Living in an Era when Market Fundamentals Determine Crude Oil Price

Theodosios Perifanis and Athanasios Dagoumas*†*

ABSTRACT

Crude oil price plays a crucial role in the trajectory of the economic activity. This paper aims at quantifying the impact of the fundamental drivers of crude oil price, over the period 2008–2017 using monthly data. This period, with sharp fluctuations of crude oil prices, has not been examined thoroughly in the literature. We apply regression analysis to examine the crude oil price drivers, concluding that crude oil price follows mostly market fundamentals, such as consumption, OPEC production, shale production and days ahead consumption for OECD stocks. Results unveil the importance of both factors of demand and supply to affect the price. We also find evidence on the considerable impact of S&P crude oil index, as a "paper oil" market indicator. We do not find evidence from indicators measuring political instability, such as the number of terrorists attacks in oil producing countries, but as well the VIX volatility index, which—besides a market instability index—could also be perceived as an index incorporating political instability. The impact of political factors is not evident in our analysis, possibly because we do not consider related dummy variables. Moreover, the paper applies bivariate VAR and GARCH analysis to examine crude oil price volatility, not finding strong volatility transmission with the examined market indices, namely the S&P crude oil and the VIX indices.

Keywords: Oil price, Shale oil, OPEC, Market fundamentals, Volatility

http://dx.doi.org/10.5547/01956574.40.SI1.tper

1. INTRODUCTION

The crude oil price has shown considerable fluctuations over the last ten years. There is a long-standing debate concerning the fundamentals of the crude oil price dynamics. The global economic activity, the OPEC's strategy, the shale oil revolution, geopolitical tensions in the region of Middle East and North Africa (MENA), as well also in other regions, raise the attention of researchers and decision makers, concerning their influence on crude oil prices. The crude oil price now seems to follow a course mainly driven by economic and market fundamentals, rather than by geopolitical developments. Although political instability and disruptions were evident in many oil producing regions over the last three years leading to the evolution of wars in MENA region, the crude oil prices remained at relatively low levels.

There is a long-standing debate on which are the fundamental drivers of crude oil price. The main question concerns on which factors, market fundamentals, economic, (geo)political or other prevail on the formation of crude oil price. The dominant role of OPEC has been identified in

* Energy & Environmental Policy Laboratory, University of Piraeus, Piraeus, 18532, Greece

† Corresponding author. E-mail: dagoumas@unipi.gr, tel:. +302104142651, Address: Energy & Environmental Policy Laboratory, University of Piraeus, Piraeus, 18532, Greece 126 Gr. Lambraki str., PC 18532, Piraeus, Greece

previous decades (Reza, 1984; Wood et. al., 2016). However, over the last years, the sharp penetration of shale oil producers, the sharp decreases of crude oil prices, the significant losses in balance sheets of OPEC members challenge the dominant role of OPEC and their potential to affect the crude oil prices. A recent paper (Pierru et. al., 2018) unveils the role of spare capacity in assessing the OPEC's impact on crude oil price volatility. When Loutia et. al. (2016) conclude that OPEC decisions affect changes over time and depend on production decisions and oil prices, while OPEC is less influential when prices are high and unconventional resources are viable. This can be partly explained by its recent statement. The 170th (Extraordinary) Meeting of the OPEC Conference made the public statement: "Based on the above observations and analysis, OPEC Member Countries have decided to conduct a serious and constructive dialogue with non-member producing countries, with the objective to stabilize the oil market and avoid the adverse impacts in the short- and medium-term." (OPEC, 2016). This is enhanced by the fact that other economies, such as the Russian economy, are also oil dependent (Perifanis and Dagoumas, 2017).

The agreement to cut production to rebalance the market initially showed results, as oil prices increased by 8% in the first quarter of 2017.[1] The price averaged at 52.9$/barrel, but a sharp decline followed in the second week of March, as shale production rebounded and inventories showed a persistent durability. World oil demand continued to increase but this was not enough to augment the pressure on the price, as this was at a slower pace than the previous years. Even if OPEC agreed to contract production by 1.2 Million barrels/day, in order to curtail any surpluses, the small shale producers seemed to have increased their drilling efficiency and be ready to exploit at low exploration costs. However, over the last weeks we notice a considerable increase in crude oil price, possibly related to the increasing tensions in Middle East, which might be not proved long-term lasting. West Texas Intermediate (WTI) and Brent indices were priced at 70.70$/bbl and 77.12$/bbl on 11th of May 2018.

There is an extended literature review on oil prices and their main drivers. The research field incorporates a vast variety of variables. Most of the research includes macroeconomic variables, as MacAvoy (1982), who reached the conclusion that oil price can be explained by economic and market fundamentals. Ewing and Thompson (2007) include macroeconomic factors as the industrial production. They suggested that prices are procyclical. Dees et al. (2007) distinguishes oil prices in relation with demand and inventories, and OPEC's behaviour as with quotas and capacity. Kaufmann et al. (2004) propose that OECD stocks, capacity utilisation, production quotas and real production over the quotas explain oil price fluctuations. Kaufmann et al. (2008) highlights refining shortages to increase prices. Kaufmann and Ullman (2009) suggested that oil price responds to fundamentals and are magnified by financial speculation. On the contrary, Kaufmann (2011) justifies price's increase during the second half of 2010 to oil disruptions. Cifarelli and Paladino (2010) argue on oil price drivers, and suggested that speculation justifies better the prices than fundamentals. Les Coleman (2012) argues that oil price fluctuations can be explained by supply, demand, political, financial and shock components.

In addition, Hamilton (1983) and Hamilton (2003) suggest price shocks have a significant economic negative effect. Especially Hamilton (2003) proposes that price shocks have asymmetrical effects, with price spikes to have much more powerful consequences than plummets. Hamilton (2005) suggests that as we extent the research period the less oil prices influence GDP growth. Mory (1993) proposes that the elasticity of GNP to oil price is low, at the level of –0.0551. Hooker (1996) argues that oil price is not a powerful determinant of economic activity as it was in the past, suggesting a structural break in 1975. Since then, unemployment and GDP cannot be explained by

1. World Bank, Commodity Markets Outlook, April 2017

oil prices. Bernanke et al. (1997) argue that energy costs are a small fraction of the total production costs, and as a consequence the monetary policies to deal with oil price spikes harmed the output. Gault (2011) suggests that a 10$/barrel price increase, during the period when the price was around 100$/barrel, would increase consumer's price index decreasing the disposable income. If gasoline demand was decreased, then this would deepen GDP decrease, as reduced income in this sector of the economy would lower spending in others. Kim and Jung (2018) unveil the dependence structure between crude oil prices, exchange rates, and the United States interest rates. Baruník et. al. (2015) examine the volatility spillovers across petroleum markets.

Considerable fluctuations were present as crude oil prices spiked to a peak of more than $145 per barrel in 2008 to a nadir of $32 per barrel in early 2009, in the heart of the global financial crisis. Then, crude oil prices increased sharply to more than 100$ per barrel in early 2011, remaining at those levels for more than 3 years, followed by a sharp decrease below the 40$ per barrel in late 2014, while prices were at levels of 50$ per barrel until June 2017. Since then prices follow an uptrend course. Although political tensions are evident in this period, those fluctuations are not strongly related to them. Economic and market factors, such as the economic activity, oil demand, OPEC and shale oil production are the key parameters in the literature review. Kisswani (2016), using monthly data from 1994 to 2014, examines whether OPEC acts as a cartel, and therefore affects crude oil prices. The findings of the paper show no evidence of cointegration between each member's production and that of OPEC indicating no cartel behavior at all exists. Moreover, the results show that OPEC production does not cause oil prices; rather it is the other way around. Okullo and Reynès, (2016) examined the imperfect cartelization of OPEC, by applying a model of global oil production. OPEC's supply strategy, although observed to be substantially more restrictive than that of a Cournot–Nash oligopoly, is found to still be more accommodative than that of a perfect cartel. The paper provides evidence that OPEC's ability to mark up the oil price is limited.

The shale oil revolution proved to be a game changer, that raised attention in literature. Behar and Ritz (2017) developed a simple equilibrium model, examining fundamental market factors, aiming to rationalize a "regime switch" by OPEC to a market-share strategy, due to the evolution of a competent shale oil production. Khalifa et al. (2017) examines the role of oil rigs, finding a non-linear relationship between oil prices and oil rigs counts. The paper provides evidence that non-linearity has softened during the most recent years, where the relationship between the variables has been stabilized. Another factor examined in the literature is the effect of announcements and news on the crude oil prices. Loutia et. al., (2016), using an EGARCH model to capture some features characterizing oil prices volatility examined the effect of OPEC announcements, concluding that OPEC decisions' effect changes over time and depends on production decisions and oil prices. Ewing and Malik (2017) using an asymmetric GARCH model, suggest that it is best to include both asymmetric effects and structural breaks in a GARCH model to accurately estimate oil price volatility dynamics. The paper finds that both good and bad news have significantly more impact on volatility, if structural breaks are accounted for in a model. Few studies focus on quantifying the influence of political and geopolitical factors. Les Coleman (2012) uses fundamental and market parameters that cover financial markets, global economic growth, demand and supply of oil, geopolitical measures as well as dummies for terrorist activity and major industry events. Although, the analysis is holistic, the considered variables are for the period 1984–2007.

Many researchers suggest that oil prices are inflated or deflated asymmetrically to market conditions by increased speculation. The phenomenon is referred as "paper oil", as it has not a physical substance. Kilian and Murphy (2010) argue that further trading regulation will not isolate price from demand, and as a matter of fact as soon as economy recovers, oil price will surge again.

They add that the speculative demand played an important role in 1979, 1986, and 1999, and not between 2003 and mid-2008. Sornette et. al. (2009) found evidence of speculation on the crude oil prices bubble during the period 2006–2008, while Cifarelli and Paladino (2010) concluded that their speculation-driven model better fits crude oil prices than one using fundamentals. Alquist and Gervais (2011) claim that financial speculation played a very modest role in the oil price surge between 2003 and 2008. Global demand and supply are the explanatory drivers for the oil price course. This argument was further suggested by Juvenal and Petrella (2015) as they identify global demand as the main driver behind oil price. They claim that financial speculation contributed to the price increase between 2004 and 2008, but they also add that oil decrease from late 2008 and onwards can be attributed to the negative global demand shock, accompanied by the speculative shock, as financial institutions refrained from commodity assets. But they continue to point out that regardless the role played by speculation, demand remains the main driver. On the contrary, Buyuksahin and Robe (2014a; 2014b) examine the period between 2000 and 2010, when growing commodity market activity by commodity index traders and financial traders was present. They suggest that oil returns are also driven by hedge fund activity, as well as that the hedge fund positions' predictive power is lower during periods of stress. They also add that hedge fund activity, macroeconomic fundamentals and the Treasury-EuroDollar (TED) spread (a proxy for financial market stress) are able to predict long-run fluctuations in commodity-equity correlations.

The above literature review shows that historically there are many studies that have examined the fundamentals of crude oil prices. However, the latest years, with sharp fluctuations of crude oil prices, have not been examined thoroughly. Moreover, those studies mainly focus on specific factors. This paper aims at examining economic, market, financial and political instability factors, towards quantifying their impact on crude oil price. We try to investigate crude oil price drivers and their nature over the ten-year period 2008–2017, using monthly data. The remainder of the paper is organized as follows. The data and methodology are described in Section 2. Section 3 presents and discusses our empirical findings. Finally, Section 4 offers some concluding remarks and the policy implications of our findings.

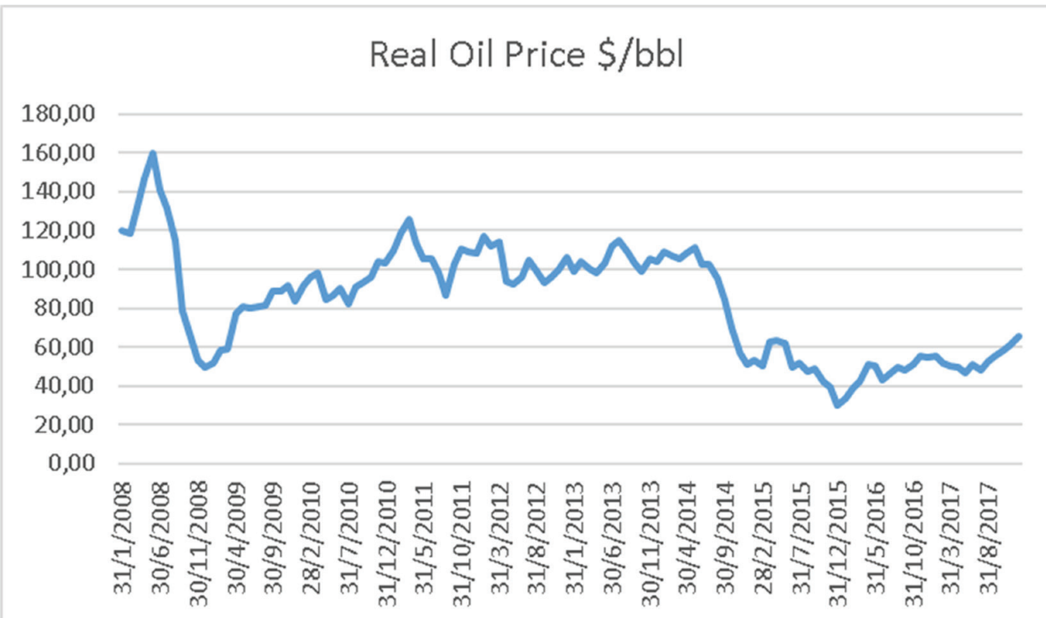
2. DATA AND METHODOLOGY

Crude oil is the most liquid and traded commodity of global economy. As a consequence, its price is the result of different factors, which include supply, demand, and political factors. The paper aims at considering economic, market, political and financial factors. Therefore, it uses several variables from different sources. West Texas Intermediate (WTI) crude oil prices are taken from MacroTrends data, provided in dollars per barrel. It is the real price and not the nominal one to account for inflation. In order to capture the crude oil consumption course, we use the interpolated world consumption by the Knoema database in thousand barrels per day. We fitted our data in monthly values by using Kilian's (2009) global real economic activity index derived from ocean freight rates. In order to capture market supply factors, we used several variables from Energy Information Administration (EIA). EIA's OPEC crude oil production is provided in thousand barrels per day. The US shale oil production is calculated after adding each region's production and it is also provided in thousand barrels per day. The last variable used by EIA concerns the days ahead of OECD consumption, that can be met by its crude oil stocks. We divided the EIA OECD total oil stocks by OECD consumption per day to derive the number of days, that the OECD oil stocks could meet OECD consumption. In order to incorporate the factor of "paper oil" trading, we used the S&P GSCI Crude Oil index. A similar index, S&P GSCI Energy index, has been used as an energy

Table 1: Variable description and data sources

Variables	Description	Data source
WCP	Monthly crude oil prices in real US dollars	MacroTrends data
WCONS	World oil consumption interpolated by Kilian global real economic activity index	Knoema database and http://www-personal.umich.edu/~lkilian/reaupdate.txt
OPECPRO	OPEC production in thousand barrels per day	EIA
SHALE	Shale production in thousand barrels per day by the regions Anadarko, Appalachia, Bakken, Eagle, Haynesville, Niobrara and Permian.	EIA
OECDD	Days the OECD oil stocks can last covering the OECD consumption	EIA
SPGSCL	S&P GSCI Crude Oil Index	Standard and Poor's
NINC	Numbers of terrorist attacks	Global Terrorism Database

Figure 1: Evolution of monthly values of real crude oil price over the period 2008–2017.



markets' financialization index in recent research on "paper oil" market (Büyükşahin and Robe. 2014a; 2014b). Finally, in order to capture political instability, we used the Chicago Board Options Exchange (CBOE) volatility index, known as VIX index, which—besides a market instability index—could also be perceived as an index incorporating political instability, as well as the number terrorist attacks in the MENA region, provided by the Global Terrorism Database (GTD) developed by the US national consortium for the Study of Terrorism And Response to Terrorism (START). However, those two variables have not provided statistically significant results, beside the fact that the latter variable extends until 2016. Table 1 provides the variables examined in this study. Figures 1–8 provide the evolution of the examined variables over the period January 2008-December 2017.

The data were converted to natural logarithms in order to obtain the respective elasticities from our models. After that, we tested whether they are stationary or not, as shown in Table 2. We used the Augmented Dickey-Fuller test and the Phillips-Perron tests. All our variables are non-stationary at levels but stationary at their first differences I(1).

Figure 2: Evolution of monthly values of the world crude oil consumption (interpolated by Kilian Index), over the period 2008–2017.

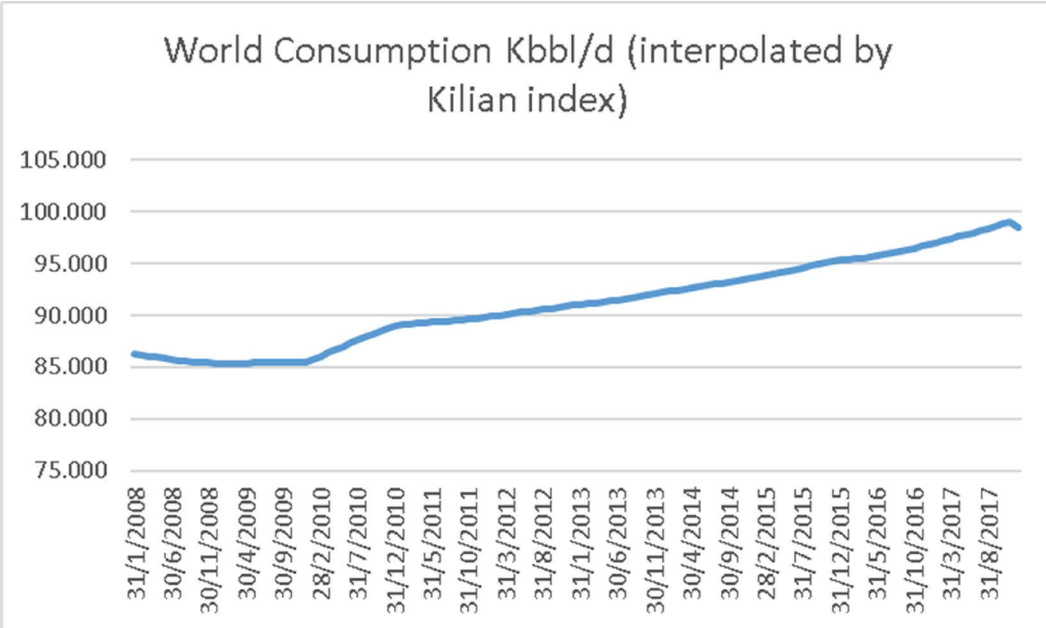


Figure 3: Evolution of monthly values of the OPEC crude oil production over the period 2008–2017.

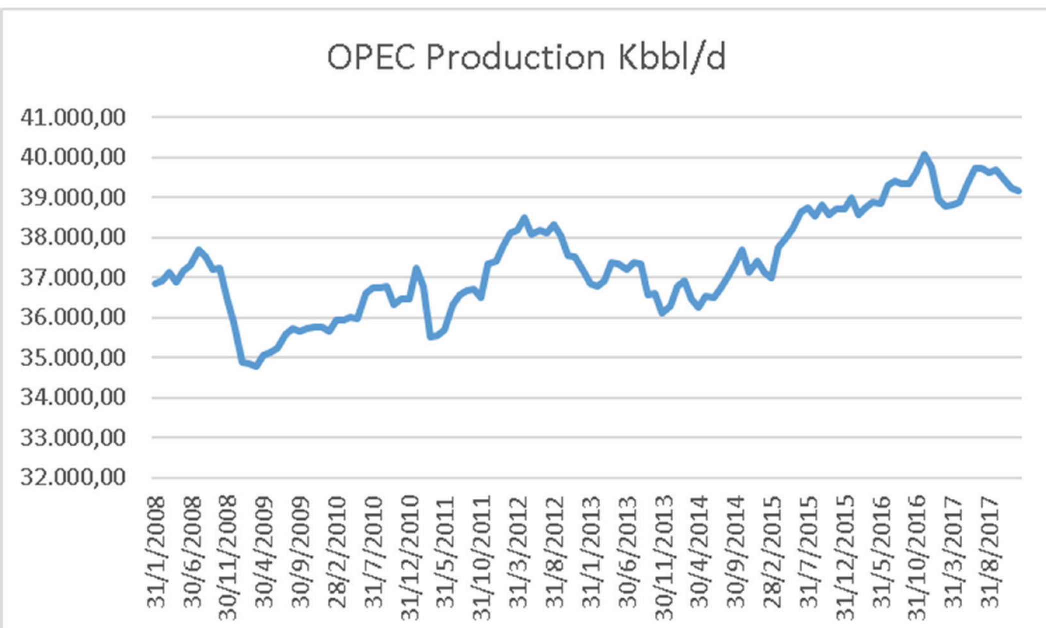


Figure 4: Evolution of monthly values of the US shale oil production over the period 2008–2017.

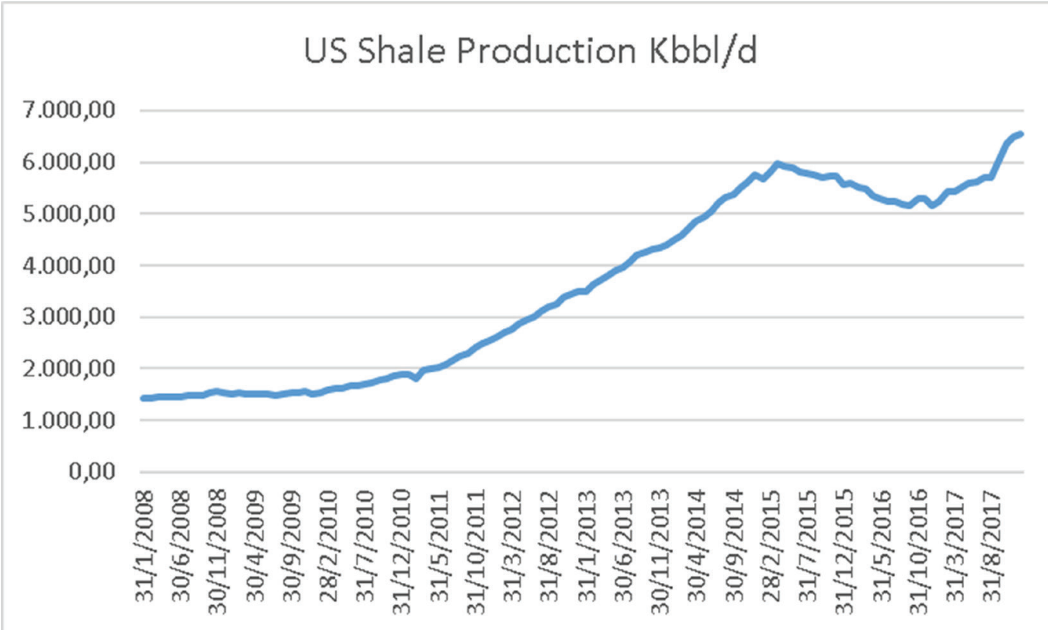


Figure 5: Evolution of monthly values of the number days that the OECD crude oil stocks can cover OECD consumption, over the period 2008–2017.

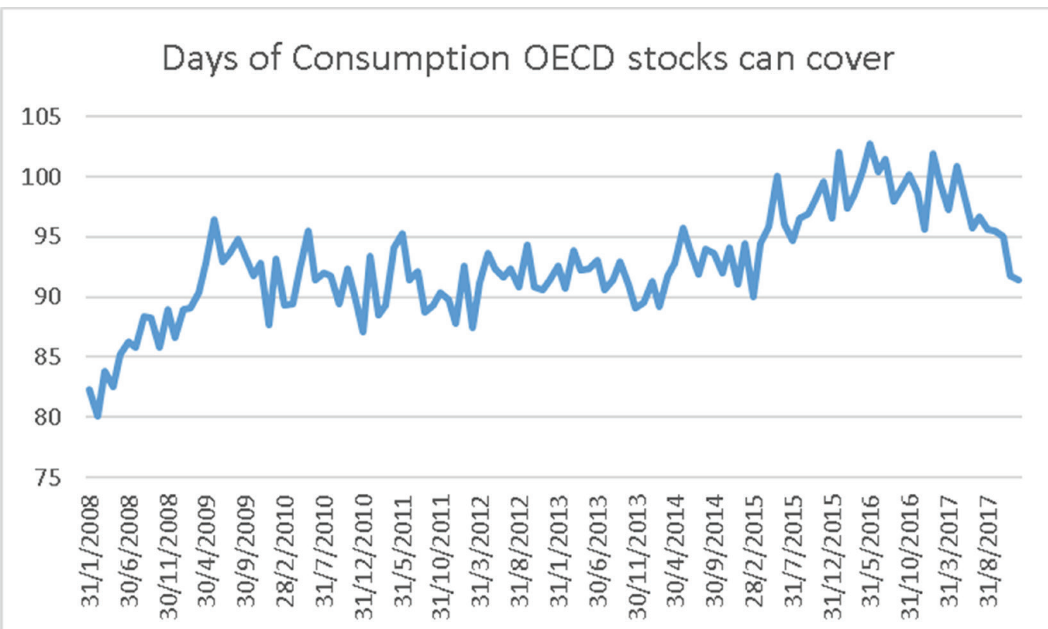


Figure 6: Evolution of monthly values of the S&P GSCI crude oil index over the period 2008–2017.

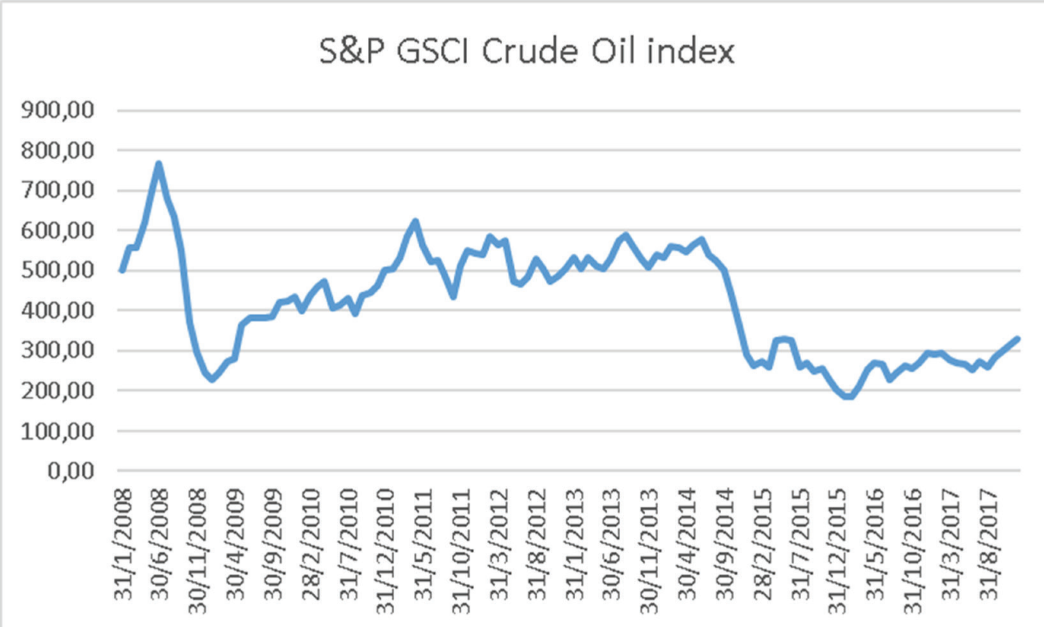


Figure 7: Evolution of monthly values of the VIX index over the period 2008–2017.

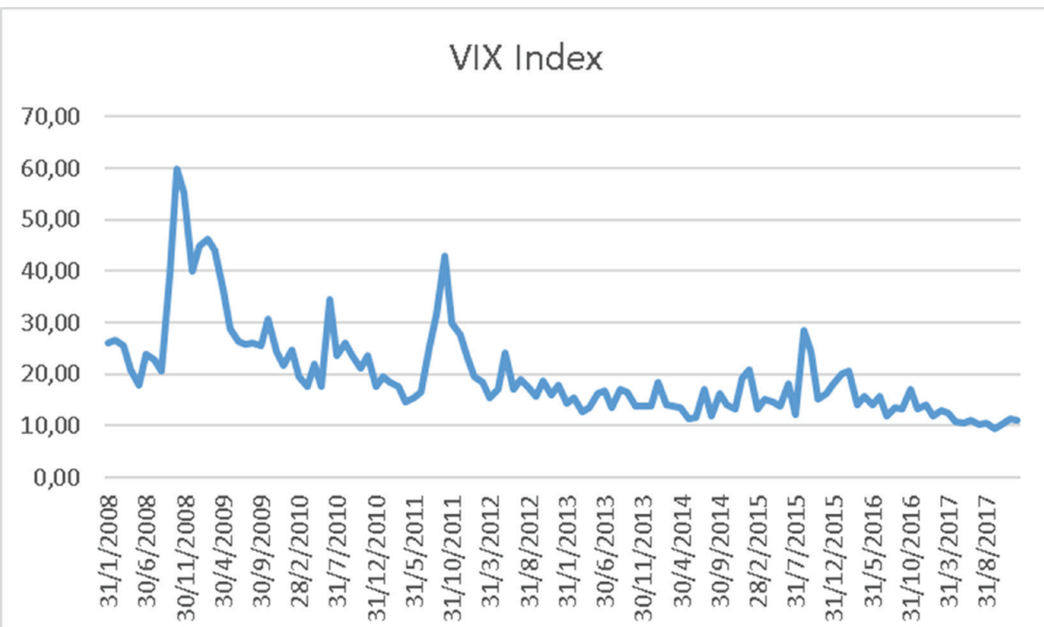


Figure 8: Evolution of monthly values of the number of terrorists attacks in oil producing countries over the period 2008–2016.

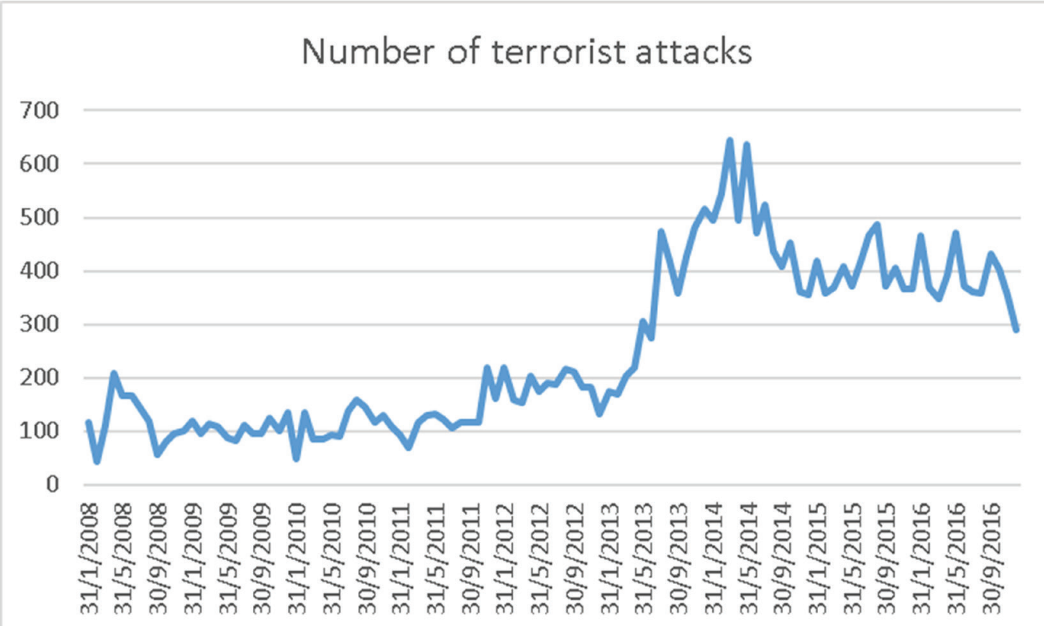


Table 2: Test for unit roots. Period 2008–2017

Level	ADF	Phillips-Perron	First difference	ADF	Phillips-Perron
WCP	–0.57[a]	–0.65[a]	Δ(WCP)	–5.68	–7.97
WCONS	1.26[a]	4.39[a]	Δ(WCONS)	–1.88[b]	–1.95[c]
OPECPRO	0.47[a]	0.59[a]	Δ(OPECPRO)	–6.96	–9.23
SHALE	4.50[a]	3.91[a]	Δ(SHALE)	–3.81	–7.31
OECDD	0.65[a]	0.65[a]	Δ(OECDD)	–12.02	–20.72
SPGSCL	–0.49[a]	–0.44[a]	Δ(SPGSCL)	–5.57	–7.40
VIX	–0.75[a]	–0.83[a]	Δ(VIX)	–14.81	–17.16
NINC	0.16[a]	0.47[a]	Δ(NINC)	–16.63	–18.95

Notes: The null hypothesis of the ADF and Phillips-Perron test is that a unit root exists. The first difference of the series is indicated by Δ.

[a] Indicates acceptance of the null hypothesis at all levels (1%, 5% and 10%).

[b] Indicates acceptance of the null hypothesis at 1% and 5%.

[c] Indicates acceptance of the null hypothesis at 1%.

Since our variables are I(1), we then test for cointegration. We conduct the Johansen cointegration test with several specifications:

None data trend
- No intercept no trend.
- With intercept no trend.

Linear data trend
- With intercept no trend.
- With intercept and trend.

Quadratic data trend
- With intercept and trend.

Table 3: Cointegration test for variables of Model 1

Johansen's maximum likelihood method test for cointegration relationship
Linear deterministic trend (Lag intervals 1 to 3) Model 1

Null Hypothesis Ho	Alternative Hypothesis, H1	Eigen Value	0.05 critical value
Maximum eigenvalues			
r=0		77.03	46.23
r≤1		31.07	40.07
Trace statistics			
r=0		173.80	125.61
r≤1		96.77	95.75
r≤2		65.69	69.81

Notes: Maximum Eigen suggest 1 and Trace value indicate 2 CE at 0.05 level

Table 4: Cointegration test for variables of Model 2

Johansen's maximum likelihood method test for cointegration relationship
Linear deterministic trend (Lag intervals 1 to 3) Model 2

Null Hypothesis Ho	Alternative Hypothesis, H1	Eigen Value	0.05 critical value
Maximum eigenvalues			
r=0		61.18	46.23
r≤1		42.03	40.07
r≤2		21.27	33.87
Trace statistics			
r=0		168.39	125.61
r≤1		106.21	95.75
r≤2		64.18	69.81

Notes: Maximum Eigen and Trace value indicate 2 CE at 0.05 level

Table 5: Cointegration test for variables of Model 3

Johansen's maximum likelihood method test for cointegration relationship
Linear deterministic trend (Lag intervals 1 to 3) Model 3

Null Hypothesis Ho	Alternative Hypothesis, H1	Eigen Value	0.05 critical value
Maximum eigenvalues			
r=0		61.16	40.07
r≤1		27.32	33.87
Trace statistics			
r=0		128.69	95.75
r≤1		67.53	69.81

Notes: Maximum Eigen and Trace value indicate 1 CE at 0.05 level

Before proceeding with the development of different models, we examined if a long run relationship among the different variables is evident. All tests present evidence that a cointegrating equation exists and as matter of fact a long run relationship exists (Tables 3–5 for Linear deterministic trend). The cointegration among our variables (for the different models examined, as described below) let us proceed with our research.

After the examination of several combinations of the above mentioned variables, we provide results for the following regression models.

Table 6: Estimation results for Model 1

Variable	Coefficients	Std. Error	Probability	Probability F	Probability Chi sq.
WCONS	1.31	0.55	0.0194[b]		
OPECPRO	–1.30	0.57	0.0248[b]		
SHALE	–0.19	0.06	0.0038[a]		
OECDD	–0.35	0.27	0.2021		
SPGSCL	1.24	0.38	0.0017[a]		
NINC	0.02	0.03	0.4689		
P_{t-1}	–0.32	0.37	0.3892		
MA	0.19	0.09	0.0310[b]		
LM test				0.0889	0.0722
Breusch-Pagan-Godfrey				0.1246	0.1256
Adj R^2	0.9322				
Durbin Watson	1.9204				

[a] Indicates significance at all levels (1%, 5% and 10%).
[b] Indicates significance at 5% and 10%.
[c] Indicates significance at 10%.

Table 7: Estimation results for Model 2

Variable	Coefficients	Std. Error	Probability	Probability F	Probability Chi sq.
WCONS	1.40	0.53	0.0108[b]		
OPECPRO	–1.25	0.54	0.0230[b]		
SHALE	–0.19	0.05	0.0003[a]		
OECDD	–0.54	0.23	0.0220[b]		
SPGSCL	1.15	0.39	0.0045[a]		
VIX	–0.06	0.04	0.1518		
P_{t-1}	–0.25	0.38	0.5072		
MA	0.17	0.08	0.0541[c]		
LM test				0.1030	0.0861
Breusch-Pagan-Godfrey				0.1582	0.1575
Adj R^2	0.9396				
Durbin Watson	1.9355				

[a] Indicates significance at all levels (1%, 5% and 10%).
[b] Indicates significance at 5% and 10%.
[c] Indicates significance at 10%.

$$WCP_t = WCONS_t + OPECPRO_t + SHALE_t + OECDD_t + SPGSCL_t + NINC_t \qquad \text{(Model 1)}$$

$$WCP_t = WCONS_t + OPECPRO_t + SHALE_t + OECDD_t + SPGSCL_t + VIX_t \qquad \text{(Model 2)}$$

$$WCP_t = WCONS_t + OPECPRO_t + SHALE_t + OECDD_t + SPGSCL_t \qquad \text{(Model 3)}$$

3. RESULTS AND DISCUSSION

Our models attempt to catch the main drivers of the oil market during the last ten years. We examined different combinations of variables, presenting the results of the three models in Tables 6–8. The last coefficients are the AutoRegressive (AR) P_{t-1} and the Moving Average (MA) coefficients. We used ARMA modelling as most of the time series present serial correlation. Box et. al. (2013) point out that conditional on pre-sample values for the AR and MA errors, the normal conditional likelihood function may be maximized by minimizing the sum of squares of the innovations. In our analysis we used the Huber White method (Huber, 1967; White, 1980) for heteroscedasticity and the conditional least squares estimation for ARMA. Results from Models 1 &2, presented in Tables

Table 8: Estimation results for Model 3.

Variable	Coefficients	Std. Error	Probability	Probability F	Probability Chi sq.
WCONS	1.35	0.54	0.0134[b]		
OPECPRO	–1.32	0.57	0.0217[b]		
SHALE	–0.16	0.04	0.0005[a]		
OECDD	–0.45	0.23	0.0547[c]		
SPGSCL	1.28	0.40	0.0018[a]		
P_{t-1}	–0.35	0.38	0.3586		
MA	0.16	0.09	0.0766[c]		
LM test				0.0778	0.0661
Breusch-Pagan-Godfrey				0.1155	0.1161
Adj R^2	0.9391				
Durbin Watson	1.8771				

[a] Indicates significance at all levels (1%, 5% and 10%).
[b] Indicates significance at 5% and 10%.
[c] Indicates significance at 10%.

6–7, as well as from other examined combinations, reveal that the variables incorporating instability (VIX index and the number of terrorist attacks in oil producing countries) do not provide statistical significant results. The most robust model, as well as that with higher explanatory capability, is Model 3, satisfying the test for the non-presence of serial correlation and heteroscedasticity, as presented in Table 8. The most robust Model 3 is described below, with their t statistic in parentheses.

$$WCP_t = 1.35WCONS_t - 1.32OPECPRO_t - 0.16SHALE_t - 0.45OECDD_t + 1.28SPGSCL_t$$
$$(2.51) \qquad (-2.32) \qquad (-3.56) \qquad (-1.94) \qquad (3.20)$$

The following discussion and concluding remarks are based on the outputs of Model 3. The results comply with economic theory, as consumption affects positively the price. As aforementioned our coefficients are also the respective elasticities. Crude price has an elastic response to consumption i.e. the price percentage change will be 1.35% to that of the consumption. The world oil demand increase is mainly concentrated in Asia, and it is expected to continue in the future. Half of the expected growth in global economy will be concentrated in India and China, where low income classes will emerge as new energy consumers. The elastic relationship also verifies the assumption that there is low substitution to oil, as oil is still considered as the main energy source, especially in the developing economies.[2]

OPEC crude oil production has a price deflating coefficient. This is again in accordance with the economic theory, as more volumes decrease prices. Apart from the negative sign, we notice that we have again an elastic relationship. If OPEC increases production by 1% then oil prices will decrease by 1.32%. This elastic relationship highlights the role which OPEC played during this period in the crude oil price formation. Initially, in order to defend its market share, OPEC refused to curtail production. This strategy had as a goal to force the new and privately owned shale producers out of the market. This is why prices followed a downward course until the 170th Extraordinary Meeting, where it was agreed with other non-member countries to restrain production. Since then, crude oil followed an upward course. The ability of OPEC to influence the market should not be considered as utter or monolithic, since the collusion of non-members was necessary. Therefore, the enhanced role of OPEC in this paper, incorporates its enhanced institutional capability to co-operate with non-OPEC countries, such as the Russian Federation, as they had the same interests. Furthermore, many

2. https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/energy-outlook/bp-energy-outlook-2018.pdf

OPEC members enjoy the privileges of low upstream costs and large reserves. The last put them in the position to influence the market to some extent considering the rest of the prevailing market conditions. On the other hand, shale oil producers are the marginal producers, which makes them vulnerable to price fluctuations. Further many OPEC countries, like Saudi Arabia hold spare capacity and can react to market developments with great ease. The last fact may also justify the elastic relationship between OPEC production and prices. This could be more obvious if we incorporated the OPEC capacity utilization as an explanatory variable, however those data were confidential and available at annual levels. This would require interpolation from annual to monthly values, which could make them unreliable, as it would not incorporate information of outages and maintenance of production assets.

Shale production was already a mature upstream technology since 2008. Hydraulic and horizontal drilling or more commonly referred as unconventional production occurred mainly in the United States. We use the sum of the most unconventionally producing regions in the US as a variable. Our result is statistically significant with negative sign. The coefficient suggests again that as more volumes reach the market, the lower the price. But the relationship is inelastic meaning that shale production has less strength than that of OPEC. A 1% increase of shale production in the US would cause a 0.16% price decrease. The contrast between the elastic relationship of OPEC and the inelastic relationship of US shale might be explained by the fact that OPEC can affect price, due to its low production costs and spare capacity, while shale oil is the vulnerable marginal producer. In addition, OPEC has the ability to export through the whole examined period, as well as to cooperate with non-OPEC members over the last years. The US lifted this kind of ban at the end of 2015[3]. Until this point, unconventional production was headed domestically and as a matter of fact it had an increased role to price formulation of WTI (Kilian, 2016), rather than on international markets. The latter explains the increase in deviation between WTI and Brent indicators over the last years. Our result is statistically significant with negative sign.

Since both conventional and unconventional producers refused to curtail volumes, an oil glut became predominant in the market. This glut was mainly stored, in oil stocks in oil consuming regions but as well as in tankers, increasing the contango phenomenon. However, the latter is not quantitively captured in our analysis. In order to capture this kind of oil glut we used the number of days OECD stocks can cover OECD consumption. We calculated this variable by dividing the total OECD oil stocks by the consumed oil per day. During the last years, stocks were highlighted by market participants, and our results suggest that this was not without a reason. The coefficient of the "days ahead of OECD consumption supported by oil stocks" variable is negative and significant at 10%. The elasticity is –0.45% meaning that a 1% increase of oil stocks by OECD would decrease price by 0.45%. The relationship is inelastic, but in conjunction with shale production poses a greater influence. USA is a member of OECD organisation, while oil stocks are mainly in the US. It was this stocked oil glut that OPEC attempted to decrease by reducing production. Reduced oil stocks could constitute the oil market tighter.

We incorporate another variable in our models as an indicator of "paper oil" market, and it is that of S&P GSCI Crude Oil index. Many researchers suggest that oil prices are inflated or deflated asymmetrically to market conditions by increased speculation. The phenomenon is referred as "paper oil", as it has not a physical substance. Our research finds evidence on the impact of "paper oil" market, as the elasticity of crude oil price to the S&P GSCI crude oil index is statistically significant, positive and elastic (+1.28). This variable is used as an indicator of crude oil markets' financialization, similarly to recent research (Büyükşahin and Robe, 2014a) using the S&P GSCI energy

3. https://www.mckinseyenergyinsights.com/insights/us-export-ban-lifting-effect-on-crude-pricing.aspx

index. The elastic relationship means that speculation is a major price driver. Speculation increases or decreases prices at a large extent. A similar conclusion was derived by Coleman (2012), finding link between crude oil prices and speculative activity. This kind of volatility might explain the large variance in oil prices during the last decade. This kind of variance further attracts participants such as hedge funds which enjoy price fluctuations. This cycle of price fluctuations should be considered among the main drivers. This fact has led us to examine the volatility transmission among the crude oil price and the other examined market indices, namely the S&P GSCI crude oil index and the VIX index. However, by using bivariate VAR methodology and bivariate GARCH models (DCC GARCH, Copula GARCH), we do not find strong relationship among those variables, concerning the transmission of volatility. However, examining a shorter time period, such as the period 2007–2009, the role of "paper oil" market could be important also in the volatility transmission, besides as a strong driver of crude oil price.

Finally, the paper results do not agree with recent papers, (Kisswani, 2016; Okullo and Reynès, 2016) concerning the capability of OPEC to affect crude oil prices over the last years. We do not study whether OPEC acts as a cartel, but as whether OPEC production volumes can influence prices. We find that OPEC can still influence prices on the assumption of production volumes. As OPEC still has a considerable production share, then it comes as a consequence that it can affect prices. Furthermore, the paper provides evidence on the crucial role of shale oil, which has also been highlighted by recent analyses (Behar and Ritz, 2017; Khalifa et al., 2017). However, the impact of OPEC production is much higher than that of shale oil, which is attributed to the fact that shale oil is the marginal producer. Moreover, the enhanced role of OPEC is attributed to its late enforced institutional capability to co-operate with non-OPEC producers, such as the Russian Federation, with aim to stabilize global crude oil market and to strengthen their balance sheets in the medium-term.

In addition, OECD stocks play a vital role for oil pricing, providing evidence that not only supply but also demand factors affect strongly the crude oil price. The oil glut which is stored makes the market less tight. Since the market is less tight then oil prices follow a downward course. It is this course that OPEC members and cooperating producers attempted to stop. We agree with Büyükşahin and Robe (2014a) who suggest that oil returns are also driven by hedge fund activity, as we also find that prices are strongly elastically formulated by speculation activity. From the analysis carried out, it is evident that over the last ten years the market fundamentals such as economic and financial factors are the critical ones of global crude oil price.

Finally, in our effort to account for political or economic instability we tried to incorporate the VIX volatility index, but it did not give satisfactory results. We tried to examine whether volatility passes from VIX index to the oil market due to political circumstances with bivariate VAR methodology and bivariate GARCH modelling (DCC GARCH, Copula GARCH), but again we did not have statistically significant results. We also used data from the University of Maryland's Study of Terrorism and Responses to Terrorism (START) for the regions of Middle East and North Africa. We also used data from the University of Maryland's Study of Terrorism and Responses to Terrorism (START) for the regions of Middle East and North Africa. We focused on these regions as they include the most important crude oil producers and reserves holders, but again we did not find evidence of their statistical significance. Those results do not undermine the role of political factors as there are other analyses (Les Coleman, 2012), that suggested incorporating dummies for political instability as important determinants of crude oil price. The main reason for not incorporating such dummies in our analysis, although we consider they are important, is the fact that they are not fully objective, as other deterministic figures. This creates a flexibility of "biased" research, as research could unveil or undermine the importance of some factors. However, this does not mean that we do not personally consider political factors as not important, but we tried to develop models with fully objective variables.

4. CONCLUDING REMARKS AND POLICY IMPLICATIONS

This paper aims at identifying and quantifying the fundamental drivers of crude oil price. The paper does not aim to focus on a specific aspect of crude oil price formation, but to examine different aspects, namely economic, market fundamental, financial and political factors. We use market and economic variables such as world crude oil consumption, OPEC oil production, U.S. shale oil production, days ahead of consumption that OECD stocks can cover. We also use the S&P GSCI crude oil index, which could be perceived as a 'paper oil" market indicator reflecting the evolution of speculation in the crude oil market. Moreover, we examine indicators measuring political instability, such as the number of terrorists attacks in oil producing countries from the University of Maryland's Study of Terrorism and Responses to Terrorism (START) for the region of Middle East and North Africa, but as well the Chicago Board Options Exchange (CBOE) volatility index, known as VIX index, which—besides a market instability index—could also be perceived as an index incorporating political instability. However, we do not consider dummies as political factors, as other researchers do, which might undermine the role of political factors in crude oil price formation in our research.

The paper examines the latest available data, namely the period between January 2008 and December 2017, where sharp fluctuations of crude oil price have been observed. This period has not been examined thoroughly in literature. By applying different methodologies, we conclude to regression models for the fundamental drivers of crude oil price, besides the bivariate VAR methodology and the bivariate GARCH models (DCC GARCH, Copula GARCH) for the crude oil price volatility. However, the latter models did not provide any evidence on the volatility relationship among crude oil price and the examined market indicators, such as the S&P GSCI crude oil index and the VIX index.

The results from the regression analysis provide evidence that the market fundamentals are the most appropriate variables to explain the recent developments in the crude oil market over the last decade. Our main result is that world oil consumption influences crude oil prices positively and considerably, as the elasticity of crude oil price to consumption is elastic (+1.35). This kind of influence may be present due to the lack of substitution between different resources of energy, especially in fast growing developing countries. Although the role of OPEC has been undermined compared to the 70s, OPEC still plays an important role as its production deflates prices, with the elasticity of crude oil price to OPEC production to be elastic (–1.32). This has to do with the supplied volumes as our research does not examine whether perfect collusion is achieved. U.S. shale oil also supresses crude oil prices, as more quantities reach the market. However, the relation is inelastic (–0.16). The variable "number of days OECD crude oil stocks can meet consumption" has an considerable effect on crude oil price, as its elasticity is –0.45. This result is important as it unveils the capability of consumption regions to affect price, besides the crucial role of supply regions such as OPEC and USA. It explains the importance of the oil glut, which was stored.

Our research examines also other -to market- factors. The impact of political instability is captured through a variable measuring the number of terrorists attacks in oil producing countries, but as well through the VIX index, which—besides a market instability index—could also be perceived as an index incorporating political instability. However, we do not find statistical evidence of the impact of those factors on crude oil price over the last decade. The role of political factors might be undermined as we do not incorporate related dummies. The main reason behind that is that those variables although important, as reported in other research papers, are subjective to some extent as other deterministic figures. This creates a flexibility of "biased" research, as research could unveil or undermine the importance of some factors. However, this does not mean that we do not consider political factors as not important, but we tried to develop models with fully objective variables. Finally, our research finds evidence on the impact of "paper oil" market, examined in our paper through the S&P GSCI crude oil index. We estimate that trading activity further adds to price's course, as the elasticity of crude oil price to the S&P GSCI crude oil index is positive and elastic (+1.28). The sign and magnitude of this elasticity unveils that speculation in commodity markets is a strong determinant of crude oil price. This result is in alliance with recent research, providing evidence on the considerable role of speculators to drive oil prices.

This fact has led us to examine the volatility transmission among the crude oil price and the other examined market indices, namely the S&P GSCI crude oil index and the VIX index. However, by using bivariate VAR methodology and bivariate GARCH models (DCC GARCH, Copula GARCH), we do not find strong relationship among those variables, concerning the transmission of volatility. This means that, for the examined ten-year period, the sharp oil price fluctuations are not strongly attributed to those variables. However, examining a shorter time period, such as the period 2007–2009, the role of "paper oil" market could be important also in the volatility transmission, besides as a driver of crude oil price.

From the analysis carried out, we conclude that crude oil price follows, over the last ten years, mostly market fundamentals, such as supplied volumes and inventories. The paper unveils the importance of both supply and demand factors to affect crude oil price. On the other hand, we find no evidence of political influences since political instability variables such as the VIX index or the indicator from the GTD are not statistical significant. This is an interesting finding as there was extended social unrest during the Arab Spring, as well as the fact that the Islamic State prevailed in vast oil producing areas for several years. The results of this paper are in accordance with MacAvoy (1982) who finds that oil price can be explained by macroeconomic fundamentals. However, as mentioned above the incorporation of dummies could unveil the importance of political factors. We agree with Kaufmann et al. (2004) on the importance of crude oil stocks for oil price fluctuations and Kaufmann and Ullman (2009) on the response to the fundamentals. The low production costs of unconventional oil production may verify Loutia's et al. (2016) result, as even low price levels may be high enough for this kind of production to restrain OPEC's influence. But OPEC remains an actor in the global oil market affecting considerably crude oil price, even the WTI, where shale oil producers have a strong presence with their volumes. The impact of OPEC's production is much higher than that of shale oil, which has proved to be a game changer in international markets but vulnerable being the marginal producer. The increased role of OPEC is highlighted by the recent developments, since OPEC refused to curtail production driving prices downwards, in order to push shale producers out of the market. We had an upward price course from the moment that OPEC decided to put the hand on the pump.

To summarize, we conclude that the crude oil price formation over the last ten years is mostly based on market fundamentals such as the demand, the supply and the inventories rather than on political or instability factors, which was the case of Les Coleman (2012), who researched a different time period, considering also different factors to capture political instability. In our analysis, the results show that the role of speculation in the crude oil market is considerable, even for a long ten-year period.

The findings are expected to have significant policy implications in energy policy formulation. Crude oil producers, such as OPEC members, are capable of affecting global crude oil price and therefore their income from hydrocarbon sectors and the balance sheet of their economies. Our analysis show that shale oil is a game changer, enhancing the role of market fundamentals and undermining the role of political factors. However, being the marginal production makes shale oil's profitability vulnerable to price fluctuations. This eliminates the role of shale oil producers, compared to that of OPEC, even for the US-based WTI indicator. However, the enhanced role of OPEC to affect crude oil price, incorporates its enhanced institutional capability to cooperate with non-OPEC producers, such as the Russian Federation. This is can be clearly noticed in the recent 170th (Extraordinary) Meeting of the OPEC Conference, which has decided: "to conduct a serious and constructive dialogue with non-member producing countries, with the objective to stabilize the oil market and avoid the adverse impacts in the short- and medium-term." (OPEC, 2016)

We expect that these market conditions will continue to prevail as long as global crude oil demand, driven by global economic activity growth, could be met by an oversupply of crude oil, provided by several competitive crude oil suppliers. Considering that these conditions are expected to stand for several years, the oil producing countries, with strong dependency of their balance sheets on high oil prices, are expected to suffer from domestic problems in their economy and possibly leading even to political instability or regime changes. The fast and efficient diversification of their economies towards the restriction of the role of the energy sector in the surplus or deficit level of their economy, is crucial for avoiding recession or even intense domestic political disputes.

Moreover, the market conditions in the global crude oil market strongly affect the conditions of natural gas market, as several contracts are oil-linked. Therefore, the relevant low crude oil prices that prevailed during the last years significantly affect economies with balance sheet dependence on gas revenues. The evolution of liquid natural gas hubs, especially in Europe as well as in the Japan Korea Market, is expected to significantly affect natural gas price dynamics. Moreover, those changes are expected to be irreversible, in the sense that once a market, such as natural gas, establishes its own dynamics, is almost totally unrealistic to be evolved in strong linkage with the dynamics of the crude oil market. Those developments are already evident in the market, as natural gas hubs become more liquid, liquefied natural gas is increasing its market penetration and dominant natural gas suppliers, such as Gazprom for European consumers, are adapting their contracts to be more hub-linked. It is not a coincidence that Gazprom admitted that one third of its contracts are now oil-linked, one third are hub-linked and one third are hybrid[4]. The latter is also strongly related to the establishment of the internal target model in the European Union, namely a liquid and dynamic natural gas market, de-linked from the crude oil market dynamics.

ABBREVIATIONS

AR	AutoRegressive
ARCH	AutoRegressive Conditional Heteroskedasticity
ARMA	AutoRegressive Moving Average
CBOE	Chicago Board Options Exchange
DCC	Dynamic Conditional Correlation
GARCH	Generalized AutoRegressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GSCI	Goldman Sachs Commodity Index
GTD	Global Terrorism Database

4. https://www.oxfordenergy.org/wpcms/wp-content/uploads/2018/03/Gazprom-in-Europe-%E2%80%93-two-Anni-Mirabiles-but-can-it-continue-Insight-29.pdf

MA	Moving Average
MENA	Middle East and North Africa
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
S&P	Standard & Poor's
START	Study of Terrorism and Responses to Terrorism
TED	Treasury-EuroDollar rate
VAR	Vector AutoRegression
VIX	CBOE volatility index
WTI	West Texas Intermediate

REFERENCES

Alquist, R. and O. Gervais (2011). *The Role of Financial Speculation in Driving the Price of Crude Oil*.

Baruník, Jozef, Evzen Kocenda, and Lukas Vácha (2015). "Volatility spillovers across petroleum markets." *The Energy Journal* 36(3): 309–329. https://doi.org/10.2139/ssrn.2600204.

Behar A. and R.A. Ritz (2017). "OPEC vs US shale: Analyzing the shift to a market-share strategy." *Energy Economics* 63: 1854. https://doi.org/10.1016/j.eneco.2016.12.021.

Bernanke, B.S., M. Gertler, M. Watson, C.A. Sims, and B.M. Friedman (1997). "Systematic monetary policy and the effects of oil price shocks." Brookings Pap. Econ. Act. 1997, 91–157. https://doi.org/10.2307/2534702.

Bouyé, E., V. Durrleman, A. Nikeghbali, G.G. Riboulet, and T. Roncalli (2000) "Copulas for Finance—A Reading Guide and Some Applications". Available at SSRN: https://ssrn.com/abstract=1032533. or http://dx.doi.org/10.2139/ssrn.1032533 Box, G.E.P., G.M. Jenkins, and G.C. Reinsel (2013). *Time Series Analysis*. John Wiley & Sons, Inc., |DOI:10.1002/9781118619193.

Büyükşahin, B. and M. Robe M. (2014a). "Does 'paper oil' matter?" Working paper, Bank of Canada.

Büyükşahin, B. and M.A. Robe (2014b). "Speculators, commodities and cross-market linkages." *J. Int. Money Financ.* 42: 38–70. https://doi.org/10.1016/j.jimonfin.2013.08.004.

Cifarelli, G. and G. Paladino (2010). "Oil price dynamics and speculation: a multivariate financial approach." *Energy Economics* 32(2): 363–372. https://doi.org/10.1016/j.eneco.2009.08.014.

Coleman, L. (2012). "Explaining crude oil prices using fundamental measures." *Energy Policy* 40: 318–324. https://doi.org/10.1016/j.enpol.2011.10.012.

Dees, S., P. Karadeloglou, R.K. Kaufmann, and M. Sanchez (2007). "Modelling the world oil market: assessment of a quarterly econometric model." *Energy Policy* 35(1): 178–191. https://doi.org/10.1016/j.enpol.2005.10.017.

Engle, R.F. and K. Sheppard (2001). "Theoretical and Empirical properties of Dynamic Conditional Correlation Multivariate GARCH." NBER Work. Pap. Ser. 1–46.

Ewing, B.T. and M.A. Thompson (2007). "Dynamic cyclical comovements of oil prices with industrial production, consumer prices, unemployment and stock prices." *Energy Policy* 35: 5535–5540. https://doi.org/10.1016/j.enpol.2007.05.018.

Ewing, B.T. and F. Malik (2017). "Modelling asymmetric volatility in oil prices under structural breaks." *Energy Econ.* 63: 227. https://doi.org/10.1016/j.eneco.2017.03.001.

Gault, N. (2011). "Oil Prices and the U.S. Economy: Some Rules of Thumb." Published in IHS Global Insight Bulletins-Perspective Article. https://www.ihs.com/country-industry-forecasting.html?ID=1065929077.

Hamilton, J.D. (1983). "Oil and the Macroeconomy since World War II." *J. Polit. Econ.* 91: 228–248. https://doi.org/10.1086/261140.

Hamilton, J.D. (2003). "What is an oil shock?" *J. Econometrics* 113: 363–398. https://doi.org/10.1016/S0304-4076(02)00207-5.

Hamilton, J.D. (2005). "Oil and the Macroeconomy." *New Palgrave Dict. Econ.* 1–17. https://doi.org/10.1086/261140.

Hartley, Peter R. and Kenneth B. Medlock III (2014). "The relationship between crude oil and natural gas prices: The role of the exchange rate." *The Energy Journal* 35(2): 25–44. https://doi.org/10.5547/01956574.35.2.2.

Hooker, M.A. (1996). "This is what happened to the oil price-macroeconomy relationship." *J. Monet. Econ.* 38: 195–213. https://doi.org/10.1016/S0304-3932(96)01281-0.

Huber, P.J. (1967). "The behavior of maximum likelihood estimation under nonstandard conditions." In *Proceedings of the fifth Berkeley symposium on mathematical statistics and probability,* L. M. Le Cam & J. Neyman (Eds.). Berkeley, CA: University of California Press

Juvenal, L. and I. Petrela (2015). “Speculation in the oil market.” *J. Appl. Econom.* 30: 621–649. doi:10.1002/jae.

Kaufmann, R.K. (2011). “The role of market fundamentals and speculation in recent price changes for crude oil.” *Energy Policy* 39(1): 105–115. https://doi.org/10.1016/j.enpol.2010.09.018.

Kaufmann, R.K. and B. Ullman (2009). “Oil prices, speculation and fundamentals.” *Energy Economics* 31: 550–558. https://doi.org/10.1016/j.eneco.2009.01.013.

Kaufmann, R.K, S. Dees, P. Karadeloglou, and M. Sanchez (2004). “Does OPEC Matter? An Econometric Analysis of Oil Prices.” *The Energy Journal* 25: 67–90. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol25-No4-4.

Kaufmann, R.K., A. Bradford, L.H. Belanger, J.P. Mclaughlin, and Y. Miki (2008). “Determinants of OPEC production: Implications for OPEC behavior.” *Energy Econ.* 30: 333–351. https://doi.org/10.1016/j.eneco.2007.04.003.

Khalifa, A., M. Caporin, and S. Hammoudeh (2017). “The relationship between oil prices and rig counts: The importance of lags.” *Energy Econ.* 63: 213. https://doi.org/10.1016/j.eneco.2017.01.015.

Kilian, L. (2009). “Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market.” *American Economic Review* 99(3): 1053–69. https://doi.org/10.1257/aer.99.3.1053.

Kilian, L. and D.P. Murphy (2014). “The Role of Inventories and Speculative Trading.” *J. Appl. Econom.* 478: 454–478. doi:10.1002/jae.

Kim. J.-M. and H. Jung (2018). “Dependence Structure between Oil Prices, Exchange Rates, and Interest Rates.” *The Energy Journal* 39: 259–280. https://doi.org/10.5547/01956574.39.2.jkim.

Kisswani, K.M. (2016). “Does OPEC act as a cartel? Empirical investigation of coordination behavior.” *Energy Policy* 97: 171. https://doi.org/10.1016/j.enpol.2016.07.013.

Loutia, A., C. Mellios, and K. Andriosopoulos (2016). “Do OPEC announcements influence oil prices?” *Energy Policy* 90: 262–272. https://doi.org/10.1016/j.enpol.2015.11.025.

MacAvoy, P. (1982). *Crude Oil Prices as Determined by OPEC and Market Fundamentals*. Ballinger, Cambridge.

Mory, J. (1993). “Oil Prices and Economic Activity: Is the Relationship Symmetric?” *The Energy Journal* 14(4): 151–161. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol14-No4-10.

Okullo, S.J. and J.F. Reynes (2016). “Imperfect cartelization in OPEC.” *Energy Econ.* 60: 333. https://doi.org/10.1016/j.eneco.2016.10.010.

OPEC (2016). “170th (Extraordinary) Meeting of the OPEC Conference.” Organization for Oil Exporting Countries Press Release. http://www.opec.org/opec_web/en/press_room/3706.htm (assessed 20 May 2018).

Perifanis, T. and A. Dagoumas (2017). “An econometric model for the oil dependence of the Russian Economy.” *International Journal of Energy Economics and Policy* 7(4): 7–13

Pierru, A., J.L. Smith, and T. Zamrik (2018). “OPEC’s Impact on Oil Price Volatility: The Role of Spare Capacity.” *The Energy Journal* 39: 173–196. https://doi.org/10.5547/01956574.39.2.apie.

Reza, A.M. (1984). “The price of oil and conflict in OPEC.” *The Energy Journal* 5: 29–33. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol5-No2-2.

Sornette, D., R. Woodard, and W.X. Zhouc (2009). “The 2006–2008 oil bubble: evidence of speculation and prediction.” *PhysicaA: Statistical Mechanics and its Applications* 388: 1571–1576. https://doi.org/10.1016/j.physa.2009.01.011.

White, H. (1980). “A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity.” *Econometrica* 48: 817–838. https://doi.org/10.2307/1912934.

Wood, A.D., C.F. Mason, and D. Finnoff (2016). “OPEC, the Seven Sisters, and oil market dominance: An evolutionary game theory and agent-based modeling approach.” *Journal of Economic Behavior & Organization* 132: 66–78. ISSN 0167-2681. https://doi.org/10.1016/j.jebo.2016.06.011.

IAEE
INTERNATIONAL ASSOCIATION *for* ENERGY ECONOMICS
WWW.IAEE.ORG

The IAEE is pleased to announce that our leading publications exhibited strong performances in the latest 2018 Impact Factors as reported by Clarivate. The Energy Journal achieved an Impact Factor of 2.456 while Economics of Energy & Environmental Policy saw an increase to 2.034.

Both publications have earned SCIMago Journal Ratings in the top quartile for Economics and Econometrics publications.

IAEE wishes to congratulate and thank all those involved including authors, editors, peer-reviewers, the editorial boards of both publications, and to you, our readers and researchers, for your invaluable contributions in making 2018 a strong year. We count on your continued support and future submission of papers to these leading publications.