IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2020, 10(4), 1-8.

Did the US Shale Oil Revolution Ruin Oil Industry Stock Market Returns?

Samuel D. Barrows*

KIMEP University, College of Social Sciences, Almaty, Kazakhstan. *Email: sam_barrows@yahoo.com

Received: 04 January 2020 **Accepted:** 19 April 2020 **DOI:** https://doi.org/10.32479/ijeep.9171

ABSTRACT

The stock market performance of the US oil industry is evaluated against a combination of benchmarks before and after the US shale oil revolution, in order to ascertain whether the increase in US shale oil production had an adverse impact on oil industry stock market returns. In 2014, the dynamic of the global crude oil supply-demand situation was such that the oil price fell because of the increased US crude oil production. Saudi Arabia and the other major producers preferred to have low oil prices, at least temporarily, in order to penalize the US shale oil players. Any oil price increase since then is seen as leading to an increase in US crude oil supply which then further reduces oil prices. The oil industry outperformed the benchmarks prior to the ramp up of US crude oil production led by the shale oil revolution, but the industry underperformed the benchmarks after these production increases. Hence, the US shale oil revolution did ruin the oil industry stock market returns. Several topics for discussion are included: The US shale oil revolution; world crude oil markets; crude oil price dynamics in the US; and crude oil price impacts on oil companies.

Keywords: Shale Oil Revolution, Crude Oil Price, Oil and Gas Industry, Stock Market Returns
JEL Classifications: Q32, Q41, Q43

1. INTRODUCTION

In 1946, US crude oil production was at 4.75 million barrels per day (mbpd), and after a continuous two-decade production increase, US crude oil production peaked at 9.64 mbpd in 1970 (EIAProd, 2019). Following significant development and project work, including the construction of the Trans-Alaskan pipeline, the Alaskan North Slope full field development saw significant increases in production in the state of Alaska during the late 1970s and peaked in 1988 at 2.02 mbpd (EIAAlaska, 2019). Despite the success in Alaska, crude oil production in the US continued its long decline hitting 5.00 mbpd in 2008, the lowest level since 1946 (EIAProd, 2019). When looking at conventional production resources, the picture was one in decline. However, shale oil production, also known as tight sands, and classified as unconventional production resources, was on an upsurge, from 373 thousand barrels per day (kbpd) in 2003, shale oil hit 554 kbpd in 2008, a 20% increase from 2007 (EIAShale, 2019). All was not lost in the US oil industry at this point in time, even though this may not have been apparent to outside observers.

2. LITERATURE REVIEW

2.1. The US Shale Oil Revolution

The technologies behind the US shale oil revolution, known as hydraulic fracturing or more simply "fracking" were initially implemented in the Barnett shale oil play in north central Texas in 1991 (Bahgat, 2014). Hydraulic fracturing is a method which pumps sand, water, and chemicals at high pressure in order to fracture the shale formation to allow oil and gas to flow from the shale rock (Ansari, 2017). Discoveries which led to the industrial operation of technologies relevant to fracking were initially based on "government funded research" then were "further developed by private oil companies" over a number of years (Bahgat, 2014).

Because of "several breakthrough innovations in technology (hydraulic fracturing, horizontal drilling, 3-D seismic survey, etc.)," commercial applications were successful in unlocking the shale formations which held "light oil with low sulphur content" (Malanichev, 2017). Many refiners prefer light oils as they produce a higher proportion of gasoline and diesel, which have more favorable economics for them (Melek et al., 2017). The existence of "thousands of independent oil companies" working on this technological frontier in conjunction with eager and flexible funding sources meant that entrepreneurial solutions were implemented (Salameh, 2013). Ambitious service companies were also important as they helped to execute many of these solutions (Malanichev, 2017).

These operating and service companies utilized continuous improvement methods in order to remain cost competitive. Through these improvements, field production levels could be increased "in as few as 6 months at a small fraction of the capital investment required by their conventional rivals" (Hartmann and Sam, 2016). Other factors impacting the entrepreneurial environment included: "competitive oilfield services markets, the largest drilling rig fleet, an established institution of private land and subsoil ownership, investment and tax incentives for developing low-yield wells, advanced transport infrastructure, environmental requirements favorable for hydraulic fracturing, efficient financial markets including stock exchange insurance tools" (Malanichev, 2018). The US, property rights in many locations allow for ownership of mineral resources, which is different than what exists in many other countries (Maugeri, 2013; Salameh, 2013). As a side note, shale oil plays are usually found in "sparsely populated areas of non-agricultural states" (Malanichev, 2018).

One major factor for success in the shale oil plays is the performance of drilling rigs with the US drilling rig productivity having increased by a factor of 15 between the years 2007 and 2017 (Malanichev, 2017). In addition, the supply of active rigs in the US in 2012 was "more than the rest of the world combined" with the result that in the US there were more than 6 times the number of completed wells than in the rest of the world that year (Maugeri, 2013). The other major factor for the success of the shale oil developments is the amount of reserves which can be technically recoverable (Malanichev, 2018). Technically recoverable shale oil resources for the US are estimated at 58 billion barrels with those outside the US estimated at 287 billion barrels (EIAWorld, 2014). One unfortunate dynamic of shale crude oil production is the steep production declines in comparison to convention crude oil production, with an average of 50% during the 1st year of production in the three biggest shale oil plays which mandates the use of multiple rigs drilling multiple wells to counter this dynamic (Maugeri, 2013).

The US shale oil revolution was, initially at least, driven by smaller, more nimble players (Salameh, 2013). These smaller players "typically search for high-risk, high-reward opportunities"; this is in comparison to "big oil" companies which typically "pursue opportunities based on an established, more risk-averse financial framework," and as a result "big oil" holdings tend to be "large, mature oil" fields which provide a more stable production profile (Maugeri, 2013). The success of these shale oil players not only halted the decline in the US crude oil production, but generated significant production increases year after year (Langer et al., 2016). With the success of the shale oil production plays, several "big oil" players have acquired several of the shale oil players (Maugeri, 2013).

The jump in 2008 of the US shale crude oil production "was a surprise to many analysts" (Baumeister and Kilian, 2016). The expectation was that barring "higher prices, no one would be chasing shale oil" (Salameh, 2013). Crude oil prices had been on a long uptrend since the low in December of 1998 with WTI at $11 per barrel and Brent at <$10 then despite the crash in 2008 and 2009, oil prices rose again and averaged above $95 from 2011 through 2014 (EIAWTI, 2019). With price as a driver, US shale production grew by more than 7.5 times between 2009 and 2015 (EIAShale, 2019). As one study noted, "strong oil prices have played their role in this regard" (Abadie and Chamorro, 2017). For more information, Figure 1 for US crude oil production versus WTI crude oil price in the Appendix.

2.2. World Crude Oil Markets

There are two major crude oil price markers in the world: West Texas intermediate (WTI) in the US and Brent in the UK; WTI is a light crude oil with an API gravity above 39 degrees and is classified as sweet because of its low sulphur reading of <0.5% (SPGlobal, 2019). Brent is also a light crude oil with an API gravity above 39 degrees with a sulphur reading of <0.5% and is produced in the North Sea (Exxon, 2018). Access to WTI through Cushing, Oklahoma, which is the trading point for WTI, is open to traders with a typically-sized cargo at 30,000 barrels (Fattouh, 2011). Cargoes in the North Sea physically connected to the Brent posting are typically-sized at 600,000 barrels (Exxon, 2018). Consequently, there are fewer barriers to entry in the physical WTI market as compared to the loadings physically connected to the Brent posting which allows WTI to have a "greater diversity of participants" (Liu et al., 2015).

The pricing of seventy percent of global crude oil production is based off of Brent, with WTI having the remaining thirty percent (Fielden, 2013). In turn, the two crude markers "serve as benchmarks for the pricing of other crude" oils and tend to react in similar dynamics to world events, "as global demand increases or supply decreases, the price of crude oil increasesm," the opposite can also be assumed (Bennett, 2015). Crude oil prices in various regions move in a concerted manner (Gulen, 1999). Overall, with regard to crude oil markets, they "are integrated in a global way" (Liao et al., 2014). As such, they are affected by a wide variety of influences such as inventories, supply, demand, dollar strength, in addition to "interest rates, political decisions, embargoes, import quotas and speculative motives" (Obadi and Gardonova, 2019). However, the primary driver is the state of the "global business cycle" (Baumeister and Kilian, 2016).

Saudi Arabia, with spare production capacity has historically played the role of a swing producer in order to exert some control on market dynamics and achieve some price stability (Hartmann and Sam, 2016). A swing producer would be expected to raise or lower production in order to counteract increasing or decreasing market price dynamics, respectively. This changed in 2011, during the "post Arab spring environment," with Saudi Arabia refusing to limit its production, as its hope was to make the US "shale oil production unprofitable" (Akacem and Pence, 2016).

The vibrant US shale crude oil production is seen "as an additional source of energy" which is significant in that it is seen as lowering the likelihood of extreme price fluctuations (Obadi and Gardonova, 2019). In 2018, the US became the world's largest crude oil producer, surpassing both Saudi Arabia and Russia (DOE, 2018). In 2018, the daily average US crude oil production was at 10.99 mbpd, more than double what it was just 10 years earlier in 2008, and in 2019, it exceeded 12 mbpd for the first time, peaking at 12.90 mbpd beginning in November of 2019 (EIAProd, 2019). Much of the volume increase was due to shale oil production, with a daily average exceeding 6.5 mbpd in 2018 then peaking above 8.1 mbpd beginning in November of 2019 (EIAShale, 2019). Because of the shale oil revolution and the growth in US crude oil production, the US has replaced Saudi Arabia as the world's swing oil producer as the US can ramp up production as prices increase "to help moderate shocks to oil supply and demand" (Newell and Priest, 2017). Such was the impact of the increase in US crude oil production, it raised the level of real GDP for the US between 2010 and 2015 by 1 percent and reduced the crude oil trade balance as a share of GDP by 1 percent as well (Melek et al., 2018).

In 2014, Brent oil prices fell from an average above $111 per barrel in June to $62 in December. With regard to the price decline in 2014, one study provides "the first quantitative analysis of the $49 drop in Brent price" in the second half of that year (Baumeister and Kilian, 2016). The study quantifies that drop as: $11-based on a decline in the global economy in June; $16-based on an increase in crude oil production in July; $9-based on crude oil storage demand in July; and $13-based on a further weakening of the global economy in December. Oil prices continued their fall, hitting $30 in early 2016 (EIABrent, 2019; EIAWTI, 2019). One study confirms the obvious link between shale oil supply and prices finding that an "increase in light oil supply causes light oil prices and fuel prices to fall" (Melek et al., 2018).

2.3. Crude Oil Price Dynamics in the US

WTI is marginally a lighter and sweeter grade as compared to Brent. Historically, before 2011, WTI would be expected to receive a higher price, both in the physical and futures markets. However, both crudes would typically trade within one to two dollars of each other unless there was some supply issue affecting one and not the other which might temporarily increase this differential; this all changed in 2011 when Brent saw an average positive differential to WTI of $15 per barrel (EIABrent, 2019; EIAWTI, 2019). From this point on, "WTI was trading at a large discount to Brent" (Liao et al., 2014). The main reason for this dynamic is the lack of adequate pipeline capacity to exit the Cushing inventory storage facilities (Akacem and Pence, 2016). Specifically, the crude oil was primarily expected to go "to the refineries on the US Gulf Coast" (Liu et al., 2015).

Typically, the major refiners in the US target the processing of heavy crude oil, more so than the rest of the world, because it is cheaper than lighter crude oils (Melek et al., 2018). The increase in shale crude oil production underlined the divergence between a supply of growing light crude oil production and a limited demand because of refinery configurations which were geared to other crude oil grades (Langer et al., 2016). The result: WTI being priced below Brent and other similar crude oil grades (Melek et al., 2018).

Related to insufficient infrastructure was the fact that during this time, the US had a crude oil export ban in place (Maugeri, 2013). Because of the export ban on crude oil, US refiners could buy crude oil at a discount and export the refined products since there was no ban on refined products (Bihani, 2018). The result was that "by 2011 the United States had become a net exporter" of refined products (Melek et al., 2018). After some deliberation with refiners wanting the crude oil export ban in place and crude oil producers wanting the cancellation of the ban stating the potential for increases in investments, jobs, and crude oil production, the ban was lifted in December of 2015 (Bihani, 2018).

As the export ban was lifted, the Brent to WTI annual average differential initially narrowed to $0.35 in 2016 compared to $3.66 in 2015. However, it began rising again to $3.33 in 2017, $6.11 in 2018, and $7.30 in 2019 due to the increases in US crude oil production and the remaining transportation bottlenecks still in place (EIABrent, 2019; EIAWTI, 2019). Table 1 on annual crude oil prices in the Appendix for more information.

2.4. Crude Oil Price Impacts on Oil Companies

Due to oil's preeminent position in the world economy, historically, crude oil prices are more volatile than other commodities with asymmetric impacts on future movements as "negative shocks lead to higher subsequent volatility than positive shocks" (Ural, 2016). The increases in US shale oil production influenced the world markets "and was a key factor in the reduction of oil prices in 2014" (Malanichev, 2018). As prices fell, further cost optimizations were made which reduced the production costs by more than 50% in the Permian midland area of West Texas (Malanichev, 2017). Due to cash requirements of the shale players, despite the fall in oil price, they kept production up as high "as possible to service their debt" (Laughlin, 2016). This allowed for the survival of these frontier players.

With regard to the link between crude oil prices and negative stock market performances, there have been a few studies on the topic. One historical study from the postwar period from 1947 through 1991 testing for causal impacts on stock markets based on oil price shocks finds that "the reaction of United States and Canadian stock prices to oil shocks can be completely accounted for by the impact of these shocks on real cash flows alone" (Jones and Kaul, 1996). The volatility around oil price movements have a direct impact in the economy as it "increases unemployment and inflation, and decreases economic growth" (Ural, 2016). These impacts can be felt at the elementary level, as oil prices have risen, "business costs have risen" as a direct result (Pirog, 2005). Another study using vector auto regression finds that both oil price levels and oil price volatility negatively impact stock market returns, especially after 1986 (Sadorsky, 1999). A more recent study of G7

Table 1: Comparison of cases

Time period cases	US market	WTI market
2002-2010	X	
2002-2010		X
2002-2010	X	X
2011-2019	X	
2011-2019		X
2011-2019	X	X

countries finds that "stock market volatility does not respond to oil supply shocks" but that "demand shocks impact significantly on the volatility of the G7 stock markets" (Bastianin et al., 2016). Another study confirms this dynamic and finds that oil "demand shocks positively affect the correlations between oil prices and stock market returns," both "during and after" the 2007-2008 time period and as a result "of uncertainties about Chinese economic growth in 2015" (Nadal et al., 2017).

With regard to impacts on other countries, one study conducts bilateral return and volatility spillover analysis in an effort to link the WTI prices to Russian stock market returns when eleven oil and gas companies in 2008 comprised 55% of the stock market capitalization (Bharn and Nikolova, 2010). The study confirms the positive link between oil price and stock market returns plus oil price spikes and stock market volatility because of the high exposure of oil companies in the index. Another study assesses the Australian stock market and oil price impacts from 1983 to 1996 and finds that the oil price negative impacts are felt in the stock market, and across some industries, but with "significant positive oil price sensitivity in the oil and gas" industry (Faff and Brailsford, 1999).

At a more basic level, the crude oil price relationship to oil company performance can be seen in the impacts on cash flow. One study finds that the price of crude oil is one of the "major determinants of cash flow" and companies tend to reduce investments when there are "reduced cash flow" periods (Arora, 2015). Another study confirms the price of crude oil as "one of the key determinants of oil industry activity" (Barrows, 2018). In Canada, one study confirms this oil price link to oil company stock market performance as it assesses the factors impacting Canadian oil and gas company stock market returns and finds a positive link between crude oil price and stock market performance (Boyer and Filion, 2007). Another study finds the relationship between the changes in oil price and the US oil and gas industry stock market returns to be positive and significant, but impacts may vary somewhat among subsectors of the industry (Mohanty and Nandha, 2011). The rise in oil prices after 2003 had an impact on the oil industry in general, but specifically, their "profits have increased" as a result during this period (Pirog, 2005). Another study assessing 1990-2008 finds that oil prices have a positive and significant impact on the financial performance of North American oil and gas companies with the great financial crisis having a larger impact than either the Asian financial crisis or the 9/11 events (Dayanandan and Donker, 2011).

With regard to oil price shocks, or spikes, a study assessed the links between WTI prices and the company performance of 54 US oil and gas companies during 1986-2008. It confirms the oil price volatility dynamic finding that both stock market "returns and risks are influenced significantly by oil price declines" more so than by oil price increases and the impacts are registered on market beta, oil beta, and stock market return variances (Mohanty et al., 2013). The study also find that larger oil and gas firms typically have lower oil betas than smaller firms. With regard to the larger firms, those in the S&P 500, the 32 oil and gas companies in the S&P 500 had $91 billion in profits in 2014, then after the fall in oil prices, those companies lost $46 billion in 2015 (Laughlin, 2016). During this time period, impacts continued to be felt in the oil and gas industry. The S&P global oil index fell 52% between June 2014 and January 2016 and between January 2015 and May 2016, "there were 77 North American energy bankruptcies" (Laughlin, 2016).

3. METHODOLOGY

Using company stock market returns is a common technique to gauge company performance. For investors, it is perhaps the most relevant. The stock market performance assessment used in this study utilizes the stock price total return monthly percent change format. For purposes here, the S&P oil and gas exploration and production select industry total return index, also known as SPSIOPTR, is selected as it includes most of the major relevant companies in the US energy industry (Bloomberg, 2019). The industry performance as measured by this index is assessed before and after the US shale oil revolution.

To assess the start of the US shale oil revolution, 2 time periods are selected: 2002-2010 and 2011-2019. The 2002-2010 period had a net US crude oil production decline of 4.5% even though the shale oil production rose by 119% during the period. The 2011-2019 period had a net US crude oil production increase of 116% with a shale oil production increase of 491%. When comparing the average production for each period, the US crude oil production for the 2011-2019 period increased by 65% compared to the 2002-2010 period and the shale oil production increased 776% during the same time period. Figure 1 in the Appendix: it displays this change graphically as the incline in shale production takes off in 2011 with a 57% increase over the previous year. Also, Table 2 in the Appendix on annual US crude oil production for more information.

In order to adjust the results to provide more meaningful comparisons, two comparative benchmarks are used. The first is the US stock market total return prices from the Center for Research in Securities Prices, also known as CRSP (Dartmouth, 2019). The second is the WTI market which is the relevant marker crude to assess the price dynamics for the shale crude oil production (EIAWTI, 2019). Both benchmarks exclude the US 1 month treasury-bill rate, which is deemed as the risk-free rate. Regressions are performed which allow assessments in a variety of cases. A study on the shipping industry utilized similar analysis techniques relating to an index which forecasts the utilization of vessels (Barrows, 2019).

The research question is: Did the US shale oil revolution ruin the oil industry stock market returns? The objective of this study is to evaluate the stock market returns between the 2 time periods. The stock price total return of the portfolios is the dependent variable in this analysis. The independent variables are the benchmarks. The basis of the research is classified as causal and correlational. The intent is to determine if there is a causal connection then quantify the relationship of the stock price total return performance of the 2 time periods to the various benchmarks. To further explore this topic and focus on quantifying the research question, two hypotheses are considered.

H_1: The 2002-2010 period is superior to the benchmarks in a majority of the three cases.
H_2: The 2011-2019 period is inferior to the benchmarks in a majority of the three cases.

The index performance during the 2 time periods is compared to the benchmarks and these comparisons utilize a version of the Fama and French three-factor model and a more basic two-factor model (Fama and French, 1993). The intent is to evaluate the long-run abnormal returns of the index less the long-run returns of the benchmarks (Barber and Lyon, 1997). The formulas used in the analysis are included below with the RF Rate representing the risk free rate.

Three-factor model:

Portfolio-RF rate=α+β(US market-RF rate)+β(WTI-RF rate)

Two-factor model:

Portfolio-RF rate=α+β(US market or WTI)-(RF rate)

This analytical approach utilizes six cases which examine the stock price total return monthly percent changes for the 2 time periods. Each time period includes one three-factor model case and two two-factor model cases. For more information, Table 1 comparison of cases below.

4. RESULTS

In the Table 2 comparison of results, the first measurement displayed is the Y-Intercept. For the cases in this study, the Y-Intercept equates to alpha. If alpha is positive then the index for the time period performed superior in relation to the benchmarks. If alpha is negative then the index for the time period performed inferior in relation to the benchmarks. Results of the cases are included in Table 2.

The alphas (Y intercepts) are positive for cases 1, 2, and 3. These results have the 2002-2010 period as performing superior in comparison to the benchmarks. The alphas are negative for cases 4, 5, and 6. These results have the 2011-2019 period as performing inferior in comparison to the benchmarks. The P-value measurements for the alphas (Y intercept) for the cases against the US market are at a 5% level and a 1% level which indicate the acceptance of the null hypotheses in a statistically significant manner. The P-values for the two cases against the WTI market are not statistically significant, and the P-values for the combination of the two cases with two benchmarks are statistically significant at 10% for the 2002-2010 period and statistically significant at 1% for the 2011-2019 period. With regard to the Adjusted R squared readings, the two cases with the highest readings are the cases utilizing two benchmarks, case 3 at 0.56 and case 6 at 0.57. Case 1 at 0.40 and case 4 at 0.45 which utilized the US market as a benchmark are next followed by case 2 at 0.31 and case 5 at 0.41 which utilized the WTI crude oil price as a benchmark.

Normally, regressions would be run using monthly data, however, when comparing the 1-month data to 2-month data, the 1-month data is much more volatile. When looking at the entire 2002-2019 period, the coefficient of variation is greater for the SPSIOPTR, US market and WTI market for the 1 month data as compared to the 2 month data by 149%, 137%, and 142%, respectively. Using 1-month data provided Adjusted R squared readings that are much lower than would be expected in all cases, including 0.09 and 0.17 for cases 2 and 5, respectively, against WTI instead of 0.31 and 0.41, respectively, using 2-month data. For this reason, all cases utilize 2-month data, and those results are presented in Table 2. Directionally, this does not change the results, but provides for a more meaningful picture of the relationships between the independent and dependent variables.

With regard to the first hypothesis considered, H_1: The 2002-2010 period is superior to the benchmarks in a majority of the three cases, thus the results confirm that the 2002-2010 period is superior to the benchmarks in all of the cases, with the measurement of two of the cases in a statistically significant manner. With regard to the second hypothesis considered, H_2: The 2011-2019 period is inferior to the benchmarks in a majority of the three cases, thus the results confirm that the 2011-2019 period is inferior to the benchmarks in all cases, with the measurement of two of the cases in a statistically significant manner.

There are studies documenting the negative link between crude oil prices and stock market performance (Jones and Kaul, 1996; Sadorsky, 1999; Faff and Brailsford, 1999; Pirog, 2005; Bastianin

Table 2: Comparison of results

Results	Alpha (Y Intercept)	t-stat	Beta one	Beta two	Adj. R2
1. 2002-2010 (US Market)	2.97**	2.49	1.02***		0.40
2. 2002-2010 (WTI)	1.74	1.32	0.48***		0.31
3. 2002-2010 (US market, WTI)	1.79*	1.69	0.83***	0.36***	0.56
4. 2011-2019 (US market)	(4.30)***	(3.20)	1.67***		0.45
5. 2011-2019 (WTI)	(0.65)	(0.51)	0.67***		0.41
6. 2011-2019 (US market, WTI)	(3.19)***	(2.62)	1.16***	0.43***	0.57

*=10%, **=5%, ***=1% denote significance levels

et al., 2016; Ural 2016; Nadal et al., 2017). Given that the slope for oil prices in 2002-2010 is 7.3, the expectation is that stock markets would be performing less than optimal because of rising oil prices. The dynamic in 2011-2019 is quite the opposite where the slope is −6.4. During this time period, stock markets would be expected to soar given the fall in oil prices, not to mention interest rates.

With regard to oil company performance, both financial performance and in the stock market, as it relates to oil prices, there are studies documenting the positive link between the two (Faff and Brailsford, 1999; Pirog, 2005; Boyer and Filion, 2007; Bharn and Nikolova, 2010; Dayanandan and Donker, 2011; Mohanty and Nandha, 2011; Mohanty et al., 2013; Arora, 2015; Laughlin, 2016; Barrows, 2018).

The expectation is that as the crude oil prices rose in the 2002-2010 time period, the oil companies would outperform the US market primarily because of the rise in oil prices which would be expected to help the oil companies and hinder the stock markets. With the fall in crude oil prices in the 2011-2019 time period, the expectation is that the oil companies would underperform the US market primarily because of the fall in oil prices which would be expected to hinder the oil company performance while helping the stock markets. The results of this study confirm these two dynamics.

5. CONCLUSION

Did the US shale oil revolution ruin the oil industry stock market returns? During the last decade, the answer, based on the results of the cases presented in this study, is a resounding yes. The longer term answer might be different, assuming the global demand for crude oil continues to increase, which is a safe bet for the foreseeable future. It is certainly possible that if demand increases faster than supply, the result would be higher prices which would benefit the oil industry.

Moving forward, with the US now a major player in the global crude oil supply picture, new opportunities including increasing exports will provide many of these players with additional revenues. Given that there is still a Brent premium over WTI, even after the cancellation of the export ban, the assumption is that as pipeline infrastructure is further developed, this premium would be reduced or even eliminated. The expectation would be that the shale oil players would then realize further benefits because of these changes.

With regard to the ability of US shale oil players to maintain their enterprises during the increased volatility during the past decade, it should be noted that these players, and the industry which supports them, have become more resilient during this process and are more able to implement cost optimizations and continue their production in the midst of falling oil prices.

REFERENCES

Abadie, L.M., Chamorro, J.M. (2017), Valuation of real options in crude oil production. Energies, 10(8), 2-21.

Akacem, M., Pence, N.E. (2016), The WTI-brent spread: Examining the factors behind it. Business Education Innovation Journal, 7(2), 155-160.

Ansari, D. (2017), OPEC, Saudi Arabia, and the shale revolution: Insights from equilibrium modelling and oil politics. Energy Policy, 111, 166-178.

Arora, S. (2015), Investment decision making in the upstream oil industry: An analysis. The IUP Journal of Business Strategy, 12(1), 40-52.

Bahgat, G. (2014), The shale gas and oil "revolution": Strategic implications for United States policy in the Middle East. The Journal of Social, Political and Economic Studies, 39(2), 219-230.

Barber, B., Lyon, J. (1997), Detecting long-run abnormal stock returns: The empirical power and specification of test statistics. Journal of Financial Economics, 43, 341-372.

Barrows, S. (2018), Are oil industry mergers becoming less profitable? International Journal of Energy Economics and Policy, 8(2), 28-31.

Barrows, S. (2019), Are bulk/container shipping companies improving compared to the Baltic dry index? Asian Social Science, 15(12), 5539.

Bastianin, A., Conti, F., Manera, M. (2016), The impacts of oil price shocks on stock market volatility: Evidence from the G7 countries. Energy Policy, 98, 160-169.

Baumeister, C., Kilian, L. (2016), Forty years of oil price fluctuations: Why the price of oil may still surprise us. Journal of Economic Perspectives, 30(1), 139-160.

Bennett, J. (2015), Behind the Signs: Factors That Affect Gasoline Prices. Inside the Vault. Vol. 20. Spring. Available from: https://www.stlouisfed.org/publications/inside-the-vault/spring-2015/behind-the-signs. [Last accessed on 2019 Dec 20].

Bharn, R., Nikolova, B. (2010), Global oil prices, oil industry and equity returns: Russian experience. Scottish Journal of Political Economy, 57(2), 169-186.

Bihani, A.D. (2018), The effects of lifting the U.S. oil export ban on market equilibrium. Journal of Petroleum Resources Economics, 1, 1-5.

Bloomberg. (2019), S&P Oil and Gas Exploration and Production Select Industry TR (SPSIOPTR) Data. Available from: https://www.bloomberg terminal. [Last accessed on 2019 Dec 18].

Boyer, M.M., Filion, D. (2007), Common and fundamental factors in stock returns of Canadian oil and gas companies. Energy Economics, 29, 428-453.

Dartmouth. (2019), Changes in CRSP Data: Fama/French 3 Factors. Available from: https://www.mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. [Last accessed on 2019 Dec 18].

Dayanandan, A., Donker, H. (2011), Oil prices and accounting profits of oil and gas companies. International Review of Financial Analysis, 20(5), 252-257.

DOE. (2018), Department of Energy: U.S. Becomes World's Largest Crude Oil Producer and Department of Energy Authorizes Short Term Natural Gas Exports, 2018. Available from: https://www.energy.gov/articles/us-becomes-world-s-largest-crude-oil-producer-and-department-energy-authorizes-short-term. [Last accessed on 2019 Dec 20].

EIAAlaska. (2019), Petroleum and Other Liquids: Alaska Field Production of Crude Oil. Available from: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrfpak2&f=a. [Last accessed on 2019 Dec 20].

EIABrent. (2019), Petroleum and Other Liquids: Europe Brent Spot Price FOB. Available from: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M. [Last accessed on 2020 Jan 03].

EIAProd. (2019), Petroleum and Other Liquids: U.S. Field Production of Crude Oil. Available from: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS2&f=A. [Last accessed on 2020 Jan 03].

EIAShale. (2019), Tight Oil Production Estimates by Play. Available from: https://www.eia.gov/petroleum/data.php#crude. [Last accessed on 2019 Dec 20].

EIAWorld. (2014), Shale Oil and Shale Gas Resources are Globally Abundant. https://www.eia.gov/todayinenergy/detail.php?id=14431. [Last accessed on 2019 Dec 20].

EIAWTI. (2019), Petroleum and Other Liquids: Cushing, OK WTI Spot Price FOB. Available from: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M. [Last accessed on 2020 Jan 03].

Exxon. (2018), Brent Blend updated 26 Nov 2018. Available from: https://www.corporate.exxonmobil.com/en/Crude-oils/Crude-trading/Brent-Blend. [Last accessed on 2019 Dec20].

Faff, R.W., Brailsford, T.J. (1999), Oil price risk and the Australian stock market. Journal of Energy Finance and Development, 4(1), 69-87.

Fama, E.F., French, K.R. (1993), Common risk factors in returns on stocks and bonds. Journal of Financial Economics, 33, 3-56.

Fattouh, B. (2011), An Anatomy of the Crude Oil Pricing System. The Oxford Institute for Energy Studies. Available from: https://www.ora.ox.ac.uk/objects/uuid:8b957970-239c-4a4f-9cbe-21830381de16. [Last accessed on 2019 Dec 15].

Fielden, S. (2013), Crazy little crude called Brent the physical trading market. RBN Energy Daily Energy Post. Available from: https://www.rbnenergy.com/crazy-little-crude-called-brent-the-physical-trading-market. [Last accessed on 2019 Dec 15].

Gulen, S.G. (1999), Regionalization in the world crude oil market: Further results. Energy Journal, 20, 125-139.

Hartmann, B., Sam, S. (2016), What low oil prices really mean. Harvard Business Review, 28, 2-6.

Jones, C.M., Kaul, G. (1996), Oil and stock markets. Journal of Finance, 51(2), 463-491.

Langer, L., Huppmann, D., Holz, F. (2016), Lifting the US crude oil export ban: A numerical partial-equilibrium analysis. Energy Policy, 97, 258-266.

Laughlin, L.S. (2016), Cleaning up after an Oil Glut. Forbes, 2016. Available from: https://www.archive.org/stream/forbes126junforb/forbes126junforb_djvu.txt. [Last accessed on 2019 Dec 16].

Liao, H.C., Lin, S.C., Huang, H.C. (2014), Are crude oil markets globalized or regionalized? Evidence from WTI and Brent. Applied Economics Letters, 21(4), 235-241.

Liu, W.M., Schultz, E., Swieringa, J. (2015), Price dynamics in global crude oil markets. The Journal of Futures Markets, 35(2), 148-162.

Malanichev, A. (2017), Analysis and Prospects of the USA Shale Oil Production. Available from: https://www.researchgate.net/publication/333092056_Analysis_and_prospects_of_the_USA_shale_oil_production. [Last accessed on 2019 Dec 09].

Malanichev, A. (2018), Limits of technological efficiency of shale oil production in the USA. Foresight and STI Governance, 12(4), 78-89.

Maugeri, L. (2013), The shale oil boom: A U.S. Phenomenon. Cambridge: Belfer Center for Science and International Affairs, Harvard University. Available from: http://www.belfercenter.ksg.harvard.edu/publication/23191/shale_oil_boom.html. [Last accessed on 2019 Dec 19].

Melek, N.C., Plante, M., Yucel, M.K. (2017), The U.S. Shale Oil Boom, the Oil Export Ban, and the Economy: A General Equilibrium Analysis. NBER Working Paper No. 23818.

Melek, N.C., Plante, M., Yucel, M.K. (2018), Resource Booms and the Macroeconomy: The Case of U.S. Shale Oil. KC Fed Research Working Papers, No. RWP 17-10.

Mohanty, S., Nandha, M. (2011), Oil risk exposure: The case of the U.S. oil and gas sector. The Financial Review, 46, 165-191.

Mohanty, S.K., Akhigbe, A., Tawfeek, A., Al-Khyal, T.A., Bugshan, T. (2013), Oil and stock market activity when prices go up and down: The case of the oil and gas industry. Review of Quantitative Finance and Accounting, 41, 253-272.

Nadal, R., Szklo, A., Lucena, A. (2017), Time-varying impacts of demand and supply oil shocks on correlations between crude oil prices and stock markets indices. Research in International Business and Finance, 42, 1011-1020.

Newell, R.G., Priest, B.C. (2017), How the Shale Boom Has Transformed the US Oil and Gas Industry. Available from: https://www.rff.org/publications/issue-briefs/how-the-shale-boom-has-transformed-the-us-oil-and-gas-industry. [Last accessed on 2019 Dec 19].

Obadi, S.M., Gardonova, K. (2019), How does the production of unconventional resources of energy influence energy security: Empirical approach. International Journal of Energy Economics and Policy, 9(5), 46-54.

Pirog, R. (2005), World Oil Demand and Its Effects on Oil Prices, CRS Report for Congress, Congressional Research Service, The Library of Congress, No. RL32530.

Sadorsky, P.A. (1999), Oil price shocks and stock market activity. Energy Economics, 21(5), 449-469.

Salameh, M.G. (2013), Impact of U.S. shale oil revolution on the global oil market, the price of oil and peak oil. International Association for Energy Economics, 1, 27-31.

SPGlobal. (2019), SP Global Platts Specification Guide America's Crude Oil, 2019. Available from: https://www.spglobal.com/platts/plattscontent/_assets/_files/en/our-methodology/methodology-specifications/americas-crude-methodology.pdf. [Last accessed on 2019 Dec 25].

Ural, M. (2016), Modelling crude oil price volatility and the effects of global financial crisis. Sosyoekonomi, 24(29), 167-181.

APPENDIX

Figure 1: US crude oil production versus West Texas intermediate crude oil price

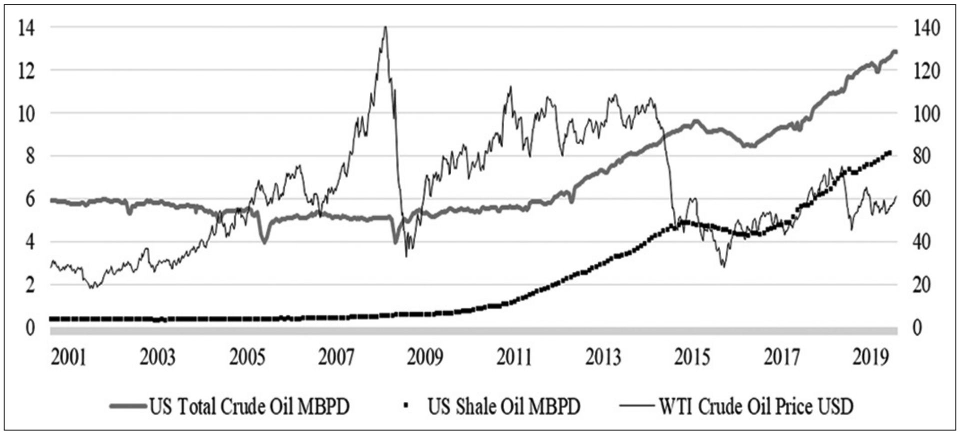

Table 1: Annual crude oil prices

Year	Average Annual Brent USD	Average Annual WTI USD	Brent minus WTI USD
2002	24.99	26.18	−1.19
2003	28.85	31.08	−2.23
2004	38.26	41.51	−3.25
2005	54.57	56.64	−2.07
2006	65.16	66.05	−0.89
2007	72.44	72.34	0.10
2008	96.94	99.67	−2.73
2009	61.74	61.95	−0.21
2010	79.61	79.48	0.13
2011	111.26	94.88	16.38
2012	111.63	94.05	17.58
2013	108.56	97.98	10.58
2014	98.97	93.17	5.80
2015	52.32	48.66	3.66
2016	43.64	43.29	0.35
2017	54.13	50.80	3.33
2018	71.34	65.23	6.11
2019	64.28	56.98	7.30

Table 2: Annual US crude oil production

Year	US Crude oil Production mbpd	Year Over Year Increase (%)	Shale Crude Oil Production mbpd	Year Over Year Increase (%)
2002	5.74		0.38	
2003	5.65	−2	0.37	−1
2004	5.44	−4	0.38	3
2005	5.18	−5	0.41	7
2006	5.09	−2	0.43	4
2007	5.07	0	0.46	8
2008	5.00	−1	0.55	20
2009	5.36	7	0.63	14
2010	5.48	2	0.83	31
2011	5.67	3	1.29	57
2012	6.52	15	2.15	66
2013	7.49	15	3.05	42
2014	8.79	17	4.11	35
2015	9.44	7	4.78	16
2016	8.84	−6	4.43	−7
2017	9.35	6	4.96	12
2018	10.99	18	6.51	31
2019	12.23	11	7.65	18
2002-2010 average	5.34		0.49	
2011-2019 average	8.81		4.33	
Percent increase (%)	65		776	
2002-2010 increase (%)	−4.5		119	
2011-2019 increase (%)	116		491	