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Introduction

The Oil Games is a series of interconnected episodes in which we explain market behavior using Kayrros’ extensive knowledge of the energy industry, mathematics, and game theory in particular. The series’ target audiences include the practitioners, investors, and observers of the oil industry who are interested in finding new ways of understanding this fascinating business.

Episode 3 showed us how game theory can help us understand the balance between OPEC and the rest of the world’s producers. It has shown the need for an arbitrator such as OPEC, it has explained why OPEC market share is so stable, and it has given us a formula for future OPEC-NOPEC deals. It has not, however, dealt with the effect of the rapid rise of shale oil production, nor has it explained the gap between the market share predicted for OPEC by game theory, and that actually achieved. In this episode of the Oil Games, we begin to understand how shale oil has changed the market—at least in the short term.

Schumpeter returns to the spotlight

For a number of years now we have been witnessing new companies, driven by disruptive innovation, change the world or make long-established industries and companies obsolete. Creation has perhaps never been so destructive since the Jacquard loom revolutionized the textile industry at the beginning of the 19th century with its punch-card technology—thereby maybe making it the first disruptive digital innovation that destroyed many jobs in the process.

Two hundred years later, if we were to name another industry, characterized by disruptive innovation, but born and developed in the US this time, and which in just half a dozen years has impacted the whole world and created a turnover of more than 100 billion dollars every year, we would probably think of the quartet of Google, Apple, Facebook and Amazon—collectively known as GAFA.

Indeed, with the rise of GAFA, as well as with the smartphones that have invaded the planet in less
than ten years, the explosion of digital photography and the bankruptcy of Kodak, the development of social networks and the decline of traditional media, everything in our daily lives has been transformed. Moreover, whole economic sectors around the world have been upset in a tidal wave of creative destruction that perfectly illustrates Schumpeter’s capitalism.

Contrary to this view, however, it could be also said that it is not really GAFA that deserves the gold medal of Schumpeterian performance at all. For over the seven years between 2007 and 2014, the rapid rise of shale oil production in the US must make it the real undisputed champion—growing by a factor of 12 to turnover $200 billion in 2014. In comparison, GAFA grew by a much more modest factor of six over the same period.

Of course, such lightning-like growth has victims—just as Schumpeter explains.

**Disruptive Innovation, or a Flash in the Pan?**

Back in 2014, we could have asked the question whether shale oil was indeed the disruptive innovation that would completely change the oil game, or would it just be a flash in the pan sparked by a decade of stratospheric oil prices?

Four years ago, those who thought that the US shale oil industry was indeed a disruptive innovation had two key arguments to make. The first was that the growth rate of the new industry over the prior seven years had been that of a disruptive industry—comparable to, or even greater than, the pace and scale of GAFA. The second was that the technical and economic characteristics of shale oil production were at odds with those of conventional oil.

In fact, disruption would be complete between the economic models of shale oil and conventional oil production.

In the shale oil industry, investments are much smaller—being in the millions of dollars while conventional oil investments run to billions. For shale oil, investment decisions are made on the scale of a small number of wells producing a few hundred thousand barrels per day. In conventional oil, billion-dollar investment decisions lead to production in the tens or hundreds of millions of barrels per day. Even though shale oil projects have become much larger and more complex in the last few years—requiring more extensive and time-consuming planning than they did in earlier days—their scale remains small compared to typical conventional oil development particularly in deepwater areas.

The shale oil lifecycle from exploration to abandonment continues to be measured in years, compared to decades for conventional oil. Operators can be 10 or even 100 times smaller than their conventional oil counterparts. They are often independent contractors, making rapid decisions, and taking measured short-term risk.

For conventional oil, the size of the decisions, the amount of the investment, and the duration of the cycle requires companies of tremendous financial size and strength. This places constraints on decision making and risk through the inertia of size that brings inevitable structural slowness.

There were therefore many arguments in 2014 to think that the DNA of shale oil would be as disruptive as that of the GAFA industries. But at the same time, however, there were also many people who thought that shale oil would be nothing more than a flash in the pan. Their main point was the cost of production. At the start, this was very high, and seemed incompatible with oil prices below $100 per barrel.

By 2014, it became urgent to settle the debate. If shale oil was not a temporary phenomenon, then it could indeed be a game-changer for the oil industry as a whole. This would not be insignificant from the geopolitical point of view. At the same time, if it were to be a flash in the pan, then it would be important to extinguish it quickly before it spread too rapidly. Even in 2014, the market share of shale oil looked as if it might overshadow even the biggest players in the sector.

That same year, however, growth in shale oil production led to oil prices showing signs of feverishness after a decade of high prices that had been driven upwards by more than $100 per barrel.

When the market expects prices to decline, storage levels fall. And when storage has dropped to the minimum needed for industrial demand and national security, backwardation sets in. From mid-2013 onward, long-dated oil futures fell $15 per barrel below the spot price. In other words, the market was anticipating a sharp drop in price while at the same time perceiving that little available storage capacity remained to permit physical arbitrage.
Yet in defiance of market expectations, the prices of both Brent and WTI remained above $100 per barrel until the second week of July 2014, although they had begun to slip some three weeks earlier. During the following six months, prices halved. Saudi Arabia then decided to accelerate the decline, pushing prices to their lowest levels for many years. By February 2016, prices were below $30 per barrel, having plunged in what could be considered to be a crash test for the US shale oil industry. Whether or not this was intentional, the test would help answer the question of shale oil being a game changer or not.

We now know the answer, but the price to pay has been very high for all producers—of both shale and conventional oil. When the worst of the downturn ended in 2016, and prices recovered to $50 per barrel, it was apparent that shale oil was no longer a flash in the pan.

**Here to Stay**

Between 2014 and 2016, US shale oil showed a degree of resilience not anticipated by the majority of observers. During this period, US production declined by no more than 6%, and production costs were greatly reduced. This was due to three factors—operational productivity gains, technical innovations, the concentration of new wells in the best areas, and the best possible well profiles. In 2016, it had become clear that shale oil production could grow again—even with oil prices at levels of only $50 per barrel.

For producers of conventional oil, however, the crash test had done a lot of damage. For Saudi Arabia, the loss of revenue is difficult to assess—but the order of magnitude is probably at least $150 billion. This is sizeable enough to require some adjustment of national budgets, but is perhaps ultimately a reasonable cost if it clarifies the answer to our question. Indeed, the dominant feeling after the crash test of 2014-2016 was more a matter of greater regret in having to accept the resilience of US shale oil production with its long-term implications than any regret linked to the shortfall in past revenue.

For the conventional oil players, the crash test has been hard, and one in which many of them have shown less resilience than the US shale oil industry itself. This difference can be explained by each industry’s economic model. Shale oil production is young and innovative, and a business that is used to a pace and a management method ten times faster than that of conventional oil development. During the crash test, the shale oil industry had enough time, agility, and speed to engineer significant transformation. Conventional oil production has never possessed the same rhythm or economic logic. Two years is short for conventional oil development, with any change in process requiring considerably longer.

As a result, the crash test led to huge losses in revenue for the conventional oil industry, raising important questions about the future. Many of the players do not have shoulders as broad as Saudi Arabia and will suffer accordingly. The story of Kodak, derailed by
smartphone manufacturers integrating digital photo and video technology into their devices, is testimony to the ability of destructive creation to bankrupt a company. Today, Venezuela is unfortunately the first oil producer to have found that new and disruptive technology in the oil industry can lead to a similar result on a much greater scale.

By 2016, therefore, a new competitive element had settled permanently in the world of oil. OPEC needed to adapt its strategy to the existence of two very different competitive groups. Not only would the organization compete with other conventional oil producers, it would also need to compete with the very different nature of the US shale oil industry that had clearly demonstrated that it was here to stay.

The Winds of Change

But as innovative and disruptive as the US shale industry may be, we can also argue that despite the oil game having significantly developed, it has not undergone any profound structural change. To understand this, we need to explain what has significantly changed as well as what has remained unchanged.

To start with, the shale oil industry reconfigured itself after the collapse in the price of oil between 2014 and 2016. It became much more efficient, entrepreneurial, and responsive. Its costs had been significantly reduced, and it could be profitable with oil at $50 per barrel. Not only that, if prices were to double, the industry could easily add 1% of total world production every year, just as it did between 2009 and 2014.

Yet some of the improvements in cost efficiency achieved by the shale oil industry have come at the cost of less agility. Projects are more complex, requiring more planning, longer lead times, and higher initial capital investment—at least at the margin. The costs of shale wells per thousand feet have declined, but the cost of individual projects has gone up significantly. As projects are now much larger, some of the gap in cost between shale and conventional oil has been bridged. It should also perhaps be noted that while the costs of shale wells per thousand feet have declined, the production per length of completion has stagnated despite the massive increases in the volumes of water and sand injected.

More importantly, it also appears that shale oil production may have limited scalability. The technology and the socio-economic context of US shale has so far proved difficult to replicate elsewhere on a similar scale although the Vaca Muerta in Argentina and the Bazenhov in Western Siberia offer significant potential. Sometimes, US shale technologies have failed in different geological contexts, as it seems to be the case in China. Sometimes the socio-economic context so favorable in the US, such as transport infrastructure or social acceptance of potential environmental risk, cannot be found elsewhere. The total ban on shale oil exploration in France is an example of this.

It seems now clear that even if the price of oil were to rise above $100 per barrel, production from shale will initially remain mainly concentrated in the US—unlikely to exceed a global limit around 12 million barrels per day. While this is significant, it represents only a fraction of world production and leads us to two important but somewhat contradictory characteristics.

In the short term, meaning a two- to three-year horizon, the importance of shale oil production is considerable since it can grow at a rate of 1% of world production each year. In the long term, however, it does not fundamentally change the balance since it cannot easily exceed 12-15% of world production—meaning that the producers of the remaining 85% of global supply remain in the same strategic position as before.

We can therefore say that shale oil is a short-term price stabilizer. This is the natural result of its ability to react quickly to rising prices and bring substantial new production on line. At the same time, with drilling and production cycles of less than two years, shale oil is perfectly compatible with investment maturities traded on the financial markets. Thus, the shale oil industry lends itself easily to hedging with dynamics closely linked to the financial markets and to the two-year oil futures curve in particular.

It should be noted in passing that price volatility is damaging to the shale oil industry as price variations between $40 and $70 per barrel trigger activity to stop and start. Conventional oil development, with its greater inertia, is less affected. It is therefore possible that fluctuations in price could favor conventional oil, or at least constitute a weapon against shale. However, the shale oil developers have good access to the financial markets and can hedge against this risk of volatility.

It should also be noted that any boom in the number of wells drilled but not completed is probably related
to the luxury of being able to decide whether or not to produce a given well in the immediate term. This is an option of great value when volatility is high, increasing in value in line with volatility.

On the other hand, there is no strong reason yet to believe that shale oil production is changing the long-term cyclical logic of the conventional oil industry, which continues to represent about 85-90% of total production. After all, price fluctuations over 10 to 15 years are probably the result of the time between initial investment and first oil, and of the unforeseen shocks that affect both demand and geopolitics.

At the same time, long periods of pressure on commodity prices have usually triggered the development of a variety of new technologies, as can be seen in the successive phases of the offshore oil industry. After their introduction and deployment, new technologies have typically lowered cost per barrel.

In this scenario, the short-term responsiveness of shale oil will help. But when US shale production reaches its limit, we will return to the long-term logic of supply, with the combination of increasing demand and declining production on the back of insufficient investment leading once again to a sustainable period of high prices similar to those of the 2014 to 2014 decade.

This brings us back to our modeling of the interaction between OPEC and the rest of the oil industry. This was one of the subjects of the previous episodes of the Kayrros Oil Games. It will be the subject of our next episode.

From One Shock to the Next

Oscillations in the price of oil seem to have a natural rhythm of their own, with a frequency of the order of ten to fifteen years. But they are also modulated and reinforced by external shocks, such as the rapid increase in Chinese demand in the high price decade from 2004 to 2014. It should also not be forgotten that the rapid growth in shale oil production that began in 2007 was itself a huge shock for the global oil industry, and that it led to the usual collapse in price and consequent sharp drop in investment. This will inevitably lead to insufficient production on a horizon of three, five or seven years depending on the possible arrival of the next demand shock, perhaps from India.