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## The Complexity of Crude Oil Prices

### SUMMARY

Energy is essential for life and vital for development. Affordable energy directly contributes to reducing poverty and improving productivity and the quality of life. This paper discusses three groups of factors that affecting crude oil prices.

**Journal of Economic Literature (JEL) codes:** D84, L71, Q31, Q41

**Keywords:** oil price, consumption, market changes, price fluctuation

### INTRODUCTION

According to many researchers, the correlation between supply and demand was the main factor driving oil price fluctuations in 20th century. For some time after the end of the Gulf War in 1991, oil prices remained relatively stable around USD 20 per barrel. A minor decline caused by the Asian economic crisis was recorded in 1997-1999, but after the US economy recovered from the 9/11 attacks in 2001, the price of oil started to dramatically rise.

Initially, price growth was attributed to fundamental factors such as production cuts by OPEC against steadily rising global demand in both developed and developing countries. According to EIA (2017), oil demand in China alone grew by 15% in 2004. However, according to the same source, global growth in consumption was gradual throughout the entire period analysed and did not exceed production increase. Kaufmann (2011) emphasizes that even though the volume of production did not change dramatically, increase in oil prices could still be caused by supply-side fundamentals. Non-OPEC countries are usually seen as price takers in oil production, and OPEC states follow some form of a strategic behaviour. This means that an unexpected change in the market share of OPEC producers can generate a supply shock. According to Kaufmann (2011), this is exactly what happened in 2004, when a decade-long steady growth in non-OPEC production was over and was compensated by growth in OPEC production.

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RESULTS

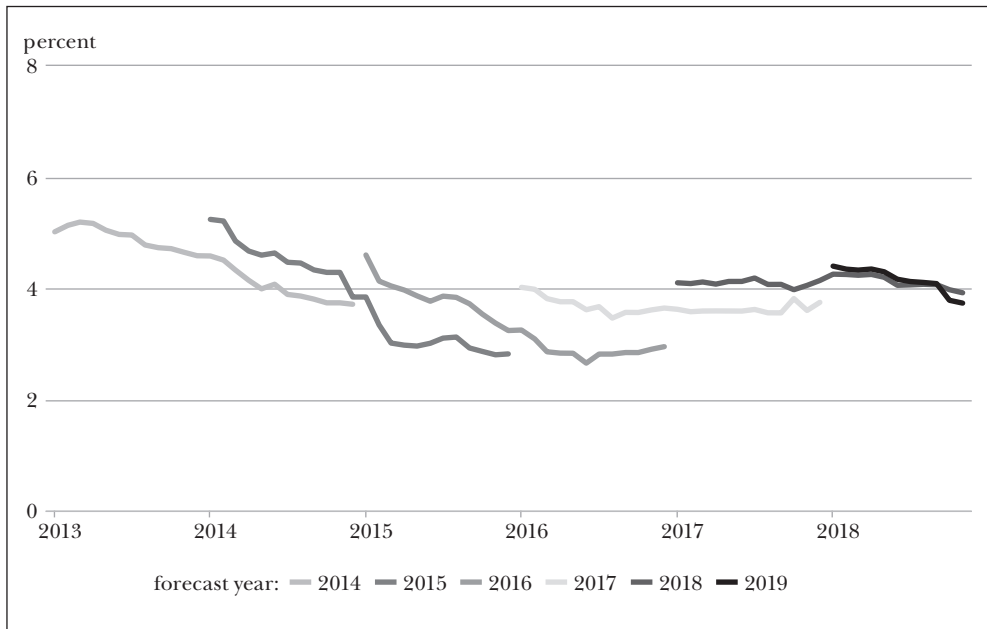
*Supply-demand fundamentals*

The structural conditions in a country's economy influence correlation between oil prices and economic growth. In developing countries a higher ratio of the economy comprised manufacturing industries, which are more energy intensive than services. Although the amount of oil used for transportation usually represents a smaller share in the total oil consumption in non-OECD countries, it tends to increase rapidly, as expanding economies increase the need to move goods and people. The per capita vehicle ownership also correlates highly with rising incomes and has considerable room to grow in non-OECD countries. For these reasons, non-OECD economic growth rates tend to be an important factor affecting oil prices. As a result of China's strong economic growth, it has become the largest energy consumer and the second larg-

est oil consumer in the world. In addition, China's rising oil consumption has been a major contributor to incremental growth in worldwide oil consumption. EIA predicts that virtually all the net increase in oil consumption in the next 25 years will come from non-OECD countries.

While oil consumption is primarily related to the current economic activity, changes in the outlook for future economic conditions can also have an immediate impact on oil prices. An improvement in the economic outlook tends to increase the chance of future tightening in the oil markets, which in turn results in higher expected future oil prices. This change in expectations is then reflected in higher oil futures prices. Rise in futures prices increases the incentive to hold inventories, which in turn decreases the available current supply and tends to raise current prices. Figure 1 shows how the projections of economic growth in non-OECD countries have changed over time for various forecast years. Estimates

Figure 1: Changes in the expectations of economic growth can affect oil prices



Source: EIA, 2017

of economic growth for 2008 fell as the year progressed (as did oil prices), and growth estimates for 2009 increased steadily throughout the year (as did oil prices).

### *Speculation*

Market participants not only buy and sell physical quantities of oil, but also trade contracts for the future delivery of oil and other energy derivatives. One of the roles of futures markets is price discovery, and as such, these markets play a role in influencing oil prices.

Oil market trading activity involves a range of participants with motivations that vary, even within an individual participant. Some, such as oil producers and airlines, have a significant commercial exposure to changes in the price of oil and petroleum-based fuels, and may seek to hedge their risks by buying and selling energy derivatives. For example, an airline may want to buy futures or options in order to avoid the possibility that its future fuel costs will rise above a certain level, while an oil producer may want to sell futures in order to lock in a price for its future output.

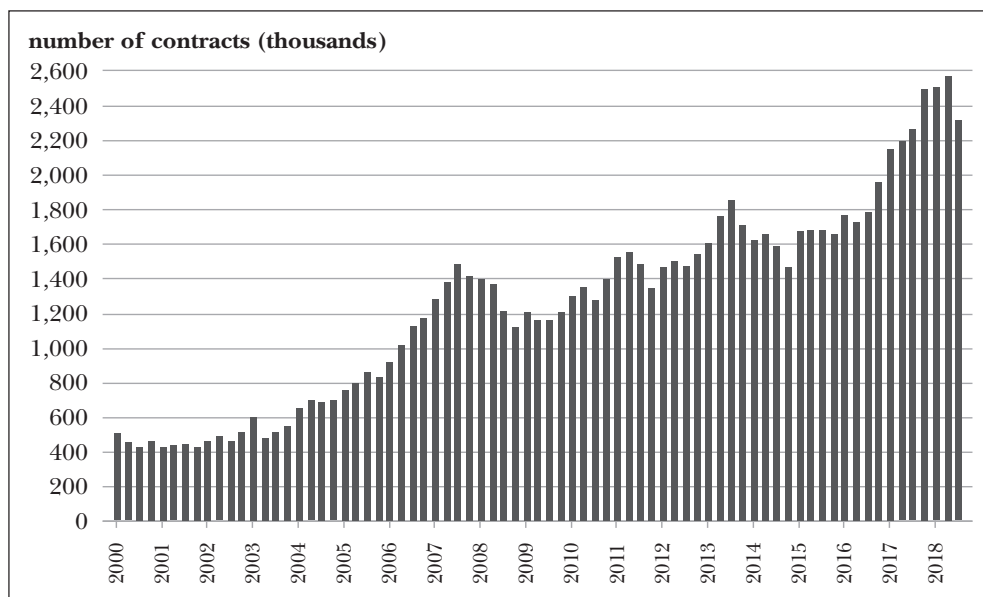
In recent years, investors have also shown interest in adding energy and other commodities as alternatives to equity and bond investments to diversify their portfolios or to hedge inflation risks. Every transaction must involve both a buyer and a seller, and the desired “long” buyer and “short” seller positions of those with direct commercial interests in the oil market do not necessarily equal each other. Banks, hedge funds, and other “non-commercial” investors can add liquidity to futures and derivative markets by taking the other side of transactions with commercial participants. On the other hand, concerns have been raised that non-commercial commodity trading and investment may “use up” liquidity and amplify price movements, particularly at times when a momentum runs strongly in a particular direction.

Activity in commodity exchange contracts has risen in recent years. One measure of activity in futures markets is open interest on exchanges, which indicates the number of contracts in a trading session that have not been settled or closed. Open interest on exchange-traded crude oil futures contracts increased substantially over the past decade, as measured by the New York Mercantile Exchange (NYMEX), the main commodities exchange for energy products in the United States. Both commercial participants (those that have a direct interest in physical oil production, consumption, or trade) and non-commercial investors (money managers and funds that are interested in trading contracts for investment and diversification purposes) have shown increased trading activity.

Care must be taken in interpreting these data, however, because the vast majority of positions are held in the less transparent over-the-counter (OTC) market rather than on stock exchanges. In addition to futures contracts, another way for market participants to invest in crude oil is through the buying and selling of options contracts. Options allow for investment exposure with limited potential for losses and provide an insurance-like instrument against adverse commodity price movements. Figure 2 shows the quarterly average of the number of outstanding oil futures contracts at the end of each NYMEX trading day. Trading in oil futures increased substantially with increase in crude oil as investment between 2003 and 2007.

The strong world economy between 2003 and 2007 with an average global growth rate of almost 5% (IMF) resulted in excess global liquidity and a subsequent boom in financial markets. Numerous new financial derivatives were created, and large amounts of speculative funds were invested in crude oil futures. New actors appeared on the crude oil market, taking long positions on futures contracts to profit from price fluctuations rather than hedging the risk of physical commodity prices. The role

Figure 2: Open interest growth in crude oil futures exchanges



Source: EIA, 2017

f extrapolative expectations in oil price rise was described by Masters (2008) and empirically confirmed by (Cifarelli–Paladino, 2009). Crude oil markets are beginning to show new features, they are now increasingly interrelated with other financial markets, such as the exchange rate market, stock markets and the futures market (Fan–Xu, 2011). Oil is traded globally in US dollars and is closely tied to its value. Based on this, Bhar and Malliaris (2011) argue that depreciation in the US dollar is one of the factors causing increase in oil prices, as oil suppliers demand their compensation for the declining value of this currency.

Fan and Xu (2011) identify the “bubble accumulation” period between March 2004 and June 2008, when vast amounts of global hedge funds started to pour money into the energy futures market, which thus promoted the forming of commodity price bubbles, especially in oil futures market. Despite a delicate balance, the supply and demand fundamentals did not seem to be important driving forces affecting crude

oil price changes. This is in line with Kaufmann and Ullman (2009), who assumed that the oil market might have undergone structural changes in September 2004.

June 2008 was marked by another structural break. Influenced by the 2008 financial crisis and global liquidity shortage, oil positions were rapidly closed, investment funds started to withdraw from oil futures markets, and the price of crude oil crashed. During this time, speculation was not driving force of crude oil prices anymore, and role of economic fundamentals was re-established.

During the global financial crisis (2008–2009), markets saw a dramatic increase in the correlation between crude oil and other commodities, as demand decreased for raw materials. However, both before and after the world economic slowdown, there were observable increases in the correlations between commodity prices. At the same time as this rise in correlations was a rise in interest in general commodity exposure. A growing number of investors were exposed to risk in commodities by investing in index-funds

market instruments that pose exposure to commodity baskets. These index funds usually establish shares in various energy and other commodities to provide diversity across a range of commodities. Exchange traded funds (ETFs), bought and sold throughout the day like individual common stocks, are also an increasingly popular means for investors, including individuals, to gain exposure to commodities as an asset class.

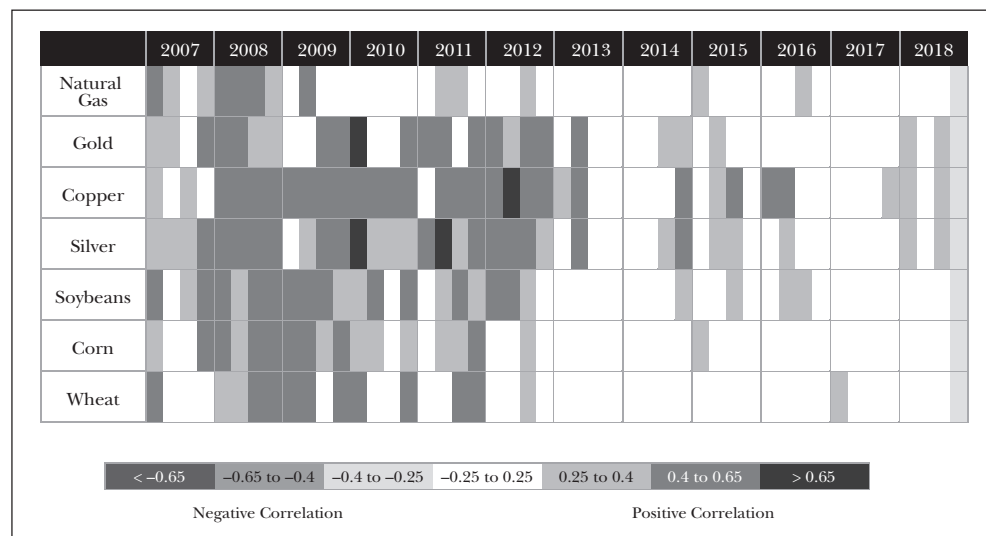
Correlation is not the same as causation, however, and the relationship between crude oil and other financial markets is complex. Even with observed movements in correlation levels, the mutual influences between crude oil price changes and changes in values of other asset classes are unclear. It is possible, for example, that high correlations are due to several primary relationships with a third common factor, such as economic growth expectations. Another complicating factor is that these relationships and their strength vary over time. The prices of crude oil and other commodities started to move together in recent years. The darker colours in Figure 3 indicate higher correlations (co-

movements) between the daily price changes of crude oil futures and several other commodities futures, calculated for each quarter. Interestingly, the historically strong correlation between oil and natural gas prices has recently ceased in North America, as natural gas prices have been kept down by the rapid development of shale gas.

Prior to 2007, stocks, bonds and exchange rates showed only infrequent, fleeting correlations to oil futures prices. In contrast, the price of crude oil showed positive correlations with stocks between 2008 and 2010, negative correlations with the value of the US dollar during most of the period between the late-2007 and the present, and more irregular but often negative correlations with bond prices during 2008 and 2010.

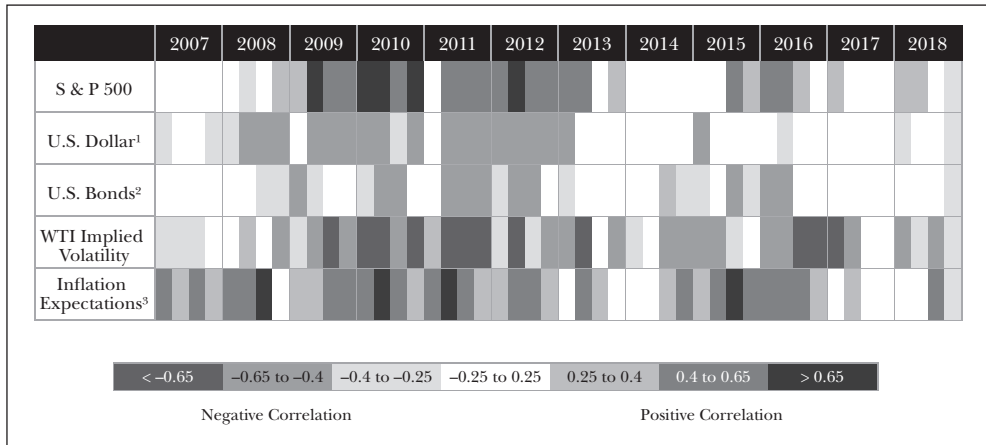
For each asset class, there are financial, physical and common underlying economic factors, such as the economic downturn and recovery, that may influence these more significant correlations. Financial factors include developments such as the growing interest in crude oil as an investment asset over the last decade. This investment interest has

Figure 3: Correlations between the daily changes in the futures prices of crude oil and other commodities



Source: EIA, 2017

Figure 4: Correlations between daily returns on crude oil futures and financial investments



- <sup>1</sup> U.S. Dollar Index (DXY), which is a weighted index of a basket of currencies, per U.S. dollar. As the dollar strengthens against other currencies, the value of the index rises.
- <sup>2</sup> U.S. bonds is based on the negative of the change in yield on 30-year U.S. government bonds because as yields rise, bond prices fall.
- <sup>3</sup> Inflation Expectations are based on daily changes in the 5 year Treasury - TIPS (Treasury Inflation Protected Securities) spread.

Source: EIA, 2017

altered financial money flow into and out of commodities. Physical crude oil markets can also be influenced by external factors. Exchange rates and economic factors play a role in crude oil production and consumption, possibly leading to price correlations. Figure 4 shows the correlations (co-movements) between oil futures prices and other financial markets on a daily basis. In recent years, oil prices and the S&P 500 have tended to move together, while oil prices have tended to move in the opposite direction of the dollar exchange rate and Treasury bonds.

*Extreme and irregular events*

Zhang et al. (2009) define extreme events as events which have serious impacts on crude oil markets lasting several years. Examples are the Gulf War of 1990-1991 and the recent global economic crisis. Irregular events are defined as events which have important but short-term effects on crude oil prices. Selected geopolitical events contributing to oil

price development are captured in Figure 4, which shows, as also confirmed by numerous authors, that extreme and irregular events can act as driving forces for crude oil price fluctuations in both long and short term.

Much of the world’s crude oil is located in regions that have historically been prone to political upheaval or have had their oil production disrupted due to political events. Several major oil price shocks have occurred at the same time as supply disruptions triggered by political events, most notably the Arab Oil Embargo in 1973-1974, the Iranian revolution and the Iran-Iraq war in the late 1970s and early 1980s, or the Persian Gulf War in 1990. More recently, disruptions to supply (or curbs on the potential development of resources) by political events have been seen in Nigeria, Venezuela, Iraq, Iran and Libya (EIA, 2017).

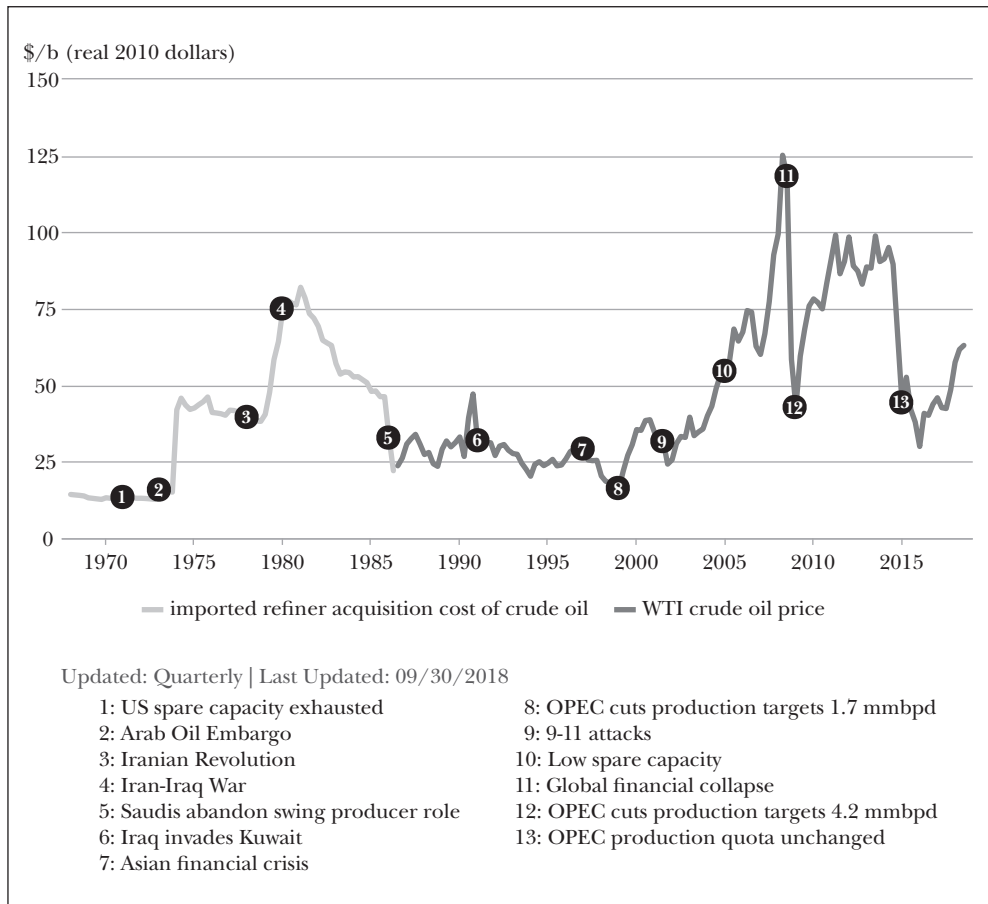
Given the history of oil supply disruptions emanating from political events, market participants are always assessing the possibility of future disruptions and their potential im-

pacts. In addition to the size and duration of a potential disruption, they also consider the availability of crude stocks and the ability of other producers to offset a potential supply loss. For example, if the market has ample spare production capacity to offset a possible disruption, its likely impact on prices would be smaller than if spare production capacity was much lower. When there are significant concerns about the potential for a disruption at a time when spare capacity and inventories are not seen as sufficient to substantially offset the associated loss in supply, prices may be above the level that might be expected if only current demand and supply

were considered, as forward-looking behaviour adds a “risk premium”.

Weather can also play a significant role in oil supply. Hurricanes in 2005, for example, shut down oil and natural gas production as well as refineries. As a result, petroleum product prices increased sharply as supplies to the market dropped. Severely cold weather can strain product markets as producers attempt to supply enough of the product, such as heating oil, to consumers in a short amount of time, resulting in higher prices. Other events such as refinery outages or pipeline problems can restrict the flow of oil and products, driving up prices.

Figure 5: Crude oil prices and special events



Source: EIA, 2017

However, the influence of these types of factors on oil prices tends to be relatively short lived. Once the problem subsides and oil and product flows return to normal, prices usually return to previous levels (EIA, 2017).

Zhang et al. (2009) also claim that the amount of extreme and irregular events is bigger in recent years of high crude oil price volatility.

Figure 5 presents the correlation between crude oil prices and various events.

### *Quality differentials*

Crude oil is traded in a global market. Prices of the many crude oil streams produced globally tend to move closely together, although there are persistent differentials between light-weight, low-sulphur (light-sweet) grades and heavier, higher-sulphur (heavy-sour) crudes that are lower in quality. Many types of crude oil are produced around the world. Variations in quality and location result in price differentials, but because oil markets are integrated globally, prices tend to move together.

### SUMMARY

Most researchers agree that the role of factors changed over time, and there were structural breaks in crude oil price development. However, there is no consensus among the authors on the specific inputs by each factor, which causes especially intense debates about the reasons for the high volatility of oil prices in recent years. Inter alia, Masters (2008), Cifarelli and Paladino (2009) and others argue that speculative attacks have had a key role in crude oil price development since 2000. An analysis by Hamilton (2008) revealed that price increases were caused by strong global demand and that speculation alone is insufficient to explain rapid growth in oil prices. Supply-side changes are the subject of Kaufmann's studies (2011).

In any case, a single factor can hardly explain crude oil price development and the especially high volatility seen in recent years. With the evolution of financial markets, the driving mechanism has become more complex. Moreover, we should keep it in mind that various factors are responsible for the long-term trend and the short-term price speculations.

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