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Financial Management

The shale oil boom and global oil majors

Liuskeöljybuumi ja monikansalliset öljy-yhtiöt

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ABSTRACT

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This bachelor's thesis studies the United States based shale oil boom and how major global oil companies are participating in it. The United States has seen enormous growth in domestic crude oil production during the last decade. This growth is attributed to shale oil. This development has made the United States world's largest crude oil producer and net exporter of crude oil. Though there has been strong volatility in price of oil over the past decade, the shale oil production growth has been resilient.

Global oil majors have become increasingly interested in participating in this boom. This study examines, how five large multinational oil companies have participated and invested in shale oil production. The study utilizes public data and information provided by the companies.

Apart from one company, all the global oil majors studied in this thesis have invested in shale oil production. These investments have included land acquisitions and corporate acquisitions. The companies involved also see their shale oil investments clearly as a strategic growth asset. Though there are three large shale oil basins in the United States, the companies involved in shale oil are heavily concentrating their investments to the largest shale oil basin, the Permian. The companies also highlight major technological advancements and productivity improvements as a rationalization for investing to shale oil production. The companies also benefit from scale and being able to operate in an integrated model, where they can capture the full petroleum value chain from exploration and production to refining and marketing.

TIIVSTELMÄ

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Tämä kandidaatintyö tutkii Yhdysvaltojen liuskeöljybuumia ja sitä, miten monikansalliset öljy-yhtiöt ovat osallistuneet siihen. Yhdysvaltain kotimainen öljyntuotanto on kokenut valtaisaa kasvua viimeisen vuosikymmenen aikana. Tämä kasvu on liuskeöljyn ansiota. Tämä kehitys on tehnyt Yhdysvalloista maailman suurimman raakaöljyntuottajan ja raakaöljyn nettoviejän. Vaikka öljyn hinta on vaihdellut voimakkaastikin viimeisen kymmenen vuoden aikana, liuskeöljytuotannon kasvu on siitä huolimatta jatkunut.

Monikansalliset öljy-yhtiöt ovat viime vuosina kiinnostuneet entistä enemmän liuskeöljybuumista ja siihen osallistumisesta. Tämä tutkimus tarkastelee, kuinka viisi monikansallista öljy-yhtiötä ovat osallistuneet ja investoineet liuskeöljytuotantoon. Tutkimuksessa hyödynnetään yhtiöiden tuottamaa julkista aineistoa.

Yhtä yhtiötä lukuun ottamatta, kaikki tutkimuksen monikansalliset yhtiöt ovat investoineet liuskeöljytuotantoon. Nämä investoinnit ovat sisältäneet maaostoja sekä yritysostoja. Yhtiöt näkevät liuskeöljytuotannon selkeästi strategisena kasvualueena. Vaikka Yhdysvalloissa on kolme suurta liuskeöljymuodostumaa, yhtiöt ovat keskittäneet liuskeöljyinvestointinsa suurimpaan muodostumaan, Permianiin. Yhtiöt painottavat merkittäviä teknologisia edistysaskeleita ja tuottavuuden parantumista perusteluna liuskeöljytuotantoon investoimiselle. Yhtiöt hyötyvät myös mittakaavaeduista ja integroidusta toimintamallista, joka auttaa saavuttamaan öljyteollisuuden koko arvoketjun öljyn etsimisestä ja tuotannosta jalostukseen sekä markkinointiin.

Contents

1. Introduction

In 2018, world's average consumption of crude oil was 99.2 million barrels per day, up from 75,9 million barrels of crude oil per day consumed in 2000 (Statista 2019a ; IEA 2001, 5). During the 2000's, there has been increasing discussion about moving to renewable energy sources and certainly a lot of effort has been put into that transition. Despite these efforts, daily worldwide oil consumption increased by over 30 % between years 2000 and 2018 (Statista 2019a ; IEA 2001, 5). It seems that the world is still heavily dependent on crude oil as a resource. McKinsey (2019) estimates, that the global oil demand will grow 0.5% annually from 2020 until 2035.

Crude oil is still an important raw material in today's society. It is used as a raw material for different plastics and as a fuel for different industries. Oil can be refined into gasoline, kerosene and diesel to provide fuel for different transportation methods. (Speight 2017, 1) Transportation is probably the most evident sector, where we are still heavily dependent on fossil fuels.

Chart 1 suggests that oil still makes a considerable amount of the world's total primary energy supply.

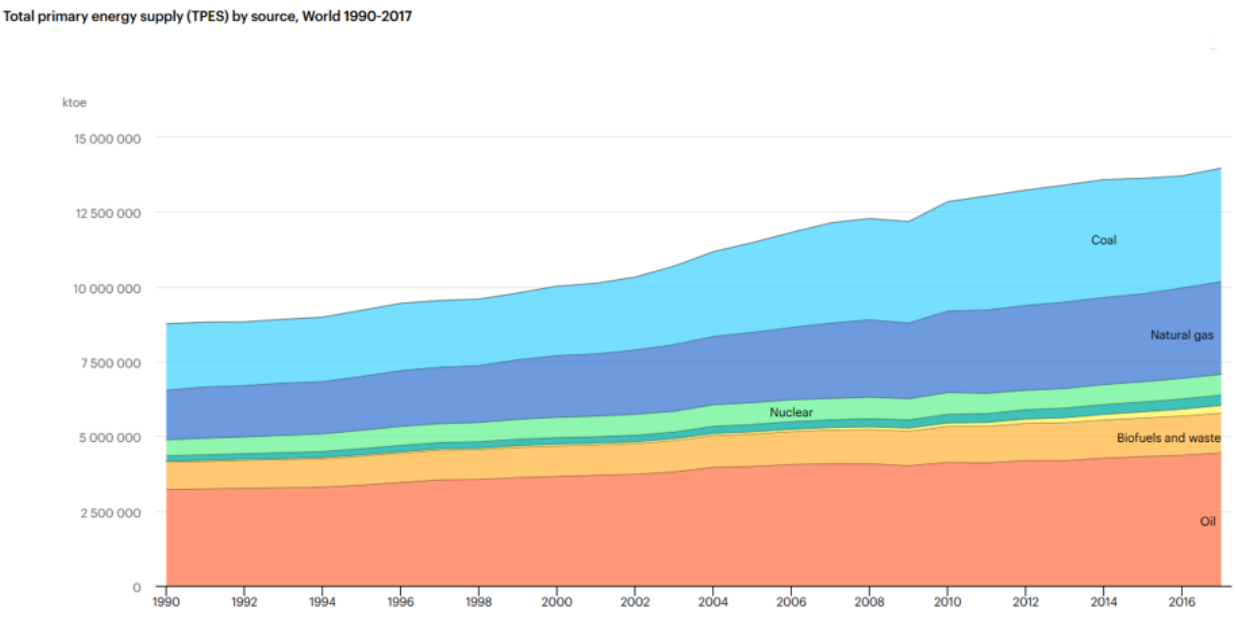

Chart 1. Total primary energy supply (TPES) by source, World 1990-2017 (IEA 2019a)

Despite crude oil being a finite resource and having had a steady demand growth, after 2014 the average annual price of crude oil has been at 50 dollars per barrel after seeing average annual prices of as high as almost 100 dollars per barrel in early 2010's (Statista 2019b). What caused the price of oil to drop in 2014 from these high levels despite steady increase in demand?

Though there are multiple factors that drive changes in price of oil, Baffes, Kose, Ohnsorge and Stocker (2015, 11) named greater than anticipated supply from unconventional sources, namely shale oil from the United States as one factor driving the price of oil. The World Bank also stated in their report in 2018 that the collapse in oil price experienced in 2014-2016 was mainly due to booming US shale production and gained efficiencies in that production. (World Bank 2018, 52).

According to U.S Energy Information Administration (EIA 2019a), after mid 2000's United States based shale oil production has experienced a sharp rise, as can be seen from chart 1 where shale oil production is highlighted as the colored area and referred as tight oil.

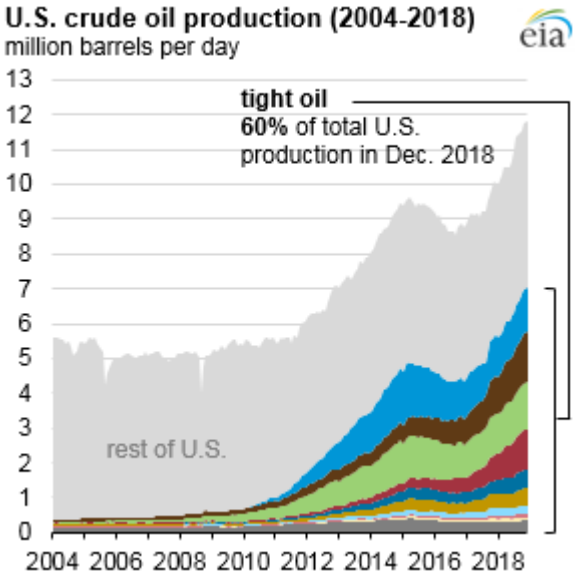

Chart 1. US crude oil production 2004-2018 (EIA 2019a)

The International Energy agency (IEA 2019b) estimates in their base case scenario, that by 2024 the United States based shale oil production will rise further to almost 10 million barrels per day from the 6,44 million barrels per day of shale oil production in 2018, estimated by the EIA (EIA, 2019b).

Shale oil is frequently referred as tight oil in the media and vice versa, though EIA prefers to use the term tight oil. According to Maugeri (2013, 2), most of the US shale formations are in effect tight oil formations. There are some differences between these two terms. Shale oil reserves are fissile and have a lot of clay, they are also separated in different layers. Tight oil formations consist of mixture of quartz and other minerals which is called siltstone, they can also consist of mudstone, but there is not a lot of clay in place. However, majority of tight oil formations look like shale on data logs and this is why the term shale has continued to be popular in both media and literature. (Maugeri 2013, 2) For the sake of clarity, shale oil -term will be used throughout this study as it has been dominantly used in academic literature and public.

The term "Oil Majors" is widely used when speaking about world's largest oil companies. The definition is not always standard. The set of companies that fall under the term, has also varied over history as there have been mergers and acquisitions in the industry over time. According to the Herold's Financial Dictionary, the companies that belong to oil majors are considered to be the following: BP plc, Royal Dutch Shell plc, Exxon Mobile Corporation, Chevron Corporation, ENI SpA, Total SA. ConocoPhillips is sometimes included in this list too, but less often after the company was split in two. Often these companies are called by the term "Big oil" too. (Herold's Financial Dictionary, 2019)

These oil majors are increasingly present in US shale oil boom. According to Jennifer Hiller of Reuters, these companies are aggressively moving into the Permian shale formation, which is considered the top US shale oil field (Hiller, 2019). Exxon Mobil and Chevron have presented aggressive plans to expand their presence and production in shale oil, as both own sizable land positions in the Permian formation (Jacobs, 2018).

The purpose of this thesis is to investigate the shale oil phenomenon and how the oil majors are participating in the booming shale oil production. Though there are many aspects to shale oil, such as environmental viewpoint and technical viewpoint. The focus of the empirical part of this study will be on the economic viewpoint.

1.1 Prior research

The shale oil boom has caused sizable attention in the media during 2010's. Some books have been written on the theme as well over the years.

There has been a fair amount of academic research done regarding shale oil, despite the surging production growth in the United States is just barely a decade old phenomenon. Shale oil itself as a resource has been known and there has also been research on it around the world.

For example, Kryukov and Moe assessed (2018, 41-50) whether fundamental conditions for developing Russia's vast shale reserves would exist. They concluded that it would be challenging to develop these resources in Russia because of different institutional landscape. They also noted that Russia's oil production is mainly dominated by a few large companies that may lack the flexibility and decision-making needed to develop shale projects.

Environmental aspect of the increasing shale oil production and the techniques used to extract the oil have also been a point of interest. Anand and Khan (2016) reviewed environmental problems and risks considering shale oil drilling techniques. Some of the risks they pointed at were, air emissions, surface spills, seismic events and high water usage. (Anand & Khan, 2016)

Maugeri (2013) studied the shale oil production in the U.S, covering many aspects like improving techniques and achieved efficiency gains, which have supported the growing production. However, he also noted that it is difficult to replicate the U.S shale boom globally, due to equipment being far less accessible internationally than in the U.S. (Maugeri 2013, 21)

The press has in recent years activated in writing stories how the multinational oil majors are planning to become major players in US shale oil. However actual research on this field has been scarce. Naumann and Philippi (2014) examined ExxonMobil's operations in shale gas fields in Europe. However, they concluded that it was increasingly difficult for the company to launch shale operations in these countries, despite, especially Poland looked very promising at the beginning. (Naumann & Philippi, 2014)

The lack of research in global majors' US shale operations might be due to fact that US shale formations have traditionally been dominated by smaller independent exploration and production companies.

1.2 Research problem, objectives and limitations

The objective of this study is to examine and present the ongoing shale oil boom in the United States and to find out how are the global oil majors participating in it. Though there has been research on shale oil production from economic perspective, there has not been much research on the companies that are participating in it.

The research question is:

"How are the global oil majors involved in US shale oil boom?"

With sub questions being:

What are the drivers for global oil majors to enter shale oil production?

What kind of challenges do the global majors face in shale oil production?

Is shale oil attractive to the companies in economic terms?

How does shale oil production benefit the integrated operating model?

Natural gas often comes as byproduct of crude oil. Shale boom has meant that natural gas production has also significantly surged hand in hand with rising oil production. However, this study concentrates on shale crude oil and does not include natural gas as area of focus.

Shale oil production can be examined from many different viewpoints. The major viewpoints have been economic, environmental and technical viewpoint. This study leans to economic viewpoint. However, a brief look at the environmental and technical aspects is necessary to understand the background and the context.

1.3 Structure of the study

This subchapter will present the structure of this study.

Chapter 1 is designed to give an introduction to this study by briefly presenting the themes of this study, which are crude oil and specifically US based shale oil production. In the first subchapter, there is a swift look at the previous research done on this field. The second subchapter will present the research questions and discuss briefly about the objectives and limitations of this study.

Chapter 2 will include theoretical background of this study. At the beginning, there will be a brief introduction to crude oil in general to gain some background for understanding shale oil. Then, the concept of shale oil will be divided into three subchapters, which will approach the concept from economic, technological and environmental viewpoint. After the subchapter of economic viewpoint, there is also a subchapter that will discuss competitive dynamics of oil exploration and production, using Michael Porter's theory of competitive strategy and advantages. Finally, at the end of chapter 2 there will be a brief look at the three largest and most important shale oil formations in the United States.

Chapter 3 will describe research methods that were used in this study. The chapter will also discuss the research data that was utilized in the study.

The following chapter 4 includes a brief introduction to each of the five case companies used in this study. This chapter will have basic information of each of the company studied in this thesis.

Chapter 5 will include the empirical part of this study. The chapter is divided into six different subchapters. Five subchapters are dedicated to each of the case companies, aiming to present how the companies are involved in the shale oil boom. Finally, there is a subchapter for discussion about the results.

Finally, chapter 6 will summarize this study by including discussion about the main findings, aiming to answer the research questions that were presented. Chapter 6 also includes discussion about the conclusions from this whole study.

2. Theoretical background

2.1 Crude oil

Crude oil is a liquid that contains a mixture of hydrocarbons. (Speight 2017, 2) It is formed from plants and animals that lived a long time, millions of years ago. (EIA 2019c) Oil and natural gas are then formed, when this organic matter is transformed by heat and pressure. Often, oil and natural gas are found together, though there are also formations that contain only one of them. (Fitzgerald 2013, 1338) Crude oil can be found stored underground in pools or reservoirs. It also exists within sedimentary rocks, in small spaces. Petroleum products which origin from crude oil are classified as nonrenewable energy sources, which means that they do not replenish in a short period of time (EIA 2019c ; EIA 2019d)

However, crude oil that exists in world is not homogenous. Quality of oil can vary widely, for example by gravity and sulfur content. Gravity is usually used to separate different crude oil qualities. Level of gravity can greatly vary between different oil qualities that are found in different parts of world. (Speight 2017, 2-4)

Geologic techniques are used to gain information about the existence of crude oil reserves. However, drilling is the only way to gain certain information of oil's presence in certain formation. Using modern technique that is available today, wells as deep as 9000 meters can be drilled. If oil is found after drilling, it can be brought to surface. (Speight 2017, 5)

Petroleum industry is usually divided into three segments, which are called upstream, midstream and downstream. Companies that find and produce crude oil are classified as upstream companies and they form the upstream industry. They can also be called exploration and production (E&P) companies. The midstream industry consists of companies that process, store, market and transport crude oil. Finally, downstream segment includes companies that operate oil refineries, petrochemical plants, distribute petroleum products and operate retail outlets. (Petroleum Services Association of Canada 2019). As explained

above, the chain of upstream, midstream and downstream segments form the full value chain in petroleum industry, which starts from an attempt to explore and find crude oil and goes all the way to the final phase where an end customer uses the final products, by for example filling his or her car with gasoline.

The price of crude oil has experienced a certain amount of volatility in its history. There has been variation both in supply and demand, depending on world events which has caused price adjustments (Business Insider 2019). In 2008 summer, just before the financial crisis took place, the price of oil climbed to almost $150 per barrel, which is significantly more than today (Business Insider 2019) However, high prices activate more supply and at this time also the US based shale oil production began to ramp up, as can be seen from chart 1.

In late 2008 at the time of financial crisis the price of oil dropped deeply, reaching the low $30's per barrel (Business Insider 2019). At this time, economies were contracting around the world and there was a general panic in different markets around the world that also caused asset prices to plunge. However, at this time the US shale oil production was relatively small, as can be seen in chart 1. The drop in price of oil was short lived as the price recovered to $70 per barrel by the next summer of 2009 and continued rising all the way until 2014 when it hit over $100 (Business Insider 2019). As can be seen in chart 1, during these years the US based shale oil production increased quite strongly and it was easy for companies to drill with rising prices. There was also constant technological improvement going on in shale oil extraction process which kept reducing unit costs, as will be presented later in this chapter.

In 2015-2016 price of oil crashed again and dropped to around $30 per barrel at lowest (Business Insider 2019). The crash has largely been regarded as a situation of oversupply (World Bank 2018). Again the price crash was relatively short lived and the price recovered to $50 per barrel later in 2016. This is also the level where the price of oil has roughly been since that. The crash of 2016 caused shale oil production to decline slightly as the chart 1 shows. However, the production has climbed strongly since that and therefore it can be said that shale oil has been quite resilient even now in "lower oil price" –era.

2.2 Shale oil and extraction process

Crude oil sources can be generally separated to conventional and unconventional sources. These are both energy sources that the oil can be extracted from. Conventional sources can be described as “normal” oil sources and they are quite straightforward to extract the oil from. Conventional resources are generally utilized early, because they are easier and cheaper to produce. They also do not require specialized technologies. However, extracting oil from unconventional sources is much more difficult. They can be trapped and have features that make it very difficult for oil to flow into a standard well that has been drilled. However, as conventional oil resources have been used extensively over the decades, unconventional resources have seen increasing utilization. (Donev, Hanania, Sheardown & Stenhouse, 2019)

Shale oil is a term used by oil industry to describe crude oil that is extracted using techniques that differ from techniques used in conventional oil production (Kilian 2017, 2). It is trapped in formations that have very low porosity and permeability, which makes it difficult for producers to extract it. In the United States, there are three large formations which have substantial amounts of shale oil in place. (Maugeri 2013, 3)

Crude oil produced from shale formations is light by its quality (Speight 2017, 20). This has caused some challenges as the refineries in the US are configured to process crude oil that is heavier by quality. Refiners have tackled this problem by blending the light shale oil with heavy oil imported from countries like Venezuela and Mexico. (DiChristopher 2018) While drilling of shale oil has especially taken off in North America, there are shale oil formations outside of the United States as well, especially in South America, North Africa and Russia (Ma, Sun and Song, Wang, Zhang X, Zhang Y 2015, 20).

The goal of conventional oil production is to extract crude oil from rock formations that are permeable. In a conventional production, after a borehole is drilled, the oil that is contained in nearby rock formations, flows into the borehole that has been drilled where it can be pumped to the surface. However, this technique does not work when crude oil is trapped in rock formations that have low permeability, these are often referred as tight rocks or shale rocks. (Kilian 2017, 2-3)

While efforts have been made to locate more conventional reservoirs, these unconventional reservoirs have become increasingly attractive due to depletion of conventional reservoirs, higher prices and technological advances. The technique used to extract oil from a shale formation is called hydraulic fracturing, often referred in media and public as “fracking”. (Fitzgerald 2013, 1337)

In hydraulic fracturing, after a deep borehole is drilled, it will be drilled horizontally into the shale rock. After this, the process of hydraulic fracturing takes place, which involves pumping a mixture of water, sand and chemicals. This mixture is pumped at a high pressure into the drilled borehole. This method causes the shale rocks to crack and small fissures open in the rocks that allow the oil that has been trapped to flow into the borehole. This combination makes it possible for oil producers to extract crude oil from a source that has been known for a long time but has previously been inaccessible. (Kilian 2017, 3)

2.3 Shale oil economics

An important question which has loomed throughout the era of rising unconventional oil supply from the US has been if extracting shale oil is really economically feasible and can it sustain. Traditionally it has been thought that shale oil drilling is very expensive compared to other crude oil sources. There has been discussion that there would have to be a certain threshold for price of oil to make it possible for shale oil to exist and survive. In other words, if oil prices were below shale oil drilling breakeven cost, would that production fade away? There have also been opinions that once the best shale areas have been drilled, this boom will vanish (Maugeri 2013, 10).

One argument is that rapidly improving drilling technologies and achieved operational efficiencies have made it possible for shale oil producers to live with lower oil prices. According to Maugeri (2013, 8), there has been constant productivity increases. For example, in the Bakken shale oil field which is located in northwestern United States, productivity per oil well more than doubled between years 2007 and 2012. Most important factors behind rising productivity have been advancements in hydraulic fracturing processes. (Maugeri 2013, 8)

The term “decline rate” is an important concept when looking at a single oil well. Decline rate is important because every oil well is a declining asset, which means that there is a fixed amount of oil available for drilling. After an oil well is ready for production, it will typically produce a maximum amount of oil at the beginning. However, the amount of oil produced will start to decline and the rate of this decline can be obtained from the so called decline curve. (Tippen 2019)

However, shale oil projects have some characteristics that differ from oil extracted from other, conventional sources. Shale oil well can be planned, drilled and completed in months, unlike projects in Deepwater or Arctic that have much longer lead times, even a decade or longer. However, shale oil wells also face much steeper decline rates. Conventional wells decline at around 6% per year and can continue producing oil for decades, in contrast, shale oil wells typically decline by as much as 60% in the first year of production. This means that in order to maintain production at flat level, new shale oil wells must be drilled at higher rate than conventional wells. (Boersma, Ebinger, Hobbs, Kleinberg, Paltsev 2016, 5)

This also means that companies concentrating on shale oil, are much more dependent on short term oil prices, than companies involved in longer term conventional projects, as much of the production from a shale well takes place in the first year of drilling. (Maugeri 2013, 11) This indeed demonstrates that shale production is based on shorter cycles, as in contrast to large, even multi-decade projects in Arctic or deepwater. It could also be argued that this makes shale oil production more flexible as new wells can be brought into production in comparably short time period.

A term that is often used when evaluating energy projects is a breakeven point. In brief, this means the point in which the profit is zero. If the oil price is above breakeven point, then profits are made. (Boersma et al 2016, 7)

There has been debate over the years regarding the breakeven point for shale oil production. It is important to note that these breakeven points vary for different shale areas. They also tend to move over time as productivity increases. This makes it challenging to find actual and updated statistics and information regarding shale’s breakeven points.

However, according to data provided by consulting group R.S Energy Group in 2018, shale oil production would be competitive even with oil prices being below $60. Breakeven prices for three largest shale fields of Bakken, Eagle ford and Permian are estimated to be approximately $47, $42 and $37 per barrel, respectively. These are breakeven prices at field level and do not include overhead and land acquisition costs (Elliott & Olson 2018a). However, it is important to note that these are averages for each basin and breakeven prices inside the basin between different areas vary.

In overall, as the boom has continued, the breakeven price for shale has indeed lowered over the years due to advancing technology and productivity. According to World Bank (2018, 53), average breakeven oil price for a shale well has come down considerably since 2013. These gains would support the idea that shale oil production is more resilient than previously thought. (World Bank 2018, 53)

The steep decline rate for shale oil wells is a fundamental challenge for production. While there have been improvements in productivity and technology, it will be interesting to see how much productivity and technology improvements will be gained in the future as the shale boom further continue.

While the economics have been researched at micro-level, the surging oil production in the US has also had impacts on macroeconomic level. According to EIA, net imports of oil and petroleum products in the US have decreased significantly over the last decade, as can be seen in chart 2. This has also made the US far less dependent on foreign oil. Traditionally the US has been importing much of its oil needs from other countries, as can be seen chart 2. This profile has now drastically changed with the introduction of shale oil.

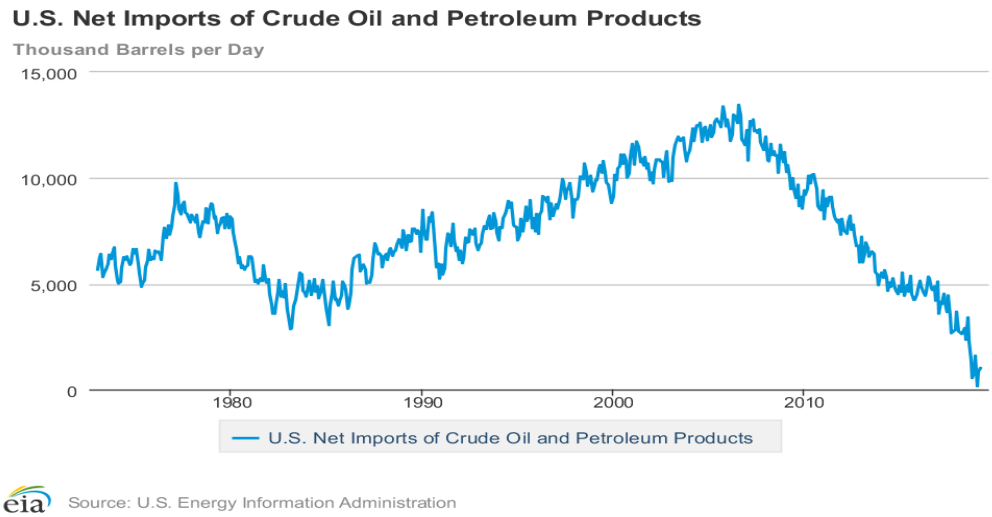

Chart 2. US Net Imports of Crude oil and Petroleum products (EIA 2019e)

In addition, domestic oil and gas industry has significantly increased its importance in the country. Consumers have benefited in form of lower energy prices, namely gasoline prices as it can be argued that without the shale oil supply coming from the US, oil prices would be far higher. (Raimi 2018) Kilian (2017, 13) provides more insight on this by estimating that in the US, cost share of crude oil in producing gasoline is about 50%. As an example, this means that a 68 percent cumulative fall in price of oil would be expected to cause a cumulative decline of 34% in the price of gasoline.

The chart below demonstrates this connection between gasoline prices and the price of crude oil.

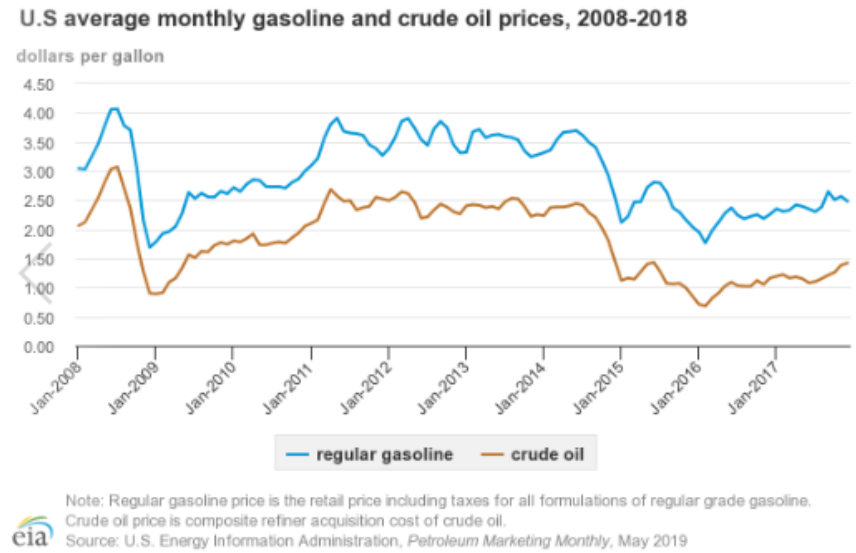

Chart 3. U.S Average Monthly Gasoline and Crude Oil Prices 2008-2018 (EIA 2019f)

The chart below presents oil consumption, production, imports and exports of the US over the decades. The shale boom began just before 2010 as can be seen from the sharp rise in production.

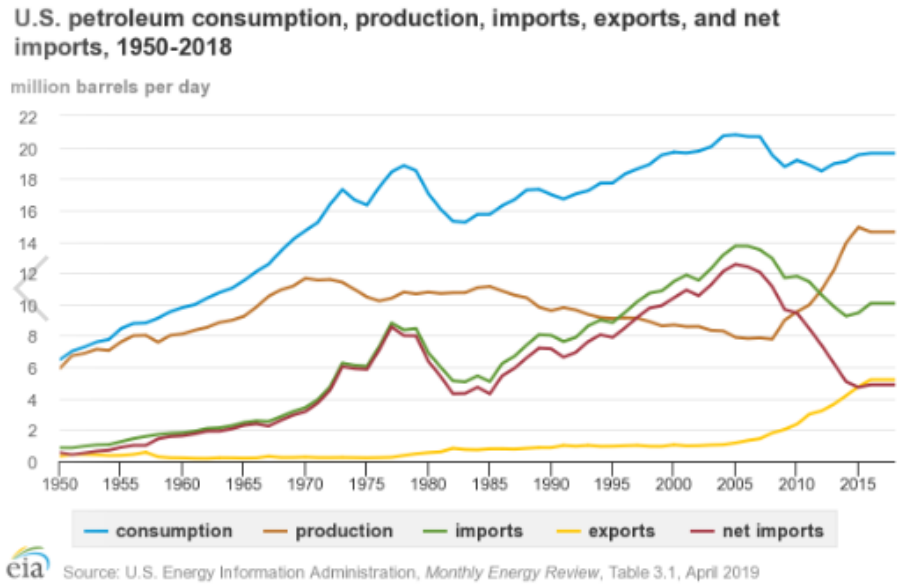

Chart 4. US Petroleum Consumption, Production, Imports, Exports and Net Imports, 1950-2018 (EIA 2019g)

The states and communities that have experienced shale activity have undoubtedly benefited in a form of job creation associated with shale oil production as Brown and Yucel (2013) pointed out in a study in which they examined economic impact of the shale boom to US states. They found out that between 2006 and 2012 especially the states of Texas and North Dakota experienced high employment growth. (Brown & Yucel 2013, 3) These two states have large shale oil producing regions as can be seen later in this study.

2.4 Competitive dynamics of oil exploration and production

Porter (1985) presents three generic strategies for a company as following: cost leadership, differentiation and focusing. According to Porter, these strategies can lead to above average performance in an industry. However, each of these strategies offer a fundamentally different route to competitiveness. (Porter 1985, 11)

In cost leadership, a company aims to be the low-cost producer in its industry. The way to achieve cost leadership may vary by industry, but it can include economies of scale, proprietary technology and preferential access to raw materials. Typically, a low-cost producer sells a product that is standard. If a company chooses differentiation strategy, it looks to be unique in some way. It can select attributes that buyers perceive as important and thus can position itself uniquely. If a company successfully differentiates itself, it can receive a premium price for its product. In third strategy which is focusing, a company chooses a narrow competitive segment in an industry. Focuser can achieve competitive advantage by solely dedicating itself to smaller segments, which may be overlooked by competitors that are looking to operate more broadly. (Porter 1985, 12-15)

Crude oil is a commodity, which means that it is hard to differentiate. If two companies choose to drill oil, it is very much the same standardized product that they produce. There are some differences between different oil qualities, like presented earlier in this study. However, crude oil is still considered to be a commodity product that is standard. When looking purely at oil production, it is hard to argue that focusing would either serve as a competitive advantage to oil company. Like other commodities, the price of oil fluctuates every day on the market. This means that an oil producing company cannot set its price, rather it is forced to take the price that is set out on the market every day.

When applying Porters three generic strategies -model, it becomes clear that the cost advantage is very much the only advantage a company drilling for oil can achieve. Porter (1985, 70) argues that economics of scale is one of the cost drivers. It arises from the ability to produce more at a larger volume, which can drive down the unit cost. Therefore if a company gains enough scale, it might be able to gain cost leadership in its industry

When mirroring this to the focus group of this study, which are the multinational major oil companies, it can be suggested that these companies would indeed have competitive advantages in an industry where the advantages are hard to obtain. By utilizing their large scale, they can drive down the unit costs of production, which would be defined as unit cost per barrel of oil produced. Because the major oil companies this study focuses on, are integrated and have refining and marketing operations, it can also be argued that these

companies can differentiate at least a little bit by adding value to the initial oil produced by refining it further.

2.5 Environmental concerns of shale oil production

Oil, as a fossil fuel has many environmental effects. Utilization of it releases carbon dioxides which are linked to global warming. It is also a finite resource which means that it will not renew like some other energy sources we use. While these are important and wide issues, the object of this subchapter is to present some environmental issues that are related directly to production and production process of shale oil.

The concerns that revolve around shale oil production are mainly attributed to extraction of oil, the process of hydraulic fracturing combined with horizontal drilling, which was presented earlier in this study.

The process of extracting shale oil requires very large amounts of water and chemicals, some of which affect human health. Drilled shale oil well can use amount of water that varies from 7600 m3 to 15200 m3, even up to 49200 m3, depending on characteristics and depth and length of the well. Source for water used varies for different shale fields. For example, in the Bakken shale field the main source for water is Missouri river. (Khan, Torres & Yadav 2016, 480) In the US, the concern has been raised over increasing amounts of water needed for the process of hydraulic fracturing (Anand & Khan 2016, 711) It is also worth noting, that even though some countries have large quantities of crude oil, they have limited amounts of water which is needed for recovery of the oil. (Speight 2017, 398)

There has also been significant attention related to potential contamination of groundwater from the drilling process. A risk that has been raised over the years is the possibility of movement of the chemical fluids used in the hydraulic fracturing process. It has been debated if these fluids could move to overlying groundwater and cause contamination. (Krupnick, Kuwayama, Olmstead 2015, 21) This contamination could pose a serious risk to local communities that use the water as drinking water. This has caused some resistance among public against hydraulic fracturing.

Some other environmental concerns are related to seismologic effects. The process of hydraulic fracturing is known to cause so called “micro-earthquakes”. However, the impact of

these micro-earthquakes is generally so small that it cannot be detected on the surface. (Anand & Khan 2016, 712) It appears that the seismic activity is caused by the very deep wells drilled and high fluid pressure that are required for the process of hydraulic fracturing. (Seismological society of America, 2019)

Regulation of hydraulic fracturing and therefore utilization of shale oil resources is largely done at state level in the US. This means that the states are mainly responsible for regulation instead of federal government. There has been debate whether the states or federal government should be regulating these activities. Proponents of federal regulation argue that this would set same standards throughout the country. (Alam, Bequn & Donaldson 2013, 133)

Even though there is potential that shale boom could at least partly be replicated in the Europe, major European countries like Germany, France and Netherlands have in effect banned hydraulic fracturing. There have been protests in Europe against utilization of local shale reserves. These protests have been mainly inspired by environmental concerns. (Gilblom, Patel 2016; Osterath 2015) These developments that have taken place in Europe over the years, seem to make it unlikely that the continent's shale reserves would be utilized, at least in foreseeable future.

While the booming shale oil production in the US has created jobs, lowered energy costs and contributed to overall economic growth, especially within the communities in the areas that shale fields are located at, there seems to be challenges from environmental point of view. Many of the environmental impacts seem to be still under investigation and debate and so it is likely that there will be more research based information on the subject in future.

2.6 Shale oil formations in the United States

According to Maugeri (2013, 3) there are three big shale oil formations in United States: Bakken, Eagle Ford and the Permian Basin.

According to EIA (EIA 2019h), these three largest formations accounted for over 80% of all shale oil produced in the United States in June 2019. Smaller formations of Anadarko, Appalachia, Haynesville and Niobrara accounted for the rest of production. When looking at the three largest formations, Permian is the largest producing basin by a significant margin,

as per EIA monthly data, it produced almost half of the all shale oil produced in the country in June 2019. (EIA 2019h)

The following map by EIA illustrates, how these shale regions are geographically located around the US.

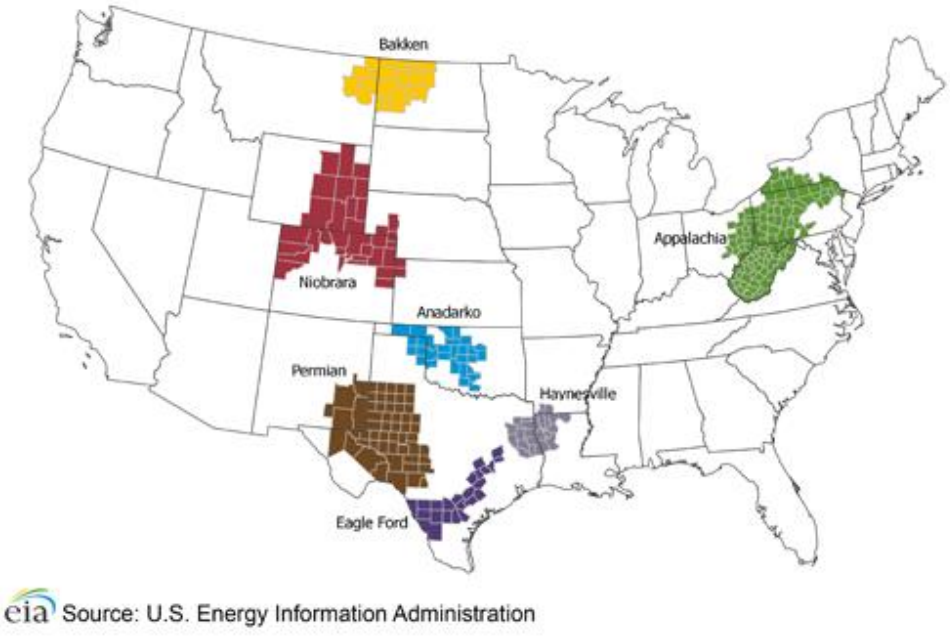

Chart 5. Shale formations in the United States, Drilling Productivity Report (EIA 2019h)

Growing shale oil production has demanded a lot of infrastructure to handle the produced crude oil and transport it further. Oil can generally be transported by either pipeline, road, rail or a ship. Pipelines are the primarily the most efficient way to transport large quantities of oil, because they are the most cost effective, energy efficient and safest way of transportation. (Karangwa 2008, 13)

When looking at the map by EIA above, two of the three most important shale oil producing areas, Eagle Ford and Permian are located fairly near to the Gulf of Mexico, which is an important region for energy industry in the US. According to EIA (2019i), over 45% of total US petroleum refining capacity is located along the Gulf Coast. This has led to sizable infrastructure needs to connect the shale regions especially Permian to the Gulf Coast area. Permian has seen a wave of investments targeting to build pipelines to deliver the shale oil to Gulf Coast refineries. (Awalt 2018, 74-75) According to consultancy group Wood

Mackenzie (2019), there is still a need for new transport capacity growth in next decade, as the Permian will further grow its production.

Because these three largest formations of Bakken, Eagle Ford and Permian have such an important position in US based shale oil production, a brief look at each of these three formations will be taken in this chapter.

Bakken

The Bakken is part of the larger Williston Basin, which is a very large sedimentary basin that spreads around the states of North Dakota, South Dakota and Montana, reaching parts of Canada as well. The Bakken formation was discovered already in 1951, however for decades, it was too costly to develop and drill. In mid 2000's the drilling and hydraulic fracturing actually started in the formation. (Maugeri 2013, 30) According to latest EIA data, the Bakken formation produced approximately 1.4 million barrels per day in June 2019. (EIA 2019h)

Areas surrounding Bakken have benefited from the surging shale oil production. Between 2007 and 2014, in the state of North Dakota real income per capita increased by 40% and employment increased by 25%. (James, Richter & Salanguit 2018, 2)

Companies operating in Bakken require higher oil prices than those operating at the other shale oil formations. According to estimates published on Wall Street Journal, consulting firm R.S. Energy Group sees that field level break-even price is $47 per barrel in Bakken formation. (Elliott & Olson 2018a)

Estimates for oil reserves in the Bakken formation vary. According to the United States Geological survey (USGS, 2013) which is a governmental scientific agency, the formations may contain 7,4 billion (estimated mean) barrels of undiscovered oil that is technically recoverable. However, it is worth noting that this estimate is from 2013.

Eagle Ford

The Eagle Ford shale field is located in the state of Texas and it is part of Western Texas basin (Maugeri 2013, 32). It is usual that shale fields contain mainly one natural resource, either natural gas or crude oil. However, the Eagle Ford shale has unique characteristics as it contains large amounts of crude oil, natural gas liquids and natural gas. (Tunstall 2014, 12)

First horizontally fractured well was drilled in the area in 2008. However it was only in 2010 when the area attracted crowd of oil and gas companies when new promising discoveries were found. Eagle Ford has somewhat different characteristics than Bakken. For example, the depths are much lower. Also the cost for drilling wells is significantly cheaper. (Maugeri 2013, 33-35) According to latest EIA data, Eagle Ford produced approximately 1.3 million barrels of oil per day, which means that production quantities of Eagle Ford and Bakken are quite similar (EIA 2019h).

Since 2010, the regions surrounding the Eagle Ford shale field have experienced significant positive economic impact. However, they also have experienced the impacts resulting from periods of lower oil prices. (Tunstall 2017, 1) Texas has traditionally had a well-known history in oil and natural gas production. United States Geological survey also noted that Texas has continued to remain in the forefront of American energy supply with large increases in production and reserves. It highlighted that these increases are due to revolutionary techniques used to drill resources that have previously been unrecoverable. (USGS 2018a)

According to estimates by consultancy group R.S Energy Group, in 2018 breakeven price at field level for Eagle Ford based shale oil was $42 (Elliott & Olson 2018a)

Due to Eagle Ford containing both crude oil and natural gas, producers have been able to mitigate to lower prices. For example, when in 2012 natural gas prices were significantly lower than in previous years, it caused slowdown in activity in shale fields that are predominantly natural gas rich. However, in Eagle Ford producers were able to focus their drilling activity on oil instead of natural gas and benefit from relatively high crude oil prices at the time. (Tunstall 2014, 13)

In 2018, USGS estimated that The Eagle Ford contains 8.5 billion barrels of oil. There are estimated to be significant amounts of natural gas and natural gas liquids in addition to crude oil. (USGS 2018a)

Permian

Permian is by far the largest producing shale area in the United States. It is located in northwest of Texas and it stretches over to the state of New Mexico as well. Permian is actually formed by several smaller basins and these smaller basins contain different shale formations. There has been conventional oil and gas production in the area already back in 1920's. However the conventional supply peaked in 1970's. Unconventional drilling methods on the Permian shale are more recent, as they started between 2010 and 2011. (Maugeri 2013, 36-37)

Since 2010 to this day, Permian has seen spectacular rise in production. In early 2010, the production was just shy of 1 million barrels per day. Almost a decade later, Permian produces over 4 million barrels per day. (EIA 2019h) While Bakken and Eagle Ford have also had a strong impact, Permian has truly been the most important shale region in terms of production. To illustrate the importance of Permian, by production quantity of 2018 it would rank just behind China as world's 9th largest oil producer if it was an independent state (EIA 2019h ; Statista 2019c)

Chart 5 illustrates the importance of Permian basin as a significant producer of shale oil in terms of 2018 production figures.

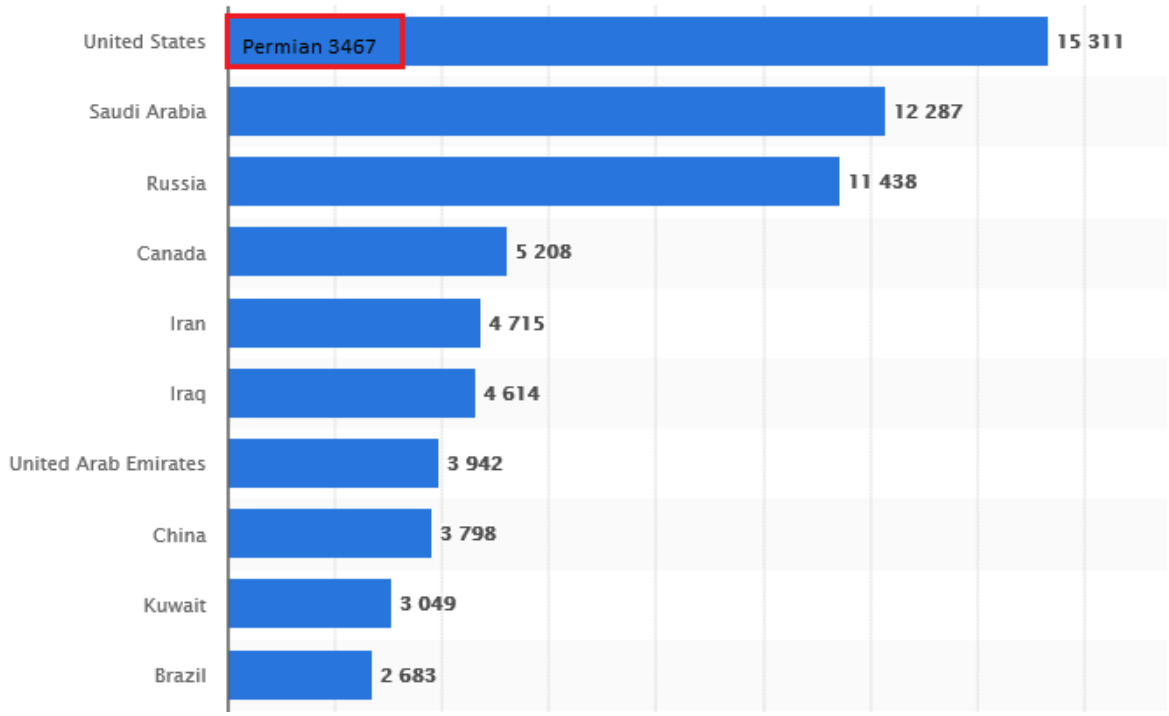

Chart 5. Oil production in the leading oil producing countries worldwide in 2018 (in 1,000 barrels per day) (Statista 2019), modified to include Permian as a standalone producer. Average production quantity for 2018 in Permian calculated with reported data available by regions from EIA (2019h)

According to information company IHS Markit, oil production from Permian is forecasted to rise to 5,4 million barrels per day by year 2023. Permian is also seen as being a major driving force in world's oil supply growth. The area is also receiving major investments to support this growth, IHS Markit estimates that there will be $308 billion of investments related to Permian production growth during 2018-2023. (IHS Markit 2018)

According to consultancy group R.S. Energy Group, in 2018 the field level break-even price at Permian formation was $37 (Elliott & Olson 2018a)

In 2018 USGS published an assessment, in which it concluded that the Permian contains estimated mean of 46.3 billion barrels of crude oil. In addition, there are significant natural gas and natural gas liquid reserves. (USGS 2018b)

3. Research data and research methods

The purpose of this chapter is to present and describe the research methods used in the study and then briefly describe the data that was used in this study and how it was gathered.

3.1 Research methods

This study was conducted using qualitative methods, specifically a case study approach due to the nature of this study and the phenomenon under research. According to Ghauri (2004, 1), case study is a useful method when the research area is not well known. Yin (1993, 31) notes, that an important rationale for using this approach is when the research needs to cover both a particular phenomenon and the context where the phenomenon is occurring.

Case study is one of the most common qualitative research methods used in business research. In case study approach, there is one or a few chosen "cases" that are then studied further. These selected cases can be for example companies or smaller parts of companies, like units. The amount of cases that are studied, is usually quite a small. Traditionally case studies have had an important role in business research. (Alasuutari, Koskinen, Peltonen 2005, 154)

According to Yin (2009, 3) the goal is to start by designing a good case study, then to collect, present and analyze the collected data. At the end, the case study is written to a compelling report or book. In case study, researcher is often studying what is common and what is unique in the case that is under research. The important question is if case studies can be generalized. Usually, they cannot. However, there can be common characters that the cases share. It is more important to understand the case than to generalize. (Metsämuuronen 2005, 207 ; Stake 2000, 238) According to Alasuutari et al. (2005, 156), a benefit of case study is that it forces to understand companies more comprehensively in a realistic surrounding.

As previously stated, in case research the interest is usually in a company or some specific process, function, unit, chain of events or historical event that is related to the company (Alasuutari et al. 2005, 157). Yin (2009, 19) emphasizes that case study can be conducted in both qualitative and quantitative methods.

This study focuses on a selected set of case companies, the global multinational oil companies and a real life phenomenon, the shale oil boom that has taken place in the United States during the past decade. Because the shale oil phenomenon is not well researched at a company level, which would include investigating this phenomenon from companies' viewpoint, a case study approach was chosen to conduct this study.

3.2 Research data

Typical qualitative research material used in case approach are interview- and literature based (Alasuutari et al. 2005, 157). Yin (2009, 99) states that evidence used in a case study can come from multiple sources, such as documentation, archival records, interviews, direct observations, participant observation and physical artifacts.

Because this study concentrated on large global oil companies that are publicly listed, different types of documents formed an important and vital basis of the empirical data used in the study. Specifically corporate annual reports, quarterly earnings reports, conference calls, investor presentations were used. The primary sources for this data were corporate websites. Each company involved had an adequate amount of data available to conduct this case study. However, there was some variance between the companies about how much and what kind of information they disclosed about their shale operations. On these websites, the companies have a wide amount of information available ranging from official and regulated documents such as annual reports and quarterly earnings reports to investor presentations, which companies generally tend to hold regularly to attract interest. In this study, the corporate websites were a rational way obtain reliable primary information as the empirical study concentrated on the companies in question.

On a few selected instances, some secondary sources were used. These were mainly articles and interviews that have been conducted by newspapers and media agencies that focus on business and economic matters. In addition, data provided by EIA was also used.
All of the data used in this research was gathered and reviewed between July and early September of 2019. The following table summarizes the data used to conduct this study.

Table 1. Sources

Type of source	Corporate information, corporate documents; presentations, annual reports, press releases	Journal articles and interviews	Data provided by government agencies
Origin	Corporate websites	Bloomberg, CNBC, Financial Times, Reuters,	U.S Energy Information Administration (EIA)
Time period in which the sources were gathered	July-September 2019	July-September 2019	July-September 2019
Time period that the sources cover	2009-2019	2016-2019	2013-2019

Publicly listed companies have fairly strict requirements for disclosing information about their operations periodically, especially for information of financial performance. However, companies may also be selective on what they choose to publish of their operations at a field level, often for competitive reasons. This was a major challenge of this study because shale oil operations are just one of the many around globe activities these companies have. However as shale oil has been a significant point of attraction and public interest, due to it being responsible for vast majority of global oil supply growth over past years, the companies have increasingly chosen to disclose information about their activities in the shale space.

4. Introduction to case companies

This chapter will take a brief look at each of the case companies. The case companies include ExxonMobil, Chevron, Shell, BP and Total, which are often referred in public as “oil majors” due to their large size and worldwide presence. These companies also operate in so called integrated model which means that they have operations in upstream, midstream and downstream segments. In other words from oil exploration and production to refining and marketing the actual, final products.

ExxonMobil Corporation

ExxonMobil Corporation (Exxon) is one of the largest publicly traded energy provider and chemical manufacturer in the world. Though ExxonMobil is an American company, it has operations around the globe. ExxonMobil practices oil exploration and production. In addition, the company is also the world's largest refiner. (ExxonMobil 2019a). ExxonMobil's total revenue was over 290 billion dollars in 2018 and during that year it had an oil equivalent production of 3,833 million barrels of which 2,266 million were liquids (ExxonMobil 2019b, 4, 37). The company's market capitalization was approximately 285 billion dollars in mid-August 2019. The company is also a large employer and it employed 71 000 regular employees at year end 2018 (ExxonMobil 2019b, 37; Yahoo Finance 2019a)

Chevron Corporation

Chevron Corporation (Chevron) is one of the world's leading integrated energy companies. Like ExxonMobil, Chevron is also American based though it operates around the world. Chevron practices oil exploration and production but it also operates in refining and other segments. (Chevron Corporation 2019a) Chevron's total revenue was over 166.6 billion dollars in 2018 and it had over 45 000 employees at year end 2018 (Chevron Corporation 2019b, 25, 50). The company had a market capitalization of over 223 billion dollars in mid-august 2019. (Yahoo Finance 2019b) Chevron had 2,930 million barrels of total net oil equivalent production per day in 2018, of which 1,782 million barrels were crude oil and other liquids (Chevron Corporation 2019b, 25)

Royal Dutch Shell PLC

Royal Dutch Shell (Shell) is a British-Dutch international energy company that practices oil exploration, production and refining. In addition, it has other operations related to energy. Like the other oil majors, Shell operates around the world, having presence in over 70 countries. In 2018 Shell had 82 000 employees on average. Among all the global oil giants, Shell had the highest revenue in 2018, reaching over 388 billion dollars. The company produced 3.7 million barrels of oil equivalent per day in 2018 of which 1,749 million were

crude oil and natural gas liquids. (Shell 2019a; Shell 2019b, 25) In mid-August, Shell had a market capitalization of over 226 billion dollars. (Yahoo Finance 2019c)

The British Petroleum PLC

The British Petroleum (BP) is a British multinational energy company that has operations in oil production and refining, but also in renewable energy. As a global oil major, BP operates around the world in all continents. (BP 2019a) The company had total revenue of over 303 billion dollars in 2018. In 2018, the BP group had oil equivalent production of 3.683 million barrels a day, of which 2.191 million barrels were crude oil and other liquids. The company employed 73 000 employees at year end 2018. (BP 2019b, 2, 21, 129) BP's market capitalization was over 122 billion dollars in mid-august 2019. (Yahoo Finance 2019d)

Total SA

Total SA (Total) is a French global energy company that produces and markets oil, natural gas and low-carbon electricity. (Total 2019a) The company has presence in more than 130 countries. Of all the oil majors, Total has the highest number of employees as it has over 104 000 employees. The company had 2.775 million barrels of oil equivalent production per day in 2018, of which 1.566 million barrels were liquids. Total's revenue reached over 209 billion dollars in 2019. (Total 2019b, 7, 254) The company had a market capitalization of approximately 126 billion dollars in mid-august. (Yahoo Finance 2019e)

5. Global oil majors' involvement in US shale oil

Shale producing regions, especially Permian have in past largely been operated by smaller independent companies, that utilized then new technology, hydraulic fracturing, which was described earlier in this study. This was time when these nimble companies could benefit from new technology and thus succeeded in leaving the majors behind in shale. These small companies have traditionally been in the forefront in applying new technology and tools in crude oil formations that are either unconventional or challenging. However, nowadays this technology is widely available and easy to copy. (Hiller 2019; Blum 2019; Livingston 2013, 33) These independent small companies differ from large integrated companies by that they are

exclusively involved in upstream exploration and production operations and do not operate in the field of refining, transportation and marketing (Livingston 2013, 33)

This picture has now changed as in recent years the global integrated energy giants have significantly stepped up their involvement and investments in US shale oil regions. For example, ExxonMobil, Chevron, BP and Shell are set to increase their production significantly by 2021. It can be also argued that these energy giants have an edge due to their superior size and huge investment capabilities. (Elliott & Olson 2018b) Some of the majors have chosen to approach rapidly growing shale production by mergers and acquisitions. For example, in early 2019 Chevron announced an agreement to acquire Anadarko Petroleum, which is a company that has significant assets in shale production (Chevron Corporation 2019c)

Though the shale oil production in the US has been surging during the past decade and lately caught the interest of global oil majors, the environmental concerns related to production process of shale oil remain. For example, Speight has discussed about these environmental challenges in length (Speight 2017, 397-402). Some of these concerns were also addressed in subchapter 2.6. With the enormous growth of shale oil, the process of hydraulic fracturing is now widely used throughout the shale oil formations of the US. Hydraulic fracturing in particular has received criticism for causing potential risks to environment.

The global majors studied in this thesis are integrated energy companies that have significant technological and investment capabilities due to their size. They also have deep expertise in operating integrated energy operations, which allows them to capture the full value chain in petroleum industry. This makes it particularly interesting to see how these companies are approaching the shale oil which has been the most high growth oil supply in the world. In this thesis, the case companies included the following oil majors: BP, Chevron, ExxonMobil, Shell and Total. In public, these companies are often attached together and simply referred to as oil majors.

5.1 ExxonMobil Corporation

Exxon has increased its presence in US shale oil regions in recent years. The company is mostly active in Bakken and Permian formations. (ExxonMobil 2019c, 39-40)

Exxon announced in 2009 that it had agreed to acquire XTO Energy in a transaction that was valued at 41 billion dollars. Exxon highlighted XTO's vast unconventional US resource base, which indicates that XTO acquisition was to become a major platform for Exxon's shale operations. (ExxonMobil 2009)

In addition, in recent years the company has also been acquiring land positions that further strengthens its position in shale and increases its oil resource base (ExxonMobil 2017). Exxon has set out ambitious targets for its Permian based shale production. The company now expects its Permian production to grow to over 1 million barrels per day by 2024, which would imply the production to grow by approximately quadruple from present level, as Exxon produced 274 thousand barrels of shale oil per day in the second quarter of 2019 (ExxonMobil 2019c, 40; The Motley Fool 2019). As mentioned in previous chapter, Exxon's total corporate level production was 3,833 million barrels per day in 2018. Using shale production data from the company (ExxonMobil 2019c, 40), the share of shale production accounts for relatively low, estimated mid-single digit of the total corporate production. However, this portion is poised to grow rapidly if the Exxon executes on its stated goals for shale production.

The company has also chosen to move more aggressively than before. In early 2019 it revised its production outlook for Permian and now expects its production to grow at significantly faster pace than expected just a year earlier, in 2018. (ExxonMobil 2019c, 39-40; ExxonMobil 2019d) These developments seem to indicate that Exxon has chosen Permian as its area of focus, which seems rational given that Permian has been the most important region in US shale growth, as previously discussed in this study. The company also seems to have a long runway to grow its production, as it has resource base of 10 billion oil equivalent barrels in Permian (ExxonMobil 2019c, 41).

Exxon lists development capability, integration through value chain and technology as the company's competitive advantages in shale (ExxonMobil 2018, 16). As an integrated multinational energy corporation, Exxon has the scale that smaller exploration companies lack. This combination allows Exxon to capture the full value chain, beginning from exploration and drilling, transporting the oil into refineries and refining it into products such as different fuels. (Exxon 2019b, 5; The Motley Fool 2019) In connection to this, the company is planning to invest significantly to expand its light shale oil refining capacity. To ensure the

connectivity of the Permian based shale oil to US Gulf Coast based refining and processing plants, Exxon is also focused on investing to transport capacity (ExxonMobil 2018, 36)

On financial side, the company indicates that it is able to survive even with lower oil prices, highlighting being able to remain profitable in shale even at a barrel price of 35 dollars. (ExxonMobil 2019c, 40 ; ExxonMobil 2019b, 2-3) Exxon's ability to make profit in shale at such a low oil price is interesting, because it is a stark contrast to the general belief that shale needs high oil prices to survive, as discussed earlier in this study.

Exxon is clearly moving rapidly in shale and has specifically set Permian as its area of focus. The company is set to benefit from its massive scale and integrated model. This integrated model allows the company to capture the full value from its production. As unlike small producers that are forced to sell their production at a market price which is set, Exxon can refine its shale oil production into petroleum products and benefit from added value. In the case of Permian shale field, this is done by transporting the oil produced by company's upstream operations to the US Gulf Coast, where it can be refined into products or shipped elsewhere for further refining (ExxonMobil 2019b, 17) Combination of scale and technology also allows it to be a low cost producer that can make profit even in lower oil price environment.

5.2 Chevron Corporation

Chevron is also strongly present in shale oil production. In addition to US, it has shale assets in Argentine and Canada, though these are significantly smaller resource bases than it has in the US. The company has put significant effort to Permian basin and its resource base went up from 9.3 billion barrels in 2017 to 16.2 billion barrels in 2019. It also claims that its Permian portfolio value more than doubled over the same time period. In its portfolio matrix, Chevron also presents its Permian portfolio as a core asset which is still immature, in other word it is in a growth phase. This highlights that Permian is an important are of focus and investments for Chevron. (Chevron Corporation 2019d, 14, 15 25, 34)

In 2019, Chevron is budgeting to invest 5.2 billion dollars to its shale assets. Out of this 5.2 billion, 3.6 billion is targeted to Permian. Like Exxon, Chevron is looking to increase its shale

based production significantly. In Permian, the company produced 421 thousand barrels per day in second quarter of 2019 and is looking to grow this production to over 750 thousand barrels per day by 2023. This implies a less aggressive growth target for Permian than Exxon, but Chevron points out in their estimates that there could be upside in the production growth. (Chevron Corporation 2019d, 18, 31)

Chevron has been aggressively driving down its development and production cost for each Permian based barrel produced. The company points that, its development and production costs per barrel produced have decreased by 40% since 2015. While Chevron doesn't precisely disclose break-even cost, it states that in 2018 these development and production costs defined by the company stood at approximately 15 dollars per barrel. This figure indicates that Chevron is operating very cost efficiently in the Permian. The company also claims to have higher internal rate of return for its wells than industry and to make over 20 percent return on its capital employed. In 2019 the company produces relatively small amount of shale oil from non-Permian based assets but estimates that this non-Permian shale base could grow its production to over 250 thousand barrels per day by 2023. (Chevron Corporation 2019d, 30, 33, 38) As mentioned in chapter 4, Chevron's total corporate level production was 2930 million barrels per day. Using shale production data from the company (Chevron Corporation 2019d, 31), it can be estimated that shale production makes up currently low double digits of Chevron's total corporate level production.

Some of the value drivers highlighted by the company in the Permian shale operations include well performance and technology. It can be argued that these drivers have played a major role in the stated cost and productivity advancements, as the company highlights the use of advanced technologies such as predictive analytics as a way to boost performance. (Chevron 2019d, 30 ; Chevron Corporation 2019e)

In April 2019, Chevron took a drastic move to grow its shale asset base by announcing its intention to acquire Anadarko Petroleum, a company that is heavily involved in US based shale oil production. The total enterprise value of this transaction would have been 50 billion dollars. Chevron presented that Anadarko's high quality assets in Permian would strengthen its position in shale oil production. (Chevron Corporation 2019c) In financial press, this deal was very much associated as Chevrons attempt to approach shale even more aggressively.

(Benny & Hiller 2019; Blas, Casey & Gilblom 2019; DiChristoper 2019) In an interview that was done shortly after announcing this deal, Chevron's CEO pointed out the importance of scale in shale oil production, which was pioneered by small, independent companies in the beginning (DiChristopher 2019).

However, later in April 2019, Occidental Petroleum Corporation announced an offer for Anadarko that was higher than Chevrons offer. Chevron chose not to increase its offer for Anadarko and the company's potential Anadarko acquisition collapsed. (Occidental Petroleum Corporation 2019; Chevron Corporation 2019f) The bidding war of these two companies for Anadarko Petroleum showed that there is a clear rational for consolidating shale assets, but Chevrons decision to walk away showed that it is not ready to strengthen its position in shale at any price.

As an integrated energy company, Chevron has an ability to transfer the oil it produces in Permian to refineries through pipelines, where the oil can be further refined, capturing the full value chain. (Chevron 2019d, 75) The company is investing in its US Gulf Coast refining capacity and acquired a refinery recently in early 2019 that has the capability of refining the Permian based light crude oil (Chevron 2019d, 65-66). This demonstrates that Chevron is also benefiting from its large scale as it can add more value by refining the oil instead of just drilling it and then selling it on.

5.3 Royal Dutch Shell PLC

In addition to its activities in the United States, Shell is involved in shale oil projects that are placed in Argentine and Canada. In the US, Shell is exploring and producing shale oil in the Permian Basin, which it entered in 2012. The Permian assets account for about half of the company's total annual shale investments (Shell 2019c, Shell 2019d) However, Shell is also heavily involved in shale natural gas production. (Shell 2019e, 51)

According to data presented by the company, it had approximately 400 000 barrels of oil equivalent shale production worldwide per day in 2018. Of this number, about half is liquid based which includes oil. This figure is poised to grow through 2025 (Shell 2019e, 43, 51). In 2018, the company produced more than 147 000 barrels of oil equivalent per day in the

Permian basin, almost doubling its production from 2017. (Shell 2019d; Shell 2019b, 38) As mentioned in chapter 4, total production for Shell at corporate level was 3,7 million barrels per day. Using the production data provided by the company for US shale (Shell 2019d), it can be estimated that the US shale production accounts for mid-single digit portion of the total corporate level production.

The company highlights the importance of driving competitive cost structure and utilizing technology to reduce operating costs and therefore enhance returns. (Shell 2019e, 51) Shell has been successful in this goal, as they have been able to reduce total well cost 40% since 2015 in their key Permian operating areas. The company sees that technology will be a vital part of their business in shale also in future. (Shell 2019f, 17) The company discloses that its break-even for Permian based shale production is at 35 dollars per barrel. (Shell 2019e, 51) The company also discloses that in Permian, it has resource inventory of over 1 billion barrels of oil equivalent that has break even at less than 40 dollars per barrel (Shell 2019b, 38).

Shell has long-lead investment projects such as deepwater oil drilling in areas like Gulf of Mexico, Brazil and Nigeria. As presented earlier in this study, shale oil projects tend to be shorter cycle projects in contrast to deepwater drilling that can take decades to complete. According to the head of Shell's US business, though the deepwater projects secure long term revenues, the shale business acts as a balance to deepwater activities. Shale oil drilling allows to be flexible with investment decisions as the operations can be ramped up or down depending on the market environment. (Raval 2018)

With today's cost efficient technology, shale projects seem to increasingly compete for capital within companies' portfolios, where the longer lead projects may traditionally have had a strong position. In Shell's case, the company is forecasting to invest 3-4 billion dollars annually to shale projects in 2021-2025, which is just a bit under what it invests to deepwater projects in those years. This implies that shale business is a high growth area for Shell in the future. (Shell 2019e, 43) However, in terms of production data, the company is presently strongly involved in shale, but the share of shale natural gas is quite high in its production profile.

5.4 The British Petroleum PLC

BP has approached the shale with acquisition strategy in recent years. Before an acquisition it made in 2018, it had mainly shale assets that were producing natural gas. (BP 2018a, 14-15)

In July 2018, the company acquired US based shale assets from multinational natural resources company BHP Group. This deal was valued at 10.5 billion dollars and it was the largest global acquisition for BP in 20 years. In this acquisition, BP received shale oil and gas assets in the basins of Permian, Eagle Ford and Haynesville. These assets had a production of 190 thousand barrels of oil equivalent production per day and included 4.6 billion barrels of oil equivalent of discovered resources. With this acquisition, BP also changed the name of the segment of its business in continental US to BPX Energy. (BP 2018b, BP 2018c, 2) This deal allowed BP to significantly expand its US based business to crude oil, where the company before mainly operated in the area of natural gas. Before this acquisition capital expenditures related to shale oil drilling made up a relatively small percentage of the company's total capital expenditures (BP 2018a, 14-15 ; Boyden Insight 2019) As mentioned in chapter 4, BP's total corporate level production was 3833 million barrels per day in 2018. Using

The rationale for this acquisition by the company's viewpoint was that it gives BP an opportunity to own world-class unconventional oil and gas assets that are poised to deliver growth into the next decade. Of the acquired assets, Permian and Eagle Ford are mostly rich in oil liquids, while Haynesville is a shale natural gas basin. This acquisition brought BP significant exposure to shale oil as before 2018 it had primarily concentrated on shale natural gas. The company intends to invest 2-2.5 billion dollars annually to these three acquired shale basins in years 2019-2021. (BP 2019b, 24 ; BP 2018a, 14 ; BP 2018b)

Like the other oil giants, BP also highlights its ability to drive down costs and operate cost efficiently. The company discloses that its unit production costs have decreased by 35% between years 2013-2018 in the continent United States. However, it is unclear how much of this cost decrease is associated with shale oil production and how much with conventional oil production. Nevertheless, the company argues that this track record in production cost improvement will give it confidence in operating the new assets. Like the other oil majors, BP also emphasizes the importance of technology in driving capital efficiencies. The company

notes that capital efficiency and well productivities will continue to improve as better technologies are deployed. (BP 2018d, 11) In addition, as BP is an integrated energy company having operations ranging from exploration to midstream to refining, it can capture some efficiencies by being able to control the value chain. (BP 2018a, 10)

BP also discloses some information about its breakeven prices for shale operations. According to the company, about half of its shale resources by barrel amount breakeven at 35 dollars per barrel and the other half of resources has a breakeven price ranging from 35 dollars to 45 dollars per barrel. (BP 2018a, 6)

In summary, BP has increased its presence in US shale oil production primarily by acquisition strategy, which brought the company significant exposure to high growth shale oil basins of Eagle Ford and Permian. Unlike some of the other oil majors, BP does not present clear estimates for the production growth for its shale oil business. However, these assets are clearly growth assets within its portfolio.

5.5 Total SA

Of all global oil majors studied in this thesis, Total is the only company that has not particularly participated in US based shale oil production. The company has assets in shale gas fields of Barnett and Utica, but these shale assets produce natural gas rather than crude oil. In the US, Total has instead focused on conventional oil drilling such as deepwater drilling in the Gulf of Mexico and projects related to liquefied natural gas (LNG). (Total 2019c, 2-5)

Because US based shale oil production has been the high-growth area in the industry during the past decade, it is interesting to study the reasons behind this decision to pass on shale. However, one challenge in finding such information is that companies might not publicly state reasons behind their decisions, in this case investment decision. There might be different motives for this, such as competitive reasons.

However, based on secondary sources, the CEO of Total has in the past made a comment that shale is quite expensive, pointing at the cost to acquire the land positions in these shale producing regions in the US. (De Beaupuy & Micklethwait 2017; Heavens, Hudson & Nasralla 2018). He also highlights that some of the other majors have already legacy positions in shale

regions, while the CEO also makes a point that Total has attractive investment opportunities and strengths in other areas such as deepwater drilling (Davis 2018).

The cost of acreage in premium shale basin such as Permian has soared recently. As the shale boom has continued, land has become increasingly attractive for buyers in that area. (Collins & Crowley 2018) In order to develop shale oil assets, a company needs to have an access to the land. As the price of land has risen in the prominent shale oil fields as stated before, it obviously becomes more expensive for a company that does not have shale assets in place to start operating in the industry. This can be linked to the first mover advantage, as according to Lieberman and Montgomery (1987, 5) preemption of scarce assets is one way to gain the first mover advantage. Thus a company that has entered the shale oil fields at the beginning of the boom by acquiring land at cheaper prices, is undoubtedly in better position than a company which is entering at a later stage. A global company like Total that does not have legacy shale oil assets, can find it more attractive to invest capital elsewhere as the cost of entry to shale is high at this point of the boom.

Total is also an integrated energy company, however it has only one refinery in the United States, which is located in Port Arthur, Texas (Total 2019d). One reason to be involved in shale the majors highlight is that it enables them to have reliable and cheap feedstock for their refining operations, as have been presented earlier in this study. This is especially true for companies that have a lot of refining capacity in the US, such as ExxonMobil (EIA 2019j). However, as Total operates only one refinery in the US, there is not necessarily as much motive to operate its own shale fields to secure this feedstock.

5.6 Discussion

This chapter will discuss about the results that were found. The findings show, that apart from Total, all of the case companies have moved in shale and some of them have presented ambitious growth plans. Table 2 presents some key findings from previous subchapters.

Table 2. Summary

	Shale oil operations	Estimated US shale production of total company production (%)	Shale oil basins	Break-even cost ($)	Refining capacity in the US (1000's of barrels per day)[1]	Shale investments outlook	Stated goals for shale production
Chevron Corporation	Yes	Low teens	Permian	n/a	925,4	$5,2B in 2019 of which 3,6B to Permian	Over 750 thousand barrels per day by 2023 in Permian
ExxonMobil Corporation	Yes	Mid single digit	Bakken, Permian	35	1732	n/a	Over one million barrels per day by 2024
Royal Dutch Shell PLC	Yes	Mid single digit	Permian	35	829,5	$3-4B annually in 2021-2025	n/a
The British Petroleum PLC	Yes	n/a	Eagle Ford, Permian	35-45	833,5	$2-2,5B annually to acquired basins of Eagle Ford, Permian and Haynesville in 2019-2021[2]	n/a
Total SA	-	-	-	-	225,5	Total is involved in shale natural gas production in the US	-

[1] Calculated for each company using data from EIA (EIA 2019j)
[2] Haynesville is shale natural gas weighted basin

Although currently shale oil makes up somewhat small amount of their total production profile, the portion of shale oil is moving up quite rapidly in their portfolios, depending on how ambitious the growth plans are. However, as the companies are mature energy companies with quite low total production growth, the high growing shale oil business inside their portfolios can make up a considerable large portion of their total production profile in the future.

Some of the companies such as BP, Chevron and Exxon have been especially active in merger and acquisition front and done sizable deals that have allowed to expand their presence in shale even more rapidly. Not all of this acquisition activity has been successful, as Chevron got outbid in its attempt to secure a multibillion acquisition which was aimed to strengthen its position in shale. However, this activity in recent years clearly show that there is a high demand for quality shale oil assets which supports the ongoing consolidation.

It is notable, that even though there are several shale basins around the US, the Permian basin has been the most prolific area and the companies under this study are concentrating heavily on that one basin. This is rational as the basin of Permian is by far the largest shale basin in terms of production and reserves as was discussed earlier in this study. The vast reserve base supports a long runway for growth for these companies.

The case companies that are involved in shale, have also made the case that shale is resilient even in a low oil price environment. The profitability of shale has been a question mark in the past as it has been traditionally thought to be very costly to produce. However, the public data presented by some of the case companies seem to dispute this, as their unit cost to produce one barrel of oil is far lower than what the market price has been in recent years.

The companies under this study that are involved in shale oil present data, that generally puts their breakeven cost below 40 dollars per barrel of shale oil. The companies have also been successful in reducing their unit costs over time, in which technology and productivity advancements have played a major role. All the case companies that are involved in shale, highlighted the importance of advanced technology. As these companies are large giants with a long experience in operating in energy space, they will have the capability to be in the forefront of utilizing advanced technologies in their shale activities also in the future.

An important rationale for these companies to be involved in shale comes from their integrated operating model. Connecting their shale fields to their refineries enable the companies to capture the full value chain. This is especially visible in the basins of Permian and Eagle Ford, where heavy investments in infrastructure have taken place to secure transport capacity. From strategic viewpoint the shale oil provides reliable and secure feedstock for the refineries in US Gulf Coast operated by the companies. By adding value through refining the companies can become less exposed to commodity price volatility. In contrast, the small independent players that have dominated the shale in the past have not had this integrated operating model and thus have been forced to sell the oil after drilling thus making them more vulnerable to oil price fluctuation. To summarize this, the global majors are looking to differentiate their production by adding value to it through refining. This follows Porters idea of differentiation, even though differentiation is hard to obtain in a commodity type of business.

Some of the companies under this study entered the shale earlier than the others. Over time, the price to acquire acreage in shale basins, especially Permian has risen considerably, making it more expensive to enter the space at a later stage. This supports the idea of first mover advantage, putting the companies that entered and acquired land early on to a better position.

In reference to earlier discussion about Porter's model of competitive advantages, much of the petroleum industry is fundamentally commodity type of business and it is hard to gain a distinct competitive advantage. However, with the increasing scale and efficiency gains, the global majors have succeeded in driving down their unit costs in shale oil production. The companies have demonstrated that they can achieve low operating costs which puts the companies and therefore shale oil as well in a strong competitive position. The companies aim to further reduce their costs and undoubtedly follow Porter's strategy of cost efficiency.

However lower commodity prices, in this case lower crude oil prices could result to a serious downturn and slowing activity for the companies that are involved in shale oil. This has been especially the case when the small independent companies were holding the shale assets. As the multinational oil majors have entered and consolidated the space, their scale and

integrated model would support the idea of shale being more resilient to lower prices than before. The integrated model also captures more of the value chain, putting the major oil companies in stronger competitive position. Though it is hard to predict the price of oil in the coming years, a severe drop in oil price could also accelerate the consolidation, as the multinationals are strongly capitalized and thus can bear the downturn much longer than the small, independent production companies. In this case, the downturn would allow the multinationals to acquire more shale assets at attractive prices and consolidate the space further.

6. Summary and conclusions

Over the past decade, the world has seen an enormous new supply in crude oil, which has been caused by unprecedented growth in United States based shale oil production. Before the introduction of shale oil, the US's oil production was steadily decreasing and the country was heavily dependent on importing its oil from foreign countries. The booming shale oil production has kept the price of oil low and thus benefited consumers in terms of lower energy costs.

Though there are shale oil basins located around the world, the largest production increases have taken place in the United States. The US has traditionally had a strong history of conventional oil production, though the conventional oil production has been steadily decreasing over the decades. The United States has also traditionally had a pro-business environment, where the government has tried to keep a low profile in interfering in economy. In contrast, in many large oil producing countries the government plays a major role in different sectors, especially energy sector and often has ownership in local oil companies. The future will tell whether shale oil will pick up in other countries as well.

There are significant challenges related to shale oil though. The new wells face a very steep decline rate which means that these shale wells deplete much faster than conventional crude oil sources. There are also number of environmental concerns regarding to shale production processes, which pose a challenge especially for the regions and communities that are in center of this boom. In past, shale oil has also had a much higher break-even cost than more traditional, conventional oil sources, which has meant that it has not been particularly

competitive to utilize the shale oil resources. However, in recent years there has been significant gains in terms of productivity and cost efficiency.

This broad picture of shale oil phenomenon was described in length in the theory part of this study. As shale oil has been a high growth area in energy sector, the global oil majors have become particularly interested in the shale oil. This has been a new phenomenon as traditionally shale oil exploration and production has been dominated by small independent oil companies that were in forefront in utilizing new technology. These global majors have had some legacy assets in the space, but they have also aggressively approached the shale oil by mergers and acquisitions, some of which have been very large value deals. Due to this evolution, these global giants have today emerged as important players in US shale oil production.

The main research question for this study was:

"How are the global oil majors involved in US shale oil boom?"

With two sub questions being:

What are the drivers for global oil majors to enter shale oil production?

What kind of challenges do the global majors face in shale oil production?

Is shale oil attractive to the companies in economic terms?

How does shale oil production benefit the integrated operating model?

As presented in chapter 5, apart from Total, all of the companies studied are involved in US based shale oil production. However, there is some variance in how aggressively the companies are approaching the space. The four companies involved, however see their shale assets clearly as a growth area in their portfolios. It is also notable, that there has been merger and acquisition activity in the space. One clear common factor is the benefit of integrated model. The companies involved in shale see a clear rationale to integrate their prospective shale assets to their refining and processing capacity. Shale assets therefore allow the companies to have a reliable feedstock for their downstream operations. One common factor

is also scale and the benefits that come with it. The companies studied have been successful in reducing their unit costs over the years. The companies studied that disclose information about costs, show fairly low break-even costs for shale production Now that the technology needed to produce shale oil economically is universally available for everyone, it can be argued that in the future the driving force for lower unit costs is scale. This makes it lucrative for the major companies to acquire more shale assets as they can also be integrated to their value chain. US based shale oil production has been an attractive sector to invest for oil companies, as it has been the most rapidly growing area in oil production. The companies studied are able to leverage their expertise and achieve decent returns even in an era of lower oil prices. There are risks related to shale oil production that the companies under this study face. As crude oil is a commodity product, it can experience large variance in price which is out of control for these companies. A major downturn in price of oil would pose a challenge and could result to shale oil being unprofitable at a low oil price. There are also environmental risks associated with the production of shale oil, namely the process of hydraulic fracturing which has been under scrutiny in the US. A major legislative change in regulation could also affect the companies that produce shale oil and make the utilization of shale oil reserves unattractive or even impossible.

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