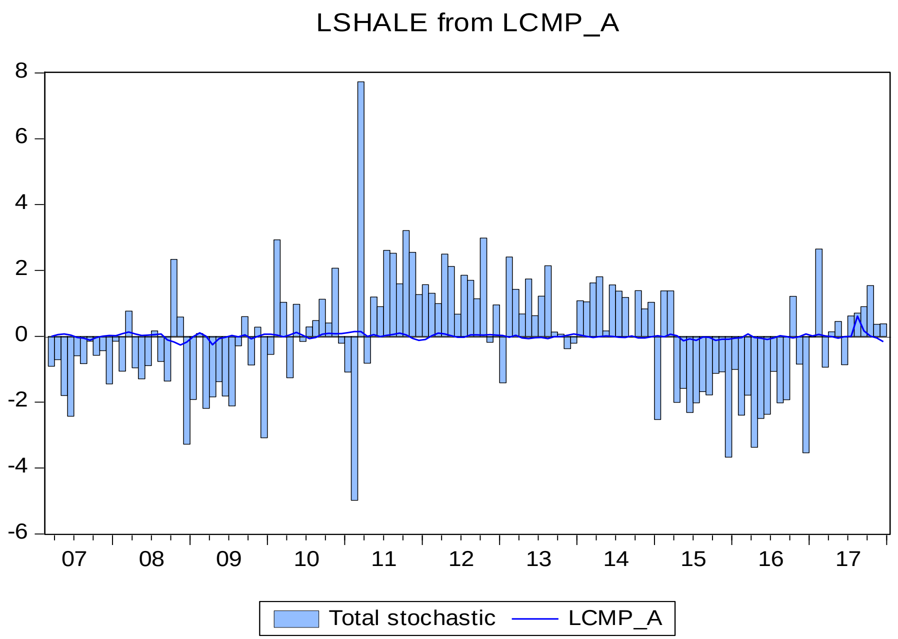
07 08 09 10 11 12 13 14 15 16 17
Total stochastic
LWTI


LSHALE from LCMP_A
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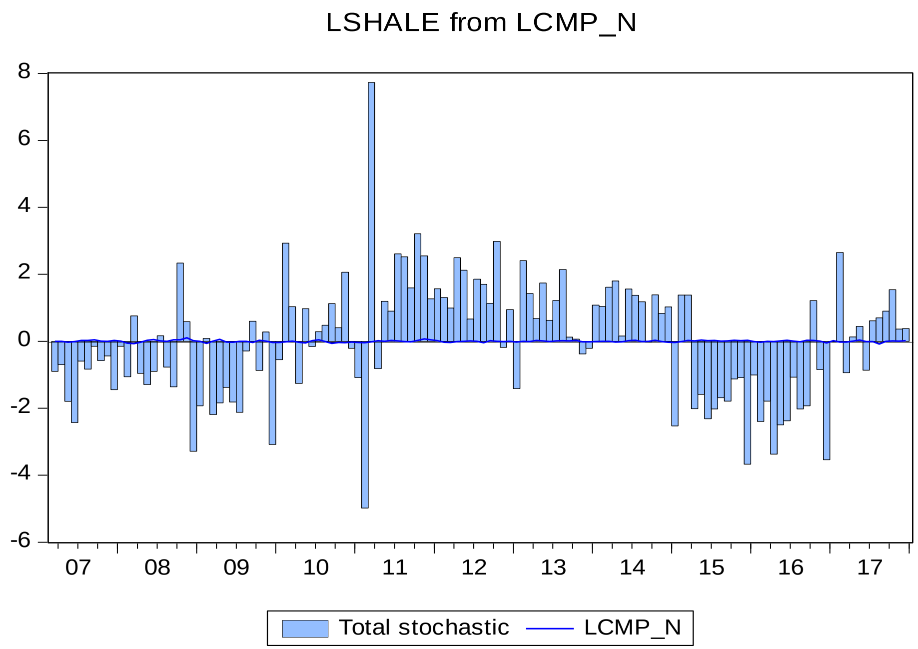
Total stochastic
LCMP_A


LSHALE from LCMP_N
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Total stochastic
LCMP_N

6.0 Conclusion

The United States has committed to technological improvements to in its drive of toppling the world's leading oil producer, by the mid-2020s and evolving into a net oil exporter by 2030. The resulting technological change in the oil and gas extractive industry has among others sped-up the rate of production in the US; has seen a surge in the US domestic oil production; responsible for all-time low US oil imports from OPEC; and enhanced employment and income generation in resource-rich communities. Based on these attractions around the shale oil revolution, we extend discussion from a body of literature (e.g. Kilian, 2009; Hamilton, 2014; Arezki and Blanchard, 2015; Mănescu and Nuño, 2015; Baumeister and Kilian, 2016; Ansari, 2017; Kilian 2017; Bataa and Park, 2017; Bataa, et al. 2017) linking the recent oil price tumble to the US shale revolution by capturing the possible spill over of such disturbances to commodity prices. Hence, we work with a structural VAR model that trace the recursive transmission dynamics from the oil supply shocks through oil price linkage with fundamentals in the commodity market. In this exercise, we explore the impulse response, forecast-error variance decomposition and historical decomposition functions for the total and shale US oil production shocks. We provide robust empirical evidences to show that the shale revolution, rather than the total US oil supply shocks, is associated with the recent oil price plunge while both oil supply shocks are associated with mild shock spill over to all- and nonfuel-commodity prices.

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