

# Visualizing World Crude Oil Price

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## 1. Introduction

The world crude oil production from 1990 to 2016 can be found in Figure 1. Generally speaking, the world crude oil production is increasing smoothly. If we just look at this figure, we must hard to believe why crude oil price ( see Figure 2) will be upside down rapidly. It is worthy for us to pay more attention on the issue of world oil price evolution. Although a lot of literature already investigate the crude oil price, these authors believe we might be able to dig some different views by applying new method: dynamic visualization technique.

### Production of crude oil and other products

World 1990 - 2016

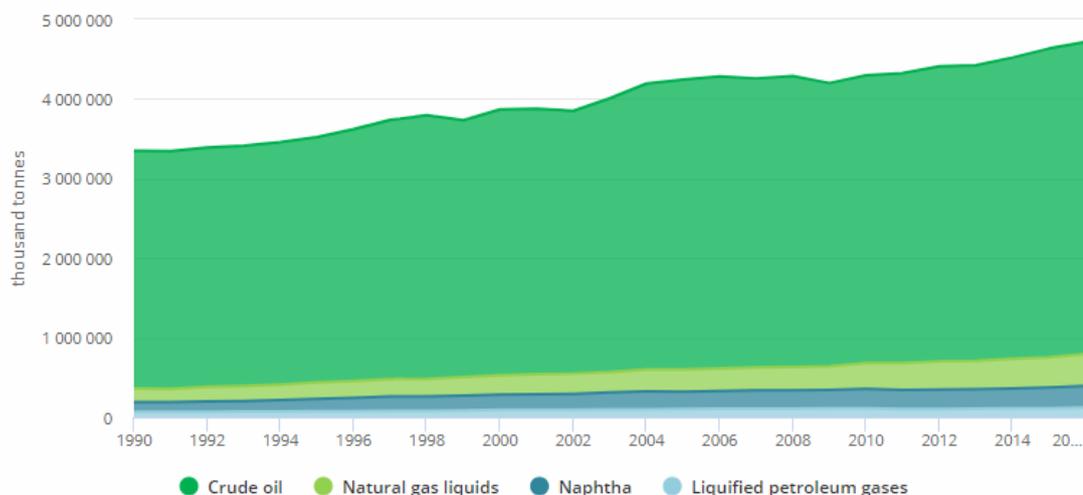


Figure 1: World Production of Crude Oil and Other Products (1990 – 2016)

Source: <https://www.iea.org/statistics/index.html?country=WORLD&year=2016&category=Oil&indicator=OilProd&mode=chart&dataTable=OIL>

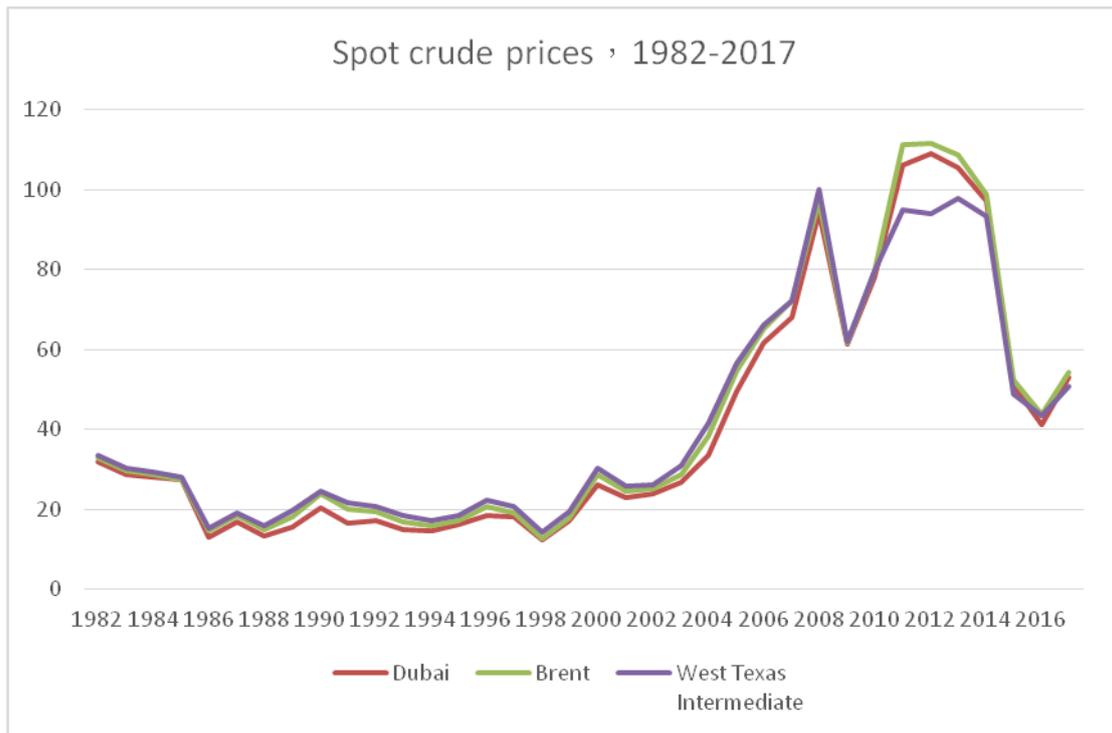


Figure 2: World Crude Oil Prices (1982 – 2017)

Sources: Data is collected BP Website.

Note: Dubai, BRENT and WTI are 3 well-known Benchmark Price in the world.

Most of the visualization charts describe the past story, this paper tries to use the visualization skill to project the crude oil price in the near future. EIA provides the crude oil price forecasting figures in its short-term energy outlook every month by showing the liquid fuel balance chart which also indicates the quarterly liquid fuel demand and supply in past years and next year. However, recent crude oil market have significant changes such as the quick response production characteristic of large shale oil supply in North America. Many small shale oil producers produce more oil very quickly once crude oil price raise to a higher level, and close their oil well also quickly as crude oil price drop down. Without capturing the relative share of this shale production, it will be hard for us to project the crude oil price in the near future.

The purpose of this paper is to capture the evolution of world crude oil production and demand by applying the dynamic visualization techniques. We drew many visualization slideshows to capture the movement of different oil production, demand, export and import in different countries in the world. We found these dynamic visualization slideshows bringing us several new hints, which can help us to project the crude oil price in the near future. The methodology is explained in Section 2. Data collection is described in Section 3. Figures and results will be illustrated in the Section 4. Conclusions are in the Section 5.

## 2. Methodology

This paper uses the data visualization method to foresee future world oil price by capturing the evolution of world crude oil production, demand, and prices. In this section, we describe our working process first, then introduce some main points of visualization method.

### 2.1 Workings Process

After reviewing all related articles, we tackle this issue step by step as below:

1. Collect oil production, consumption, export, import etc., for all countries from JODI data bank and BP data bank.
2. Collect the tight oil production in US<sup>1</sup>, OPEC's utilization rate, WTI and BRENT spot price<sup>2</sup> from EIA.
3. Draw dynamic visualization slideshows for oil production, consumption, export, import etc. respectively for related countries from January 2002 to December 2018.
4. Separate the shale oil production and non-shale oil production.
5. Evaluate the relationship among the market situation, WTI and Brent.
6. Combine above information with the corresponding WTI and BRENT price trend to judge the most probably price movement in the near future.
7. Conclusions.

## 2.2 Visualization Method

Data visualization is very popular currently in almost every areas. With the help of data visualization, people can display the data more precisely and effectively, and then can communicate easily and quickly. Tufte (1983) brought us lots idea for building more better figures. Following his viewpoints, more and more visualization concepts are addressed. Yang (2001) categorized the visualization concepts systematically from the mankind's eye. More and more articles investigate the topics of data visualization. Some of them argued that the improper display of data visualization just brings us more Chart Junk (Borkin et al., 2013; Few and Edge, 2011). Fortunately, these arguments did not slow down the development of data visualization. In fact, it is more popular today. Kjærgaard et al. (2016) built a visualization case and shown that the visualization method can actually enhance the energy efficiency in the commercial and industrial buildings. Other application in the oil market can be found in Muhammad (2012) and Qiang & Fan (2016).

The coverage of visualization method is tremendous. This paper only applies a small parts of some basic concepts. Except those chart types well-known by public (e.g. Bar Chart, Heat Map), these authors uses dynamic bar line visualization slideshow to discover more oil market information. The basic visualization concepts can be found from Liao et al. (2018). Dynamic visualization is also applied in our paper, which is more popular today. Lowe (2004) already addressed the idea of dynamic visualization. He believe the dynamic presentation will be very helpful to enhance the effectiveness of education and communication. Wang et al. (2015) connect the big data and visualization method more recently. They summarized several types of visualization, and pointed out recent progress of dynamic visualization. The idea of country oil production, consumption and other oil related variables slideshows in our paper actually come from the GDP slideshow published by World Bank.

## 3. Data Collection

From JODI data bank, we collect the monthly data of oil production, consumption, export, import etc. respectively for top 30 countries and for some specific countries (i.e. OPEC member countries and East Asia countries) from January 2002 to December 2018 in the world. Except the country level data from JODI data bank, we also collect the aggregate level data from other data sources. We collect the annual oil consumption data for the whole world, and for East Asia from BP(2018). We also collect the tight oil production in US, OPEC's utilization rate (quarterly data) and the WTI, BRENT monthly spot price from EIA.

## 4. Oil Price Projection Based on Our Visualization Slideshow

Following our working process, we first drew several dynamic visualization slideshows.

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<sup>1</sup> Tight oil can be regarded as shale oil, please see more explanation in EIA website.

<sup>2</sup> We only collect WTI and BRENT is because of the data convenience. It is not easy to collect the data of Dubai price. Moreover, the price of WTI and BRENT is more popular in the area of financial market.

The tabulate software is used to draw many visualization figures and slideshows. The findings from dynamic visualization slideshows is illustrated in Section 4.1, then more analyses are implemented to project the probably future oil price trend in other sections.

#### 4.1 Findings from Dynamic Visualization Slideshows

According to those results of our dynamic visualization slideshows, we select some important slideshows and tackle our problem step by step as the illustration below.

##### 4.1.1 Main Countries Concerns in Our Paper

Using monthly data from January, 2002 to December, 2018 for all oil production and consumption data described above, our dynamic visualization slideshows reveal that the oil production of OPEC and the oil consumption of East Asia play very important role in the world oil market in last two decades. Thereby, we spend more time to investigate those country data in OPEC and East Asia.

##### 4.1.2 The Implication from OPEC Production Slideshow

Comparing the simple bar line pictures, the dynamic visualization bar line slideshows bring us more helpful information. The slideshow below reveals that Saudi Arabia plays a very important role to maintain OPEC's production level. Although the other OPEC members' production fluctuate a lot, Saudi Arabia always can make up the loss of production or cut its own production to maintain OPEC's production level. No wonder OPEC can dominates world oil price for past 60 years.

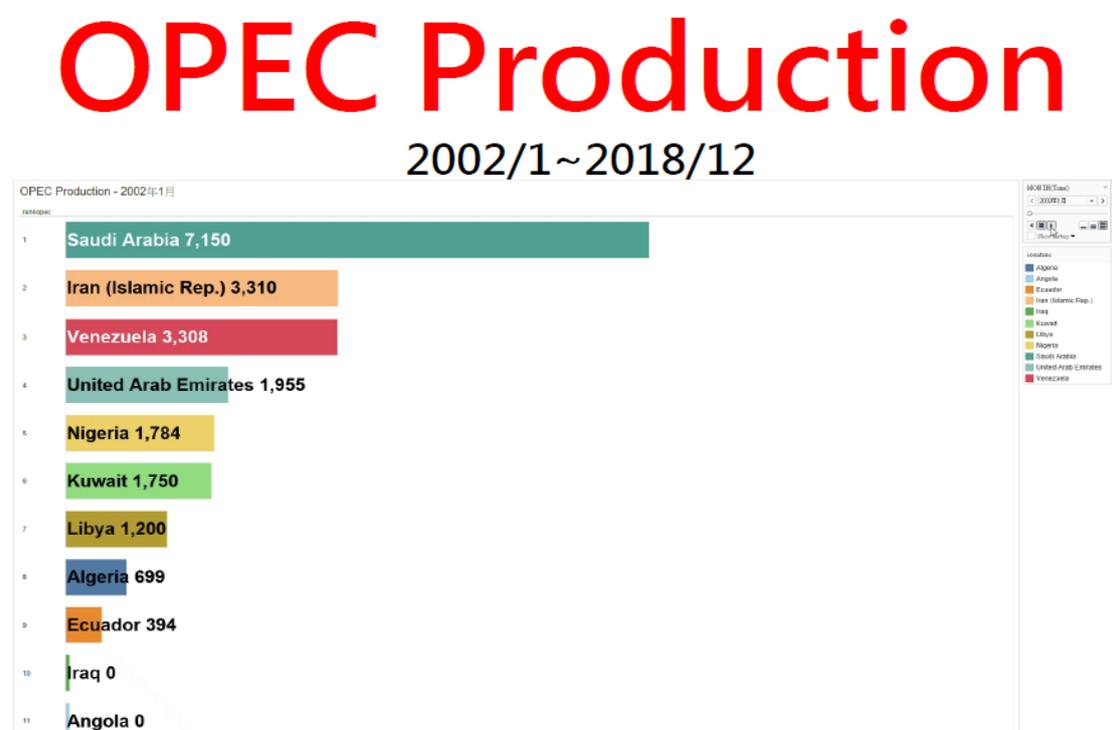


Figure 3. Monthly oil production of all OPEC countries<sup>3</sup>.

Data Sources: JODI data bank.

Note: Slideshow can be seen in the attached ppt. file

<sup>3</sup> the dynamic slideshow can only be seen in the ppt file, which will be presented in the oral section of the conference.

### 4.1.3 The Implication from OPEC Export Slideshow

Similar to the OPEC production slideshow, the OPEC export slideshow also indicating the important role of Saudi Arabia. In order to play a good actor of swing producer for maintaining OPEC monopoly power, Saudi Arabia's export is ranging from 5247 to 8344 thousand barrel per day (see sub Figure in Figure 4). The display of slideshow, points out that some of the OPEC member countries face supply disruption when Saudi Arabia's export boomed up to more than 8 million barrel per day. Investigating the dynamic slideshow, we find the blue bar (i.e. the production of Saudi Arabia) will reach the right hand side target, which are marked as 2002, 2016 and 2018 after we see the slideshow again and again. Usually, world oil price will gain up very quickly if Saudi Arabia's export booms up more and more for recovering the production loss of other OPEC member. Although we find oil price do increase quickly after 2002, but not the year after 2016 and 2018. This phenomenon is worthy to be investigated.

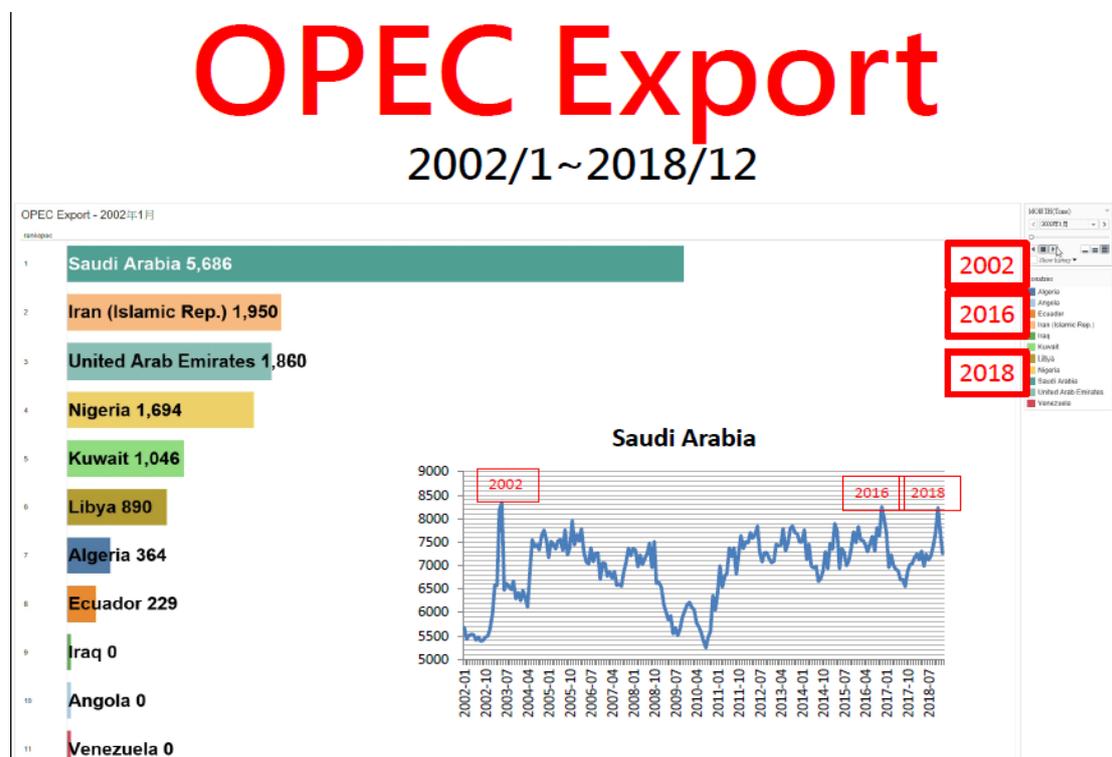


Figure 4. Monthly oil export of all OPEC countries.

Data Sources: JODI data bank.

Note: Slideshow can be seen in the attached ppt. file

### 4.1.4 The Implication from East Asia Consumption Slideshow

All above dynamic visualization slideshows focus on the supply side of world oil market, in order to better capturing the world oil price, the demand side is also concerned in our research. After watching more dynamic visualization slideshows, we found the oil consumption in East Asia is the key factor for deciding world oil price. Thus we also drew the dynamic visualization slideshows for East Asia countries. Although we only display the annual data slideshow currently due to the time limitation, the slideshow results tell us the rapid oil consumption growth in East Asia do affect the world oil price, especially for the cases in China.

# East Asia Oil Consumption

1980~2018

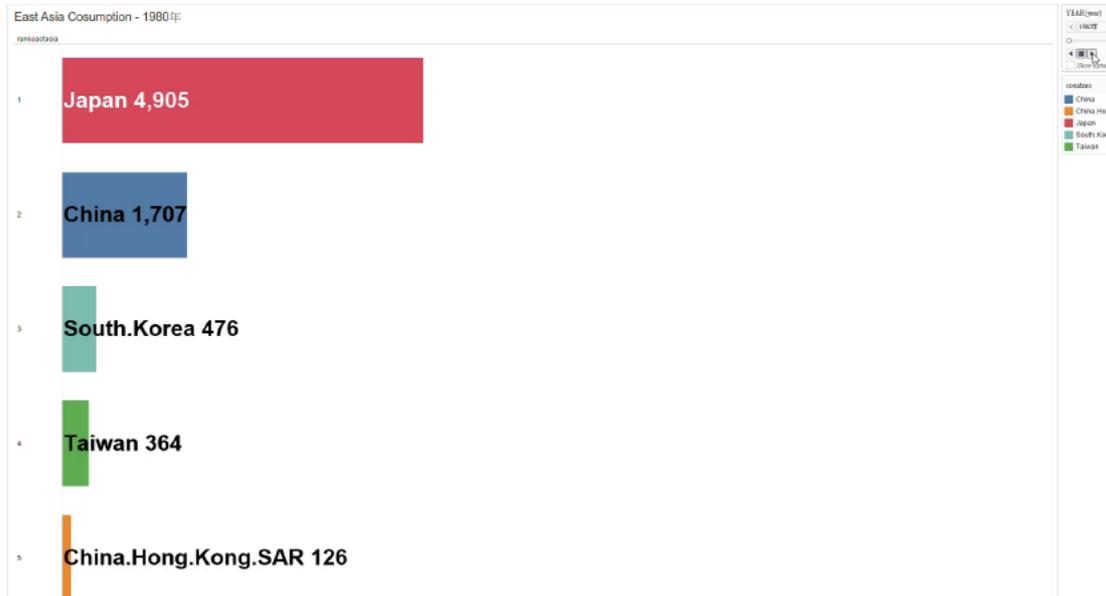


Figure 5. Annual oil consumption of East Asia countries.

Data Sources: BP Statistical Review of World Energy, June 2018.

Note: Slideshow can be seen in the attached ppt. file

## 4.2 OPEC Are Losing Monopoly Power

Based on above observation, we think the statement of "OPEC are losing monopoly power" by some newspapers may not be a temporary situation but more probably be a long-term trend. In order to investigate this statement, we try to connect the curve of utilization rate of OPEC, the curve of WTI, the curve of BRENT and the curve of shale oil production in US together in next subsection.

### 4.2.1 the Utilization Rate of OPEC

It is well-known that the capacity utilization rate of OPEC has strong impact on the world crude oil price as some literature contended (e.g. Mabro, 1991; Fattouh, 2007). Since OPEC is the only organization with oil production excess capacity, the utilization rate of OPEC actually represents the potential gap between world oil demand and supply. Higher utilization rate implies that oil market will meet the oil supply shortage problem. Since oil is a key factor for economy activity nowadays, those oil importers will definitely buy more oil from the market as they found the potential world oil shortage problem. This is the reason why crude oil price will be pushed up to higher and higher once OPEC's utilization rate reaches some certain higher level. Figure 6 depicts the relationship between OPEC's utilization rate and the change of oil price ( $\Delta p$ ). We found that crude oil price will change very quickly once OPEC's utilization rate is up to more than 90%. The most famous case is the evidence occurred in the year of 2006 to 2008. At that period, world crude oil price rocked up very rapidly as OPEC's utilization rate jumped to be more than 95%, many people worried that the world crude oil would be exhausted soon.

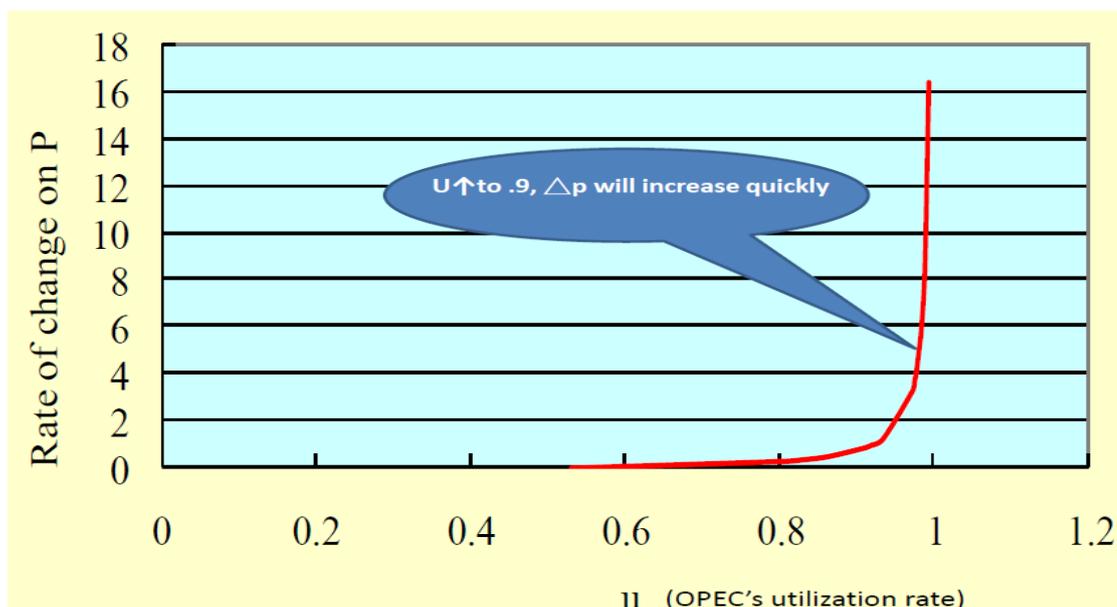


Figure 6. The relationship between the change of price ( $\Delta p$ ) and OPEC's utilization rate ( $u$ )

#### 4.2.2 WTI, BRENT

Because WTI and BRENT are the most important benchmark crude oil prices today, we choose these two spot prices to capture the trend of world oil price.

#### 4.2.3 Shale Oil Production in US

Our dynamic visualization slideshows in Section 4.1, points out the different oil market movement trend after 2016. Since the shale oil production in US is the most apparent new evidence of world oil market in past few years, we collect the data of shale oil production in US to implement our analyses.

#### 4.2.4 Shale Production in US Almost Fully Replaces the Role of OPEC's Utilization Rate

We collected the quarterly data of OPEC's utilization rate, and selected corresponding data from all monthly data of WTI, BRENT and shale oil production in US from EIA<sup>4</sup>. Then we arrange a consistent quarterly data for implementing our analyses. Finally, we drew a picture shown as Figure 7. The utilization rate (green line) before 2010 can well explain the oil price trend no matter for WTI or BRENT, but no more good explanation after 2010. During the period from 2010 to 2014, OPEC's higher utilization rate still has strong impact on both WTI and BRENT, but the gap between WTI and BRENT is extended as OPEC's utilization rate increase. Shale production in US increase once world oil price increase. Unfortunately, many of the increasing shale production can hardly be transported to the market due to the pipeline limitation in US. Thus we found the bigger gap between WTI and BRENT.

After 2017, the increase of utilization rate only has little impact on crude oil price, but more effect on the extension of the gap between WTI (purple line) or BRENT (red line). We find the shale oil production in US (blue line with star sign) almost fully replace the role of OPEC's utilization rate. In the right side of Figure 7, OPEC's utilization rate is still keep in high level, but WTI or BRENT only change little, while the shale oil production in US increase rapidly.

<sup>4</sup> Since more people are more familiar with "shale oil", we use shale oil here rather than the tight oil in the data from EIA as we mentioned in footnote 1.

The worry of oil supply shortage is almost fully cancelled out by the increase of shale oil production.

### 4.3 Most Probably World Oil Price in the Near Future

We believe the quick response production characteristic of large shale oil supply in North America should be the main reason for maintain relative lower price. Obviously, \$60 US per barrel currently is much lower than \$110 US per barrel in the year from 2011 to 2014. Many small shale oil producers produce more oil very quickly once crude oil price raises to a higher level, and close their oil well also quickly as crude oil price drops down. Generally speaking, the crude oil price (BRENT) will not go too far away from current \$60 US per barrel in the forthcoming years since shale oil reserve is still rich in the near future. However, recent record high oil production in US may imply less adjustment capability for cancelling out the effect of production cut from OPEC, which will deviate oil price from the lower oil price band in past few year.

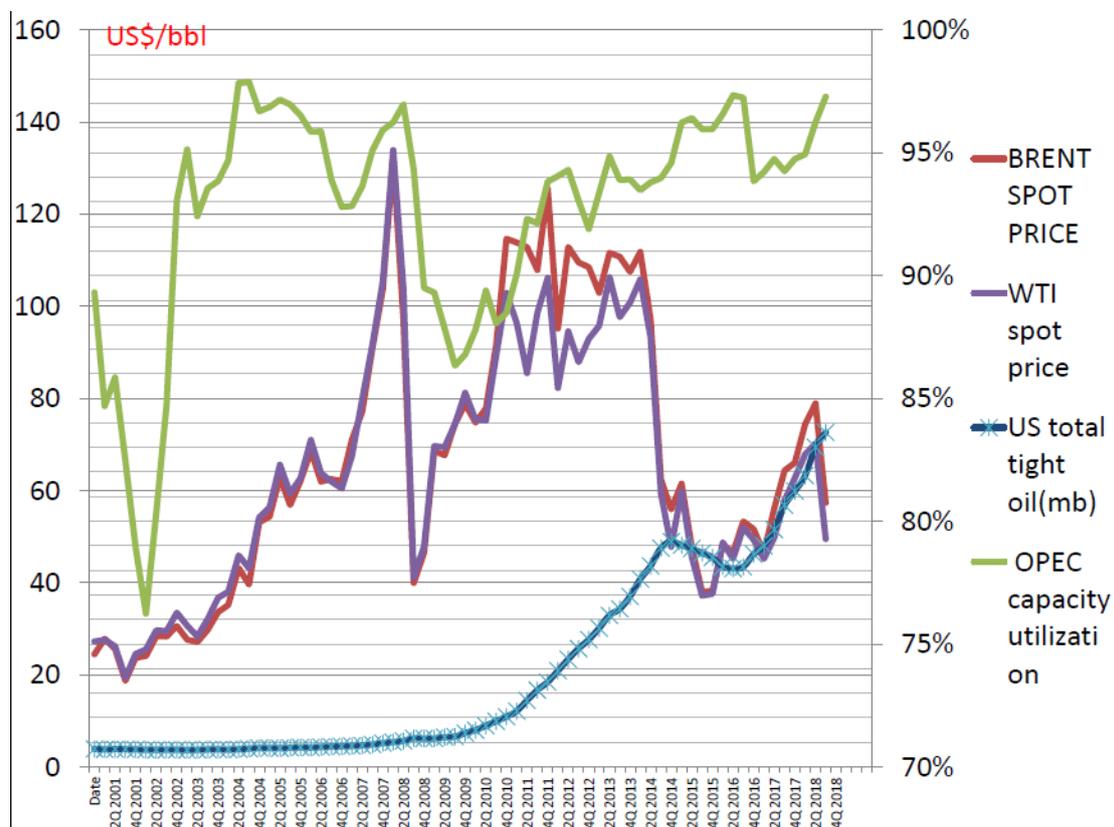


Figure 7. The trend of OPEC utilization rate, WTI, BRENT spot price and tight oil production in US. Data Sources: JODI data bank.

## 5. Conclusions

Visualization skill is more popular today with the help of ICT and big data. This paper using the dynamic visualization technique to draw some interesting slideshows based on the rich data from JODI data bank and some other data sources. From the dynamic bar line slideshows, it is much easier for us to capture the dynamic change for all countries. Based on this dynamic visualization skill, we found different oil market movement trend after 2016. Then we implement more analyses and found the shale oil production in US almost fully replaces the role of OPEC's utilization rate after 2017 from Figure 7. We think the crude oil price (BRENT) will not go too far away from \$60-\$80 US per barrel in the forthcoming years since shale oil reserve is still rich in the near future. However, recent record high oil production in US may imply less adjustment capability for cancelling out the effect of

production cut from OPEC, which will deviate oil price from the lower oil price band in past few year.

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