Norwegian School of Economics

Bergen, Spring 2018

Capital Structure in the Petroleum Industry

An empirical study of determinants in the period 1999-2016

Daniel Hagtvedt

Supervisor: Associate Professor Aksel Mjøs

MSc. Economics and Business Administration

Major: Financial Economics

Master Thesis

NORWEGIAN SCHOOL OF ECONOMICS

Abstract

This thesis studies the determinants of capital structure in global independent petroleum exploration and production (E&P) firms in the period 1999-2016. I have used two definitions of leverage; (*i*) Debt-to-Assets, and (*ii*) Debt-to-Capital. Both definitions are expressed using book and market values, giving four different dependent variables to analyse.

The three most popular capital structure theories among academics have been tested; (1) Trade-off theory, (2) Pecking Order theory, and (3) Market Timing theory. Based on multiple regression models using fixed effects estimation I identify six firm-specific factors that reliably determines capital structure in E&P firms; *profitability* (-), *credit rating* (+), *lagged leverage ratio* (+), *market-to-book assets ratio* (-), *asset tangibility* (+), and *reserve replacement ratio* (+). The inclusion of macroeconomic factors does not add any considerable value to the regression models. However, I have identified five macroeconomic factors that tend to determine capital structure for E&P firms; *oil* (-), *MSCI* (+), *GDP* (+), *term spread* (+), and *E&P capital expenditures* (+).

Furthermore, this thesis is aimed at finding differences in capital structure determinants between oilfield services firms (OFS) and E&P firms. I identify four firm-specific factors that reliably determines capital structure in OFS firms; *non-debt tax shield* (-), *tangibility* (+), *median industry leverage* (+), and *lagged leverage ratio* (+). Most of the included macroeconomic factors are significant for OFS, although with opposite signs compared to E&P. I hence find evidence that leverage in the E&P sector is pro-cyclical, while it is counter-cyclical in the OFS sector.

Based on the empirical evidence, it seems that neither of the main theories are fully able to predict capital structure. However, the results suggest that both the trade-off and pecking order theory are about equally accurate in explaining capital structure decisions for both E&P and OFS firms.

Keywords: *Capital Structure, Pecking Order, Trade-Off, Market Timing, Petroleum*

Foreword and Acknowledgments

This thesis marks the end of two challenging, yet highly rewarding years at the Norwegian School of Economics. The writing process has been demanding and sometimes frustrating. However, it has given me valuable insights into corporate finance in the petroleum industry, as well as provided me with useful tools for my future career after graduation. Hopefully, the reader will find this thesis as interesting to read as it has been for me to write it.

Before proceeding, I want to take this opportunity to acknowledge the persons who deserve it the most. The completion of this thesis would not have been possible without the help and support of certain individuals.

I first want to express my sincere gratitude to my two supervisors, Mgr. Arnt Inge Enoksen and Assoc. Prof. Aksel Mjøs, for their guidance, valuable contributions and quick responses. I would also like to thank my future colleagues at EY for their constructive inputs, whose names could not be mentioned.

Further, I am thankful to Det Stavangerske Dampskibselskab AS for providing me with a much-needed scholarship during my studies at NHH. Your donation was much appreciated.

I am forever grateful to my family for their love and support throughout my life. Without them I would not have reached this milestone. Finally, I want to thank my fiancée, Marthe, for her endless love and encouragement. She has been, and always will be, my most important source of motivation.

Bergen, June 2018

Daniel Hagtvedt

Table of Contents

List of Figures

List of Tables

"When you combine ignorance and leverage, you get some pretty interesting results."

– Warren Buffett, American investor and business magnate

I. INTRODUCTION

Background and motivation

This thesis is written in collaboration with EY[1]. The process of choosing a theme and problem statement has thus been highly influenced by my career goals. However, the structure, reflections, choices, analyses and conclusions are my own and fully independent of EY.

My choice of theme comes from my deep interest in corporate finance. As corporate finance is my master's specialization, it would be natural for me to choose a theme within this topic area. Furthermore, the choice of a firm's capital structure is a fundamental question in corporate finance. Thus, I wanted to enhance my knowledge about capital structure decisions.

I have chosen to focus my study at the petroleum industry. My motivation for focusing on one industry only is mainly due to the vast amount of studies aiming at corporates in general. There is, however, reason to believe that determinants of leverage policy might vary significantly between industries. When it comes to why I chose to aim my study towards petroleum, it is due to several reasons. First, my homeland – Norway – is considered one of the world's major oil and gas producing countries. Since petroleum activities are an important part of Norway's economy I find it beneficial to learn more about the industry. Second, I have a background from Stavanger – the oil capital of Norway. Naturally due to the high presence of petroleum firms in the region, as well as the broad coverage in media, this makes me highly motivated to learn more about oil and gas. Lastly, I am planning to start my career at the transactions department at EY in Stavanger after my graduation, where several clients are connected to oil and gas. An introduction to the industry prior to start-up would hence be valuable to both me and my future employer.

[1] Previously Ernst & Young

Problem statement

This thesis seeks to find the determinants of capital structure in the petroleum industry on a global level. Specifically, it aims at answering the following problem statement:

"What are the determinants of capital structure decisions in independent petroleum exploration and production companies, in the time frame 1999-2016?"

Additionally, the following research questions are to be answered:

- *Which of the main theories are most appropriate in explaining capital structure decisions for independent exploration and production companies?*
- *Do the determinants differ from oilfield service companies?*

Contribution

Capital structure is an important topic in corporate finance and has been highly debated among academics since Miller and Modigliani's capital structure irrelevancy theorem. This has resulted in a huge literature studying at capital structure decisions. To my knowledge, however, there are few studies of capital structure that have focused on the petroleum industry. This paper would hence contribute to the existing research by providing additional evidence from a specific industry. Moreover, the comparison of capital structure determinants between sectors within the same industry would provide more knowledge on leverage policies among the industry players. My thesis is hence relevant for students, academics and business executives with interest in capital structure in the petroleum industry.

Outline

The remainder of this paper is organized as follows. Section II introduces the petroleum industry. Section III discusses the selected theories on capital structure, as well as some acknowledged survey results. Section IV provides information on the data collection and variable constructions. Section V presents methodology for this study. Section VI presents results from the empirical analysis. Section VII concludes the paper. Section VIII provides criticism and suggestions for further research.

"A century ago, petroleum – what we call oil – was just an obscure commodity; today it is almost as vital to human existence as water."

– James Buchan, Scottish novelist and historian

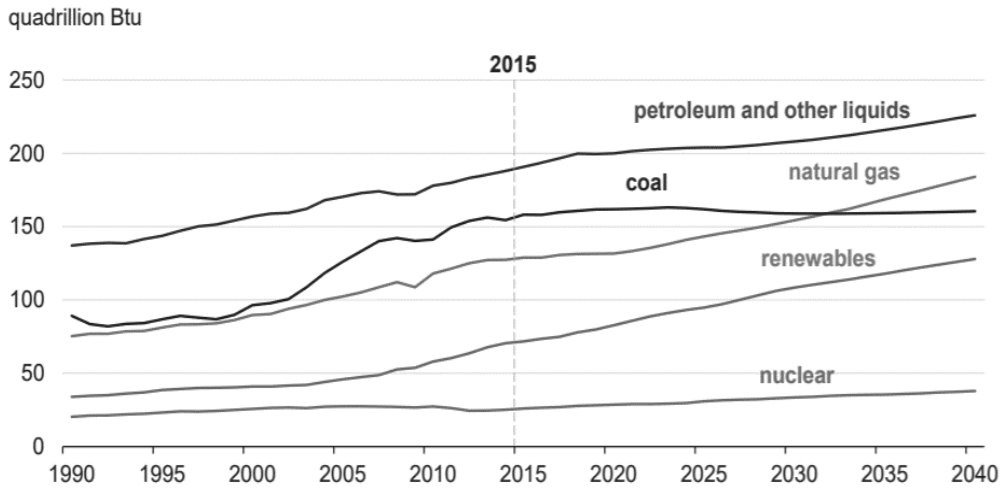
II. THE PETROLEUM INDUSTRY

I find it necessary to give a brief description of the industry I am studying, and thus provide you – the reader – a basic overview of how oil and gas companies operate. Section II provides this overview, starting with an introduction to oil and gas. I continue by presenting the value chain and some of its key players. Finally, I provide a short overview of taxation and some important accounting methods for E&P firms.

Introduction to Oil & Gas

The petroleum industry is one of the largest in the world, and accounts for a major part of the global economy. Oil and gas have during the past decades been the major sources of energy, and as shown by Figure 1, this trend is predicted to continue in the decades to come. Even in these times of great focus on renewable energies, the U.S. Energy Information Administration (2017) predicts that the demand for oil and gas will increase in the future and still dominate the global energy consumption.

Figure 1 - World energy consumption by energy source

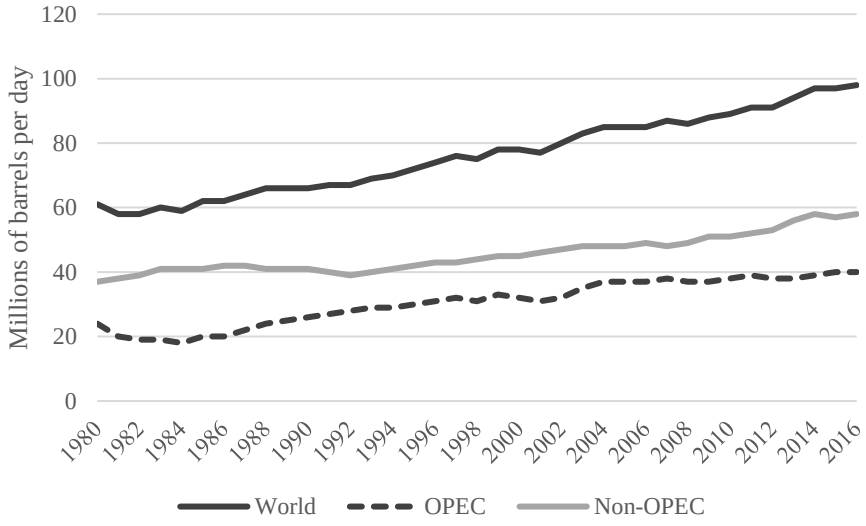


Source: U.S. Energy Information Administration (2017)

It is not difficult to understand why the petroleum industry is of such great importance to our lives. For instance, it produces a vast number of products that are used on daily basis. Products such as gasoline, diesel fuel, home heating oil and jet fuel are all from the petroleum industry. Furthermore, oil and gas have an impact on the world's political and economic environment as it serves as a strategic resource. As put by Inkpen and Moffett (2011, p. 41); *"… oil and gas must be viewed as integral to the national security and national wealth of almost all countries."*

As the demand for oil and gas has increased during the last decades, so has the supply. Figure 2 shows the global petroleum production between 1980 to 2016, where it can be observed that global production has had a steady increase. This increase is mainly due to advancements in technology allowing for extraction of petroleum reserves in more challenging areas (Inkpen & Moffett, 2011). An example is technology that has paved the way for exploration on ultra-deep waters, giving access to petroleum reserves not reachable in the past. This innovation has led to higher production than ever before.

Figure 2 - Global Petroleum Production

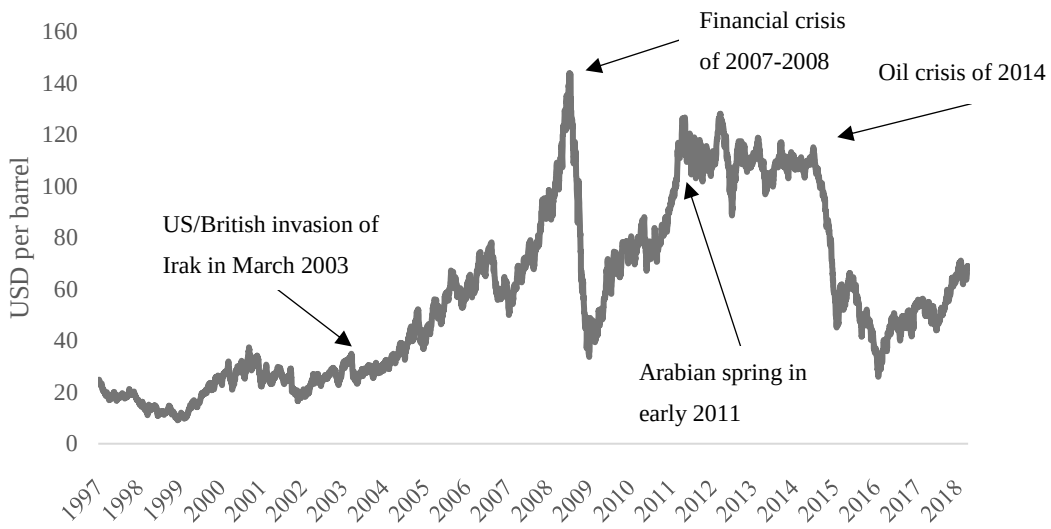


Source: Data obtained from U.S. Energy Information Administration (2018)

Even with growing demand for petroleum products, the industry is described as highly cyclical. This makes it vulnerable to macroeconomic events, such as international conflicts and economic crisis. One of the reasons for the industry's volatility is due to its dependency

on crude oil prices. The crude oil price is mostly driven by the global supply and demand for petroleum products but is vulnerable to economic shocks. This makes oil price highly unpredictable, and is one of the two primary top-line risks (Inkpen & Moffett, 2011). As shown by Figure 3, the oil price is highly volatile and subject to geopolitical risk. During the global financial crisis of 2007-2008, Brent crude oil price plunged over 70%. A similar scenario has been observed in recent years, where the latest and still ongoing oil price crisis has shaken all industry players, leading to an era of low oil prices, bankruptcies and industry consolidation. This has been especially dramatic for the oilfield services (OFS) sector, which is more fragmented than ever (EY, 2017).

Figure 3 - Development in Brent Crude Oil Price



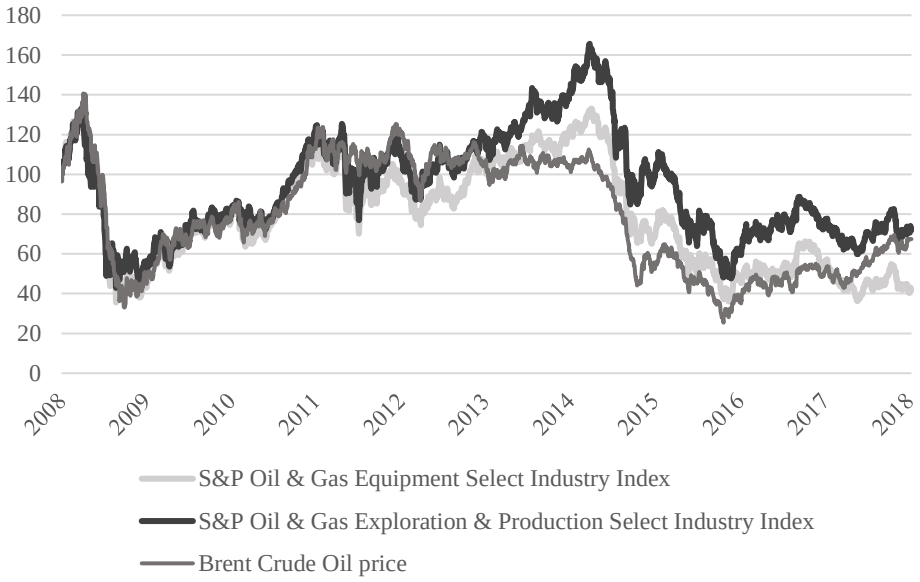
Source: Data obtained from Federal Reserve Bank of St. Louis (2018a)

The effect of crude oil prices on oil and gas companies can be reflected in stock market movements, where market performance tends to follow the trend of oil prices. Figure 4 provides the indexed performance of Brent crude oil price, E&P market index and OFS market index[2]. It is observed that E&P and oilfield service firms tend to suffer stock price declines in periods where the oil price has dropped. The financial crisis starting in 2007 and the oil crisis in 2014 have particularly had a negative effect on both sectors. Interestingly, these two sectors have had about the same market performance prior to the start of the

[2] All series are starting at 100 at 31th March 2008.

Arabian spring in early 2011. After this period, however, they have shown different movements in stock market returns.

Figure 4 - Indexed market and crude oil performance



Source: Data obtained from S&P Dow Jones Indices (2018a) , S&P Dow Jones Indices (2018b) and Federal Reserve Bank of St. Louis (2018a).

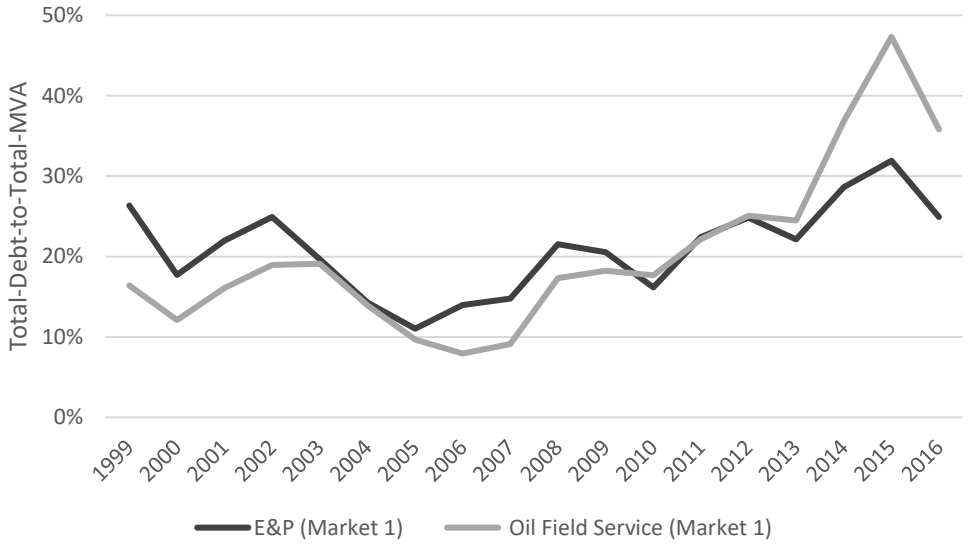
The two sectors have also shown similarities in leverage policy. Figure 5 on the next page shows the historical median market leverage for both the E&P and the OFS sector. It appears that both have had similar trend in leverage ratios prior to 2013. However, market leverage in OFS firms rose significantly after the oil price crisis starting in 2014. This increase appears to have been less dramatic for E&P firms.

Although leverage has increased for both sectors, the average credit ratings have experienced a similar trend. Figure 6 provides historical equally weighted average S&P credit rating by SIC-code for my collected data sample[3]. As we can observe from Figure 6, most of the observations have shown increased credit ratings since the end of the financial crisis in 2007-

[3] Credit ratings from the two other major credit rating agencies, Moody's and Fitch, are not included due to difficulties with obtaining historical credit ratings.

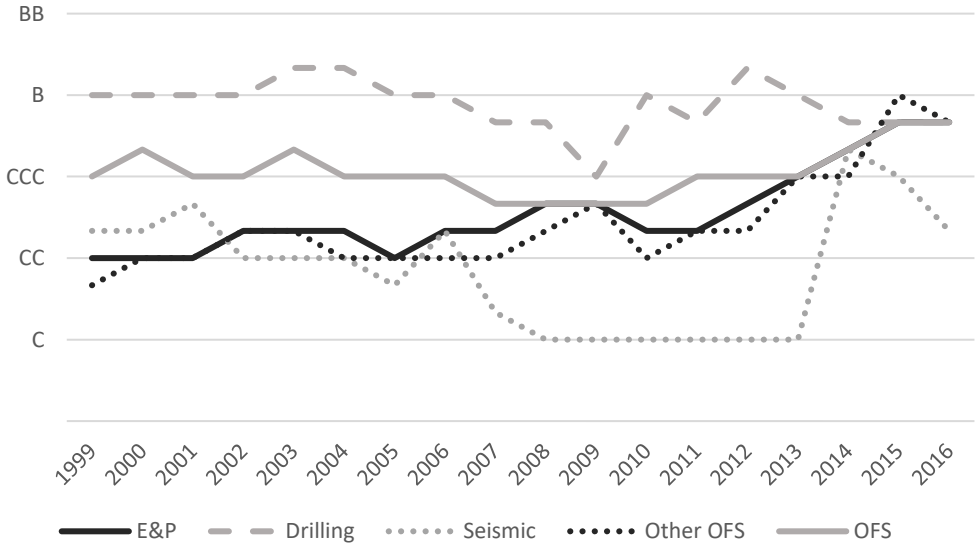
2008. Drilling service providers seem to have the highest average credit rating relative to the other oilfield service providers, while seismic service providers appear to have the lowest.

Figure 5 - Median market leverage in E&P vs Oilfield Service



Source: Data obtained from CRSP/Compustat Merged

Figure 6 - Historical change in average S&P credit rating



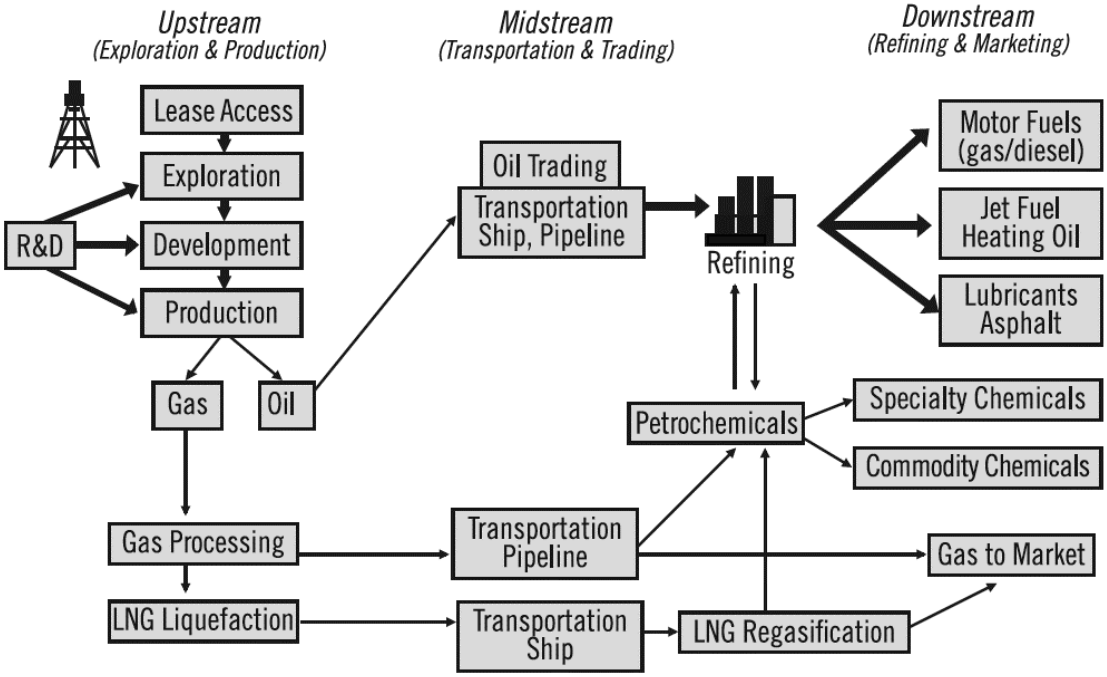
Source: Data obtained from Capital IQ North America

From the short description presented in this subsection, I deduce that although the petroleum industry is of vital importance it is far from being free of challenges. The cyclical nature of the industry makes it vulnerable to a variety of challenges such as political, technological and environmental risks. This may alter the balance between supply and demand for oil and gas, resulting in potential oil price shocks as we have experienced in recent times. Another potential challenge is that the industry requires massive amounts of capital for its major investments. Being highly capital-intensive reduces barriers of entry but poses reduced flexibility in meeting sudden changes in oil demand. A common assumption should thus be that all of these challenges are accounted for when petroleum firms are making financing decisions. However, the industry is divided into several business sectors with different value propositions and business risks. As described by Bender and Ward (2008), firms should attempt to choose the appropriate financial risk to match their level of business risk. Consequently, there are expected differences in optimal capital structure between sectors. The next subsection provides an overview of these business sectors by presenting the petroleum value chain.

Petroleum value chain

The petroleum value chain is usually separated into three business segments depending on their activities; (*A*) Upstream, (*B*) Midstream, and (*C*) Downstream. Since this study is aimed at the upstream segment, I am not discussing midstream and downstream in detail. Figure 7 provides a simplified overview of the global petroleum value chain and its components. Each of the three value chain segments are then presented separately.

Figure 7 - Global petroleum value chain



Source: Inkpen and Moffett (2011, p. 21)

A. Upstream

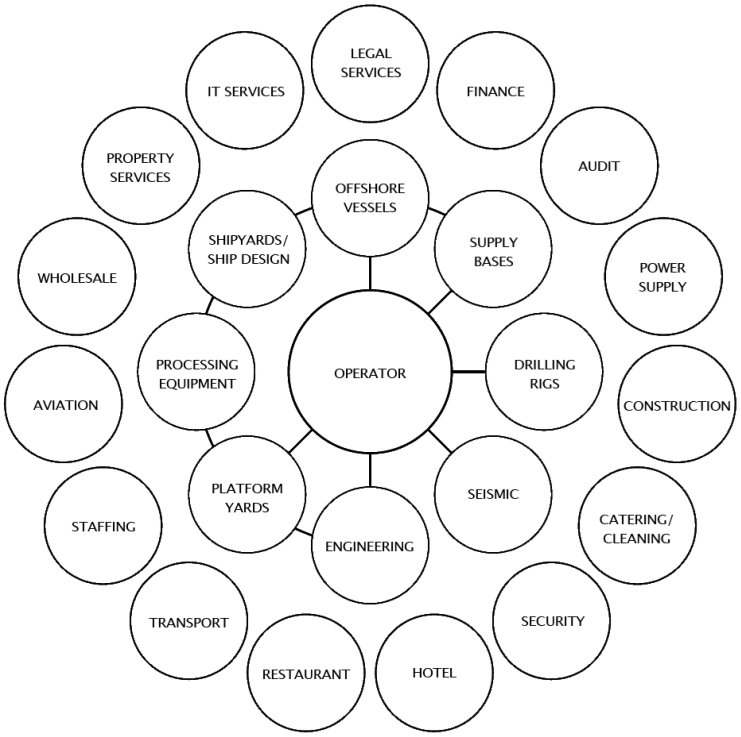
Upstream activities consist of exploration, development and production of petroleum reserves. All players within this segment are hence focused towards finding and extracting oil and gas to the surface. Exploration and production contains several detailed steps that are beyond the scope of this thesis. However, Wright and Gallun (2008) gives a clear overview of the procedure in exploring for petroleum reserves. According to them, the E&P process starts with finding an area of interest that has high probability of containing petroleum deposits. For this task, E&P firms use petroleum geologists to analyse the rock formations. Seismic service providers may be hired already in this process, providing general reconnaissance[4] surveys to assist the geologists in determining areas of interest. When an area of interest is found, the E&P firm must obtain a leasing agreement from the area owner, usually a government. When the leasing agreement has been obtained, more detailed seismic studies might be carried out and the E&P firm may contract drilling service providers to drill test wells. Based on these tests, petroleum engineers find the probable amount to produce and

[4] Geological and geophysical study covering a broad area (Wright & Gallun, 2008)

the most effective way of extracting the oil and gas. When all tests have been done and the potential of high quantity of petroleum reserves is acceptable, a well is drilled and the production begins.

As described in the simplified steps above, the upstream segment constitutes of several players with different sizes, capabilities and strategies. Figure 8 summarizes all subsectors that are either directly or indirectly related to petroleum activity.

Figure 8 - Direct and indirect petroleum related activity



Source: Norsk Petroleum (2018)

The inner circle represents the E&P sector, while the middle circle constitutes subsectors in OFS. The outer circle represents service providers that are indirectly related to petroleum activity, and hence not discussed in this study. Due to the scope of this thesis, I am only presenting three key players; (*i*) Independent E&P Companies, (*ii*) Integrated Oil Companies, and (*iii*) Oilfield Services Companies[5].

[5] For a more detailed description of industry players, please see Inkpen and Moffett (2011), Downey (2009) and Wright and Gallun (2008).

(*i*) Independent E&P Companies

Oil and gas firms that generate nearly all of its revenues from oil and/or gas production is often referred to as an independent E&P company (Inkpen & Moffett, 2011). According to Downey (2009), independent E&P companies tend to have the highest business risk, as well as the potential for highest return. The higher risk-return trade-off arises due to the uncertainty regarding the amount of petroleum reserves when exploring new areas. As previously mentioned, independent E&P companies are the focus of my study. Examples of such firms are ConocoPhillips, Devon Energy, and CNOOC Limited.

(*ii*) Integrated Oil Companies

Oil and gas firms that participate in the whole value chain, from upstream to downstream, are called integrated oil companies (IOC). Hence, these firms are producing, refining and marketing their petroleum products themselves. IOCs are usually large oil and gas companies, where the largest are often referred to as "supermajors". Examples of supermajors are Chevron, BP, Shell, Total and ExxonMobil. Since IOCs are tied to several parts of the value chain, their corporate strategy would differ from that of an independent E&P firm. There are also major differences in size and level of governmental influences between these two key players. Due to these differences, I have decided to not include IOCs in this study.

(*iii*) Oilfield Services Companies

Oilfield service companies (OFS) provide services to oil and gas producers that are directly related to exploration, development and/or production. Hence, they provide the equipment, manpower and skills to the E&P sector. The OFS sector is relatively competitive, where each player must struggle for higher efficiency than its competitors. Since this sector is highly dependent on employment from E&P firms they must offer services at lower prices in periods with low exploration activity. This leads to lower margins for the whole OFS sector in downturns and makes it especially vulnerable to fluctuations in demand for oil and gas.

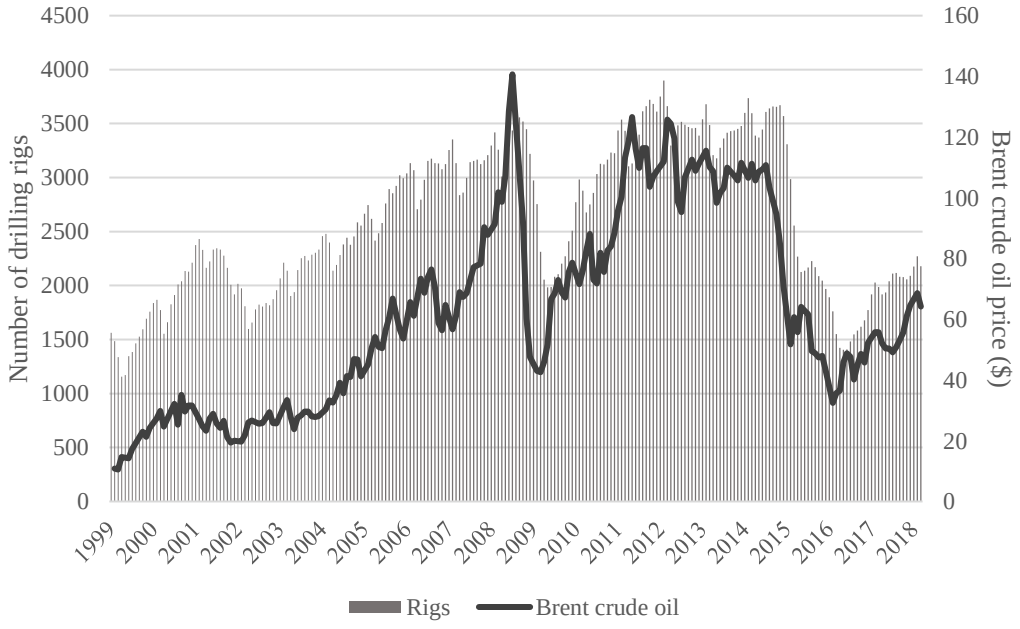
The OFS sector constitutes several firms with different value propositions. This makes up several subsectors within OFS. I have chosen to present these according to four-digit SIC codes, giving three different groups of OFS firms; Drilling services (*1381*), Seismic services (*1382*), and Other services (*1389*).

Drilling services (1381)

There are few E&P firms that own their own rigs. Hence, most upstream oil and gas explorers hire drilling companies on a contract basis to drill for petroleum reserves. These service firms provide the service of drilling for subsurface petroleum reserves either onshore or offshore using special drilling equipment. Examples of drilling rig providers are Transocean, Baker Hughes, and Weatherford.

In recent years, drilling service providers have been in distress due to fewer rig contracts provided by E&P firms. This development is a direct consequence of the latest oil price crisis in 2014. As we can observe in Figure 9, the number of active rigs tends to closely follow the performance of oil price.

Figure 9 - International rig count



Source: Data obtained from Baker Hughes (2018) and Federal Reserve Bank of St. Louis (2018a)

Seismic services (1382)

Another activity where E&P companies tend to hire contractors is seismic analysis. Seismic analysis consists of mapping subsurface geological structures using sound waves (Inkpen & Moffett, 2011). This method gives highly detailed maps of the rock formations and layers, providing important information to determine the most efficient and cost-effective extraction method. Recent innovation in seismology has had great impact on drilling success. However due to high costs, seismic studies is usually only performed when there is high indications of petroleum reserves (Wright & Gallun, 2008). Examples of seismic providers are Petroleum Geo-Services, Dawson Geophysical Company, and CGG Veritas.

Similar to drilling services, seismic providers have been in distress for the last years. Mohn and Osmundsen (2011) find evidence for a "bad news effect" between oil price and exploration activity. Since E&P companies tend to reduce their exploration activity during downturns, it is often seismic studies that are affected first due to their early placement in the value chain.

Other (1389)

Including seismic and drilling services, there are also other services that are common for E&P firms to hire. Such services could be the provision of other exploring and production equipment, maintenance services, transportation and/or support services on a contractual basis.

B. Midstream

Midstream activities consist of storing, trading and transporting crude oil and gas. For example, a firm operating in the midstream segment is responsible of transporting crude oil by ship tanker, pipelines, railcar tanker and/or truck tanker (Downey, 2009). Examples of firms within this segment are Frontline Ltd, Plains All American Pipeline, and Kinder Morgan. The midstream segment is not part of my study and will hence not apply to the rest of my thesis.

C. Downstream

Downstream consists of refining, marketing and selling petroleum products to the market. This segment is where the fuel products, such as gasoline and diesel, are refined and sold to consumers at fuelling stations. Examples of firms within this segment are IndianOil, Valero Energy and SK Energy. Similar to midstream, the downstream segment will hence not apply to the rest of my thesis.

Petroleum accounting and taxation

The petroleum industry is subject to complex accounting standards which should be considered. However, due to the scope of this thesis I will not go into detail on this topic[6]. Nonetheless, it is useful to have a basic understanding of the differences between two historical costs methods when analysing E&P firms; (*i*) Successful efforts, and (*ii*) Full cost. A firm's choice of method may have an impact on the financial items I study.

(*i*) Successful efforts method

Under successful efforts, only exploration expenses resulting in proved reserves are capitalized (Wright & Gallun, 2008). Unsuccessful exploration expenses are not considered an asset that will generate future economic benefits and are hence expensed.

(*ii*) Full cost method

Under full cost, all exploration expenses are capitalized and are therefore not included in the income statement (Wright & Gallun, 2008). This means that both successful and unsuccessful exploration expenses are capitalized as assets, even when it is not expected to generate future economic benefits. This makes the full cost method less conservative than successful efforts.

[6] For a more detailed overview of oil & gas accounting and taxation, please see Wright and Gallun (2008).

Based on my obtained data sample I find that 27% of the total observations use full cost, 36% use successful efforts, and 37% provide no information[7]. Due to this wide spread, I have chosen to keep all observations regardless of accounting method. This decision offers the benefit of preserving the number of observations at an acceptable level. I have also chosen not to control for this in my regression models due to the large amount of observations with missing information. This choice is, however, not optimal and must be kept in mind for the rest of this study.

Another important concern is how taxes affect capital structure. Taxes reduce both the net cash flow available to investors and raises the break-even barrels production requirement (Inkpen & Moffett, 2011). Thus, the taxation of the petroleum industry should influence capital structure decisions. However, the taxation of petroleum companies varies across countries, making it difficult to study accurately on a global scale. The taxation of each observation may also vary depending on how the total debt is divided between the parent company and subsidiaries in different jurisdictions. I will therefore simplify my study of tax effect on leverage and will only discuss taxation at an overall level for the rest of this thesis.

[7] Accounting method is found using footnote codes *TG* and *TH* in Compustat /CRSP Merged for successful efforts and full cost, respectively.

"Equity is soft, debt hard. Equity is forgiving, debt insistent. Equity is a pillow, debt a sword."

– Gordon B. Stewart III & David M. Glassman

III. THEORY

Section III presents relevant theory. I start by presenting capital structure theory in perfect capital markets. I continue by presenting three main theories in imperfect capital markets. Finally, I provide an overview of capital structure determinants according to acknowledged survey evidence.

Capital structure in perfect capital markets

In perfect capital markets, Modigliani and Miller (1958) claim that capital structure will not affect a firm's value or cost of capital. They assumed either explicitly or implicitly the following:

1. *There are no corporate taxes and no personal taxes.*
2. *Operating cash flows are unaffected by changes in capital structure.*
3. *There are no bankruptcy costs.*
4. *All investors can borrow and lend at the risk-free rate.*
5. *There are no agency costs.*
6. *Firms issue only two types of claims: risk-free debt and (risky) equity.*
7. *All firms are assumed to have the same business risk.*
8. *All cash flow streams are perpetuities.*
9. *Capital markets are frictionless.*
10. *Corporate insiders and outsiders have the same information.*

(Copeland, 2013)

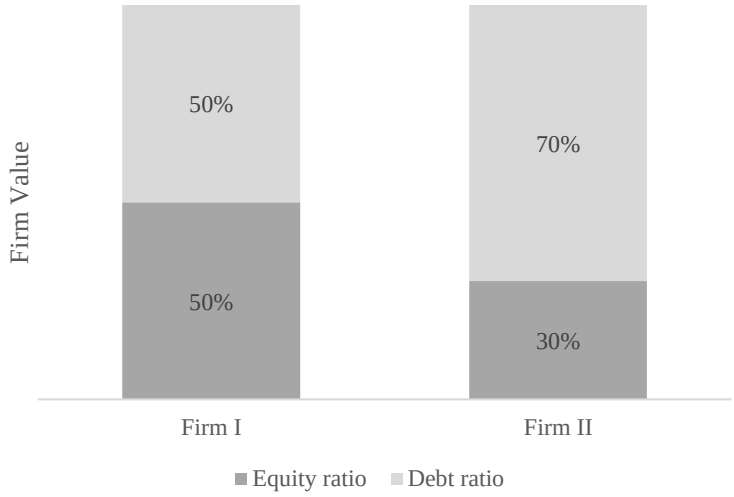
Given these assumptions, their findings are known as the Miller Modigliani (MM) propositions, which are presented on the next page.

MM Proposition I

"In a perfect capital market, the total value of a firm is equal to the market value of the total cash flow generated by its assets and is not affected by its choice of capital structure" (Berk & DeMarzo, 2014, p. 483).

The argument behind this proposition is that the source of a firm's value comes exclusively from the free cash flow generated by its assets, and not how the cash flow is divided between debt- and equity holders. Hence, the capital structure should neither increase nor decrease firm value. Consequently, two identical firms only differing in their capital structure should have the same value, as illustrated in Figure 10[8].

Figure 10 - Example of MM Proposition I



MM Proposition II

"The cost of capital of levered equity increases with the firm's market value debt-equity ratio" (Berk & DeMarzo, 2014, p. 489).

[8] Self-made figure

The most widely used cost of capital is the weighted values of cost of equity and cost of debt after tax. This is called the weighted average cost of capital (WACC). Assuming perfect capital markets gives the following equation:

$$r_{WACC} = \frac{E}{D+E} * r_E + \frac{D}{D+E} * r_D \qquad (1)$$

$Where;$

$r_{WACC}\ is\ the\ weighted\ cost\ of\ capital\ (WACC)$

$r_E\ is\ the\ cost\ of\ levered\ equity$

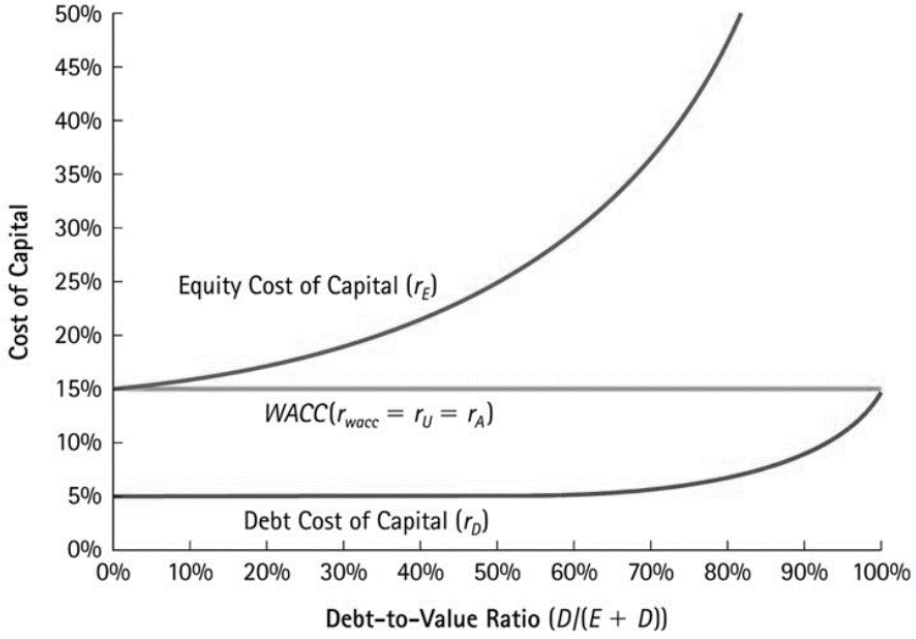
$r_D\ is\ the\ cost\ of\ debt$

$E\ is\ the\ market\ value\ of\ equity$

$D\ is\ the\ market\ value\ of\ debt$

According to the second proposition, the cost of equity increases with increased leverage. In perfect capital markets, the WACC remains constant, independent of the chosen leverage ratio. This increase in cost of equity is due to larger debt obligations undertaken by the firm. Hence the reduction in cost of capital from debt is offset by an increase in cost of equity, holding the WACC fixed. This relationship is shown in Figure 11 on the next page, where the WACC remains constant and independent of leverage ratio.

Figure 11 - WACC and leverage in perfect capital markets



Source: Berk and DeMarzo (2014, p. 490)

Capital structure in imperfect capital markets

As expressed by Modigliani and Miller (1958), capital structure is irrelevant in perfect capital markets. However, the real world is subject to market imperfections such as taxes and transaction costs. Hence the assumption of perfect capital markets is strong and highly unlikely, which has led to several papers trying to explain why capital structure *is* relevant. In recent literature there are three popular capital structure theories for imperfect capital markets; (*i*) the Trade-off theory, (*ii*) the Pecking Order theory, and (*iii*) the Market Timing theory. Each of these are explained separately below.

(*i*) Trade-off theory

Due to the strong assumptions of perfect capital markets, Modigliani and Miller (1963) introduce corporate income taxes into their original model. When corporate taxes are introduced, it gives a benefit to debt due to the interest payments being tax deductible. This benefit is often called the interest tax shield, which increases the value of a firm due lower

future tax payments[9]. Since corporate taxes are the only market imperfection, there are only benefits of using debt. Their findings suggest that when introducing corporate taxes, firms would have an incentive to be 100% debt financed[10]. The trade-off theory was first proposed by Kraus and Litzenberger (1973) as a response to this extreme prediction. The theory is based on the idea that firms must make a trade-off between the benefits and costs of using leverage. They argue that firms must balance the benefit of the interest tax shield and the financial distress costs when determining capital structure. Such financial distress costs, also called bankruptcy costs, arise due to the threat of bankruptcy. Examples are legal and admirative costs in the event of bankruptcy[11], or costs associated with financial distress prior to bankruptcy such as fire sales of assets and loss of customers[12] (Berk & DeMarzo, 2014).

Not surprisingly, financial distress costs have a negative effect on firm value. As shown in Equation 2, the value of a levered firm is equal to the value of the firm as if it was 100% equity financed, plus the present value of the interest tax shield, minus the present value of all financial distress costs.

$$V^L = V^U + PV(ITS) - PV(BC) \quad (2)$$

$Where;$

V^L *is the levered value of the firm*

V^U *is the unlevered value of the firm*

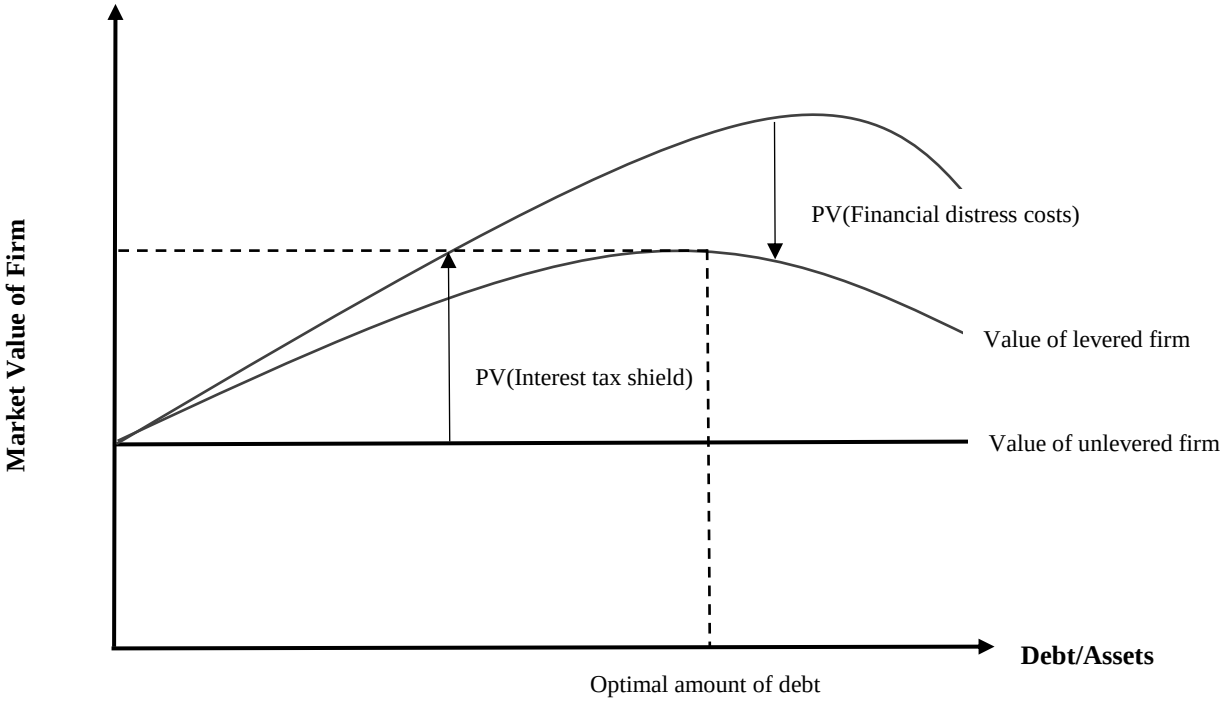
$PV(ITS)$ *is the present value of future interest tax shields*

$PV(BC)$ *is the present value of bankruptcy costs*

Based on this equation, there should be an optimal leverage ratio that balances the benefits and costs of debt. The optimal capital structure by trading off the present value of future interest tax shields and the financial distress costs is shown in Figure 12 on the next page.

[9] A more complete description of interest tax shields includes personal taxes, which was first introduced by Miller (1977). I have, however, chosen to not cover personal taxes due to the scope of this thesis.
[10] Assuming riskless debt
[11] Direct bankruptcy costs
[12] Indirect bankruptcy costs

Figure 12 - Firm value and leverage according to the static trade-off theory



Source: based on Myers (1984)

Extensions of the trade-off theory has been made since Kraus and Litzenberger (1973), introducing agency theory to the model. Jensen and Meckling (1976) claim that under a specific set of assumptions[13], debt has a negative effect on firm value due to agency costs[14]. They argue that by introducing debt financing, equity becomes similar to a call option, which gives incentives to excessive risk-taking. This leads to an asset substitution effect, meaning that shareholders desire to replace low-risk assets with riskier assets (Berk & DeMarzo, 2014). Assuming that management is acting on equity holders best interest this would lead to investments in riskier projects, but not necessarily with positive-NPV. This overinvestment problem is an agency cost of debt financing. Another agency cost related to debt is the underinvestment problem, also called debt overhang. If a firm faces debt overhang it implies that it may choose to forego positive-NPV projects if the firm is in financial distress.

[13] For a detailed overview of assumptions, please see Jensen and Meckling (1976).
[14] Agency costs arise when ownership and control are separated. It might be due to conflicts of interest between owners and managers, or between shareholders and debtholders (Copeland, 2013).

Based on the issues mentioned above, there are both over- and underinvestment problems arising from debt financing according to agency theory. However, there are also claimed to be agency benefits of using debt. Jensen (1986) argues that there is an agency benefit of using leverage, namely the benefit of reducing agency costs of free cash flow. He uses the petroleum industry as example, explaining that the large free cash flows in the industry led to unprofitable investments and so-called "empire building". He argues that by using more debt, such firms should lower agency costs by reducing the amount available to management for wasteful spending. He also adds that debt has a disciplinary effect on management, since it must be repaid to avoid bankruptcy. All these factors represent agency benefits of debt. Hence there is also a trade-off between agency benefit and costs, which should give an optimal capital structure by finding the optimal balance.

Usually we separate the trade-off theory into a static and a dynamic model. A firm follows the static trade-off theory if leverage is determined by a single period trade-off between benefits and costs of leverage (Baker & Martin, 2011). This means that firms will chose their optimal capital structure and hold this fixed. To keep the leverage ratio constant by rebalancing equity and debt is, however, costly due to transaction costs. The dynamic trade-off theory therefore allows for deviations from the optimal capital structure in the short run.

(*ii*) Pecking Order Theory

The pecking order theory, first proposed by Myers (1984), is based on how asymmetric information between management and the market affects the choice of capital structure. Since management has more complete information about the firm, the market will react according to the management's actions, interpreting their behaviour as a sign about the firm's current economic state. According to this theory, the market believes that managers will prefer to issue equity if they perceive it as overvalued. Issuing overvalued equity provides a gain to the firm, raising more capital than the actual value of the issued equity. Issuing undervalued equity, on the other hand, imposes a cost to the firm since it raises less capital than its actual value. Issuing equity or debt hence has a signalling effect to the market (Myers & Majluf, 1984). Issuing debt signals that management expects the firm to be able to handle increased debt obligations in the future. It might also signal that equity is undervalued, further strengthening a positive signal in favour of higher firm value. Issuing equity, on the other hand, would according to the pecking order theory signal the opposite.

Due to this market reaction to management signalling, the pecking order theory states that firms prefer to use retained earnings to fund investments, rather than debt or equity. If there are insufficient retained earnings, debt is preferred over equity. This suggests that management follows a hierarchy of financing sources, which is presented in Table 1 below.

Table 1 - Ranking of preferred financing source

	Financing source	**Degree of sensitivity to asymmetric information**
Internal financing	Retained earnings	Low
External financing	Debt	
	Equity	High

Source: based on Myers and Majluf (1984)

Although the pecking order theory is one of the most accepted it has some challenges. In spite of its ability to predict the choice of financing source it does not predict an optimal capital structure, in contrast with the trade-off theory. Another challenge with this theory is that it is more likely to hold when the extent of asymmetric information is large (Baker & Martin, 2011).

(*iii*) Market Timing Theory

Another theory that has gained popularity in the recent years is the market timing theory, first proposed by Baker and Wurgler (2002). They studied how equity market timing affected the choice of capital structure. They found evidence suggesting that firms tend to time the market, only issuing equity when the market is perceived as favourable. New equity will therefore be issued if the firm is perceived as overvalued, while new debt will be issued if it is perceived as undervalued. This theory might also suggest that firms issue debt when the debt markets are considered favourable. The theory is hence based on the assumption that markets are inefficient.

Baker and Wurgler (2002) argue that a firm's capital structure is not a result from optimization strategies, but rather a cumulative outcome from past market timing attempts.

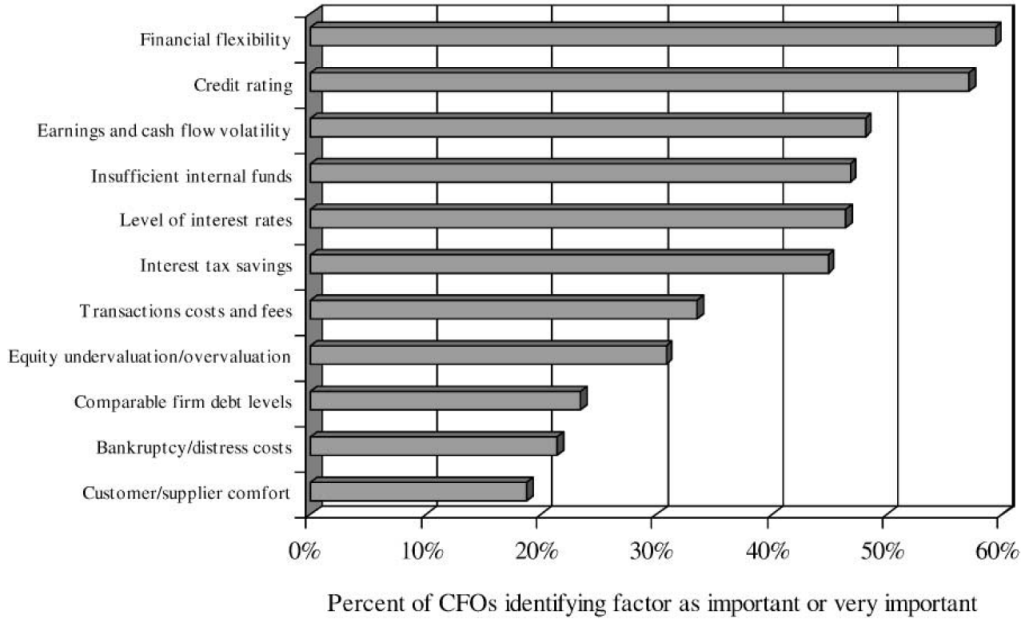
Hence, a similar criticism to the pecking order theory, is that it does not predict an optimal capital structure. Another challenge is that this theory is driven by market psychology and may not be a persistent predictor of capital structure in the long run.

Capital structure policy in practice

Theory and practice have the unfortunate tendency of differing, and therefore it might be useful to add a practical perspective on the choice of leverage policy. Surveys have the ability of providing a practical view and can be regarded as supplement to theory. However, surveys measure beliefs and may not fully represent reality. Thus, results from surveys should be treated with care, and only function as suggestive presentations.

One of the most acknowledged surveys on capital structure was conducted by Graham and Harvey (2001). They survey 392 U.S. CFOs on the practices of corporate finance, where one of the focus areas is capital structure. As shown in Figure 13 on the next page, their results suggest that CFOs value financial flexibility the most, followed by credit rating and earnings volatility. Interestingly, CFOs tend only to moderately consider the tax advantages when making capital structure decisions. These results suggest that CFOs are more concerned with bankruptcy costs. However, when CFOs were asked specifically about the importance of bankruptcy costs in determining capital structure, they ranked this as one of the least important factors. Some other factors that were perceived as the least explanatory for capital structure were industry debt levels, equity under-/overvaluation and transaction costs. The findings of Graham and Harvey (2001) suggest that practical determinants are somewhat unclear when it comes to theory predictions, being both consistent and inconsistent with all of the three major theories.

Figure 13 - Debt policy factors



Source: Graham and Harvey (2001, p. 210)

Bancel and Mittoo (2004), also using surveys to study capital structure determinants, find evidence supporting the findings of Graham and Harvey (2001). Based on the survey of European CFOs they also find results suggesting financial flexibility as the most dominant factor in determining capital structure, closely followed by credit rating. However, European CFOs tend to value the tax advantages as more important than earnings volatility when determining capital structure. Their findings are more consistent with the trade-off theory, although the evidence only provides medium support.

Based on the survey results, it appears that financial flexibility is the most important factor when making capital structure decisions. However, this possible determinant is difficult to include. As described by Baker and Martin (2011), firms can use several different sources of financing to enhance their financial flexibility, such as cash holdings and bank credit lines. Bancel and Mittoo (2011) further claim that the choice of financing source is likely to vary between firms, making financial flexibility unobservable and hard to measure. I have therefore chosen to not study financial flexibility when testing for capital structure determinants.

During my independent work, I have sent out surveys to several CFOs in both independent E&P firms and in OFS firms in my data sample. However, the response rate has been

extremely weak, only resulting in two completed surveys. The answers may therefore not be representative for the population and will hence not be used to draw any conclusions in the remainder of this study. Nonetheless, it still gives value to my thesis, giving a suggestive presentation on capital structure determinants. The ranking from each CFO is presented in Table 2 below.

Table 2 - CFO ranking of leverage determinants

Ranking	E&P firm	OFS firm
1.	Financial distress costs	Earnings volatility
2.	Financial flexibility	Financial Distress costs
3.	Oil price	Oil price
4.	Interest levels	Credit rating
5.	Interest tax savings	Interest levels
6.	Earnings volatility	Financial flexibility
7.	Credit rating	Tax savings

Source: survey results based on the responses from two CFOs, one for each sector

Based on the responses, it appears to be some similarities between the two sectors. A major difference from the results of Graham and Harvey (2001) is that both CFOs rank financial distress as one of the most important factors when determining leverage. Furthermore, they both rank the oil price as an important factor, and they claim that they do not use leverage ratio for signalling purposes.

Nevertheless, it appears that there are some differences between the two sectors. According to the CFO in the OFS firm, leverage ratio is allowed to deviate from the target depending on the stage of the business cycle. The CFO in E&P, however, states that the firm has no target leverage, but attempts to time their financing activities when markets are considered attractive. This suggests a market timing behaviour for the E&P firm. Furthermore, the CFO in the E&P firm consider financial flexibility as one of the most important factors when determining capital structure, being in accordance with previous survey results. Contrarily, the CFO in the OFS firm consider this factor as the least important. Lastly, the CFO in the OFS firm claims that they reduced their leverage policy following the financial crisis, and that they are likely to reduce it again following the recent oil price crisis. The CFO in the E&P firm, on the other hand, claims that the latest oil price crisis will have no effect on leverage policy. This suggests that business cycle has an impact on leverage policy for OFS.

As previously mentioned, these results should only be regarded as suggestive presentations.

"…it should be remembered that oil is not an ordinary commodity like tea or coffee. Oil is a strategic commodity… Oil is too important a commodity to be left to the vagaries of the spot or the futures markets, or any other type of speculative endeavour."

– Sheik Ahmed Zaki Yamani, Saudi Arabian Minister of Oil, 1983

IV. DATA

Section IV presents information on my data collection. I start with an overview of data sources and sample selection, and then continue with discussing how I handle extreme observations. Finally, I present all variables used for regressions and how they are related to capital structure according to theory and previous empirical research.

Sample selection

The data sample consists of 353 publicly traded firms on CRSP/Compustat Merged (CCM) for the timeframe 1999-2016[15], which gives 3,996 firm year observations. I only consider firms with fully consolidated balance sheet items. The data sample is reported on an annual basis and in US dollars[16]. Furthermore, I require non-missing data for all balance sheet items used in the analysis and drop all firms with assets under $1M, in accordance with Danis, Rettl, and Whited (2014), Faulkender and Petersen (2006) and Drobetz, Gounopoulos, Merikas, and Schröder (2013). Since regressions using panel data need minimum two observations for each firm, I have chosen a requirement of minimum three observations per entity. This is in accordance with Mjøs (2007) and Drobetz et al. (2013). Due to a long time period in my data sample there could be bias arising from inflation. I have therefore inflated all absolute continuous variables to 2016 dollars to make all observations comparable.

Each firm has been selected using four-digit Standard Industrial Classification (SIC) codes. Firms with SIC code 1311 are identified as E&P firms, while firms with SIC codes 1381,

[15] The choice of period is due to the lack of data on petroleum reserves and production amount prior to 1999 and after 2016.

[16] 95% of all firm year observations are reported in domestic standards generally in accordance with or fully compliant with International Financial Reporting Standards (IFRS), indicated by accounting standard codes DI and DS.

1382 and 1389 are identified as oilfield service firms. For a detailed description of SIC codes, please see Appendix E. In accordance with Lehn and Zhu (2016), I have not included natural gas liquid (NGL) producers, which are identified with SIC code 1321. This choice is due to the lack of data on petroleum reserves for natural gas producers, as well as that Compustat has more extensive data on oil production. I am hence focusing on oil producers in this paper, although most of these are also involved in gas production. Furthermore, I have not included SIC code 2911, which contains IOCs. As previously mentioned, this decision is due to major differences between independent E&P firms and IOCs. It would hence be prudent to exclude IOCs from the data sample, since the risk of including IOCs might lead to fallacious conclusions.

Monthly stock returns from the last three years[17] are obtained from CCM. Unfortunately, due to the large number of observation years I had to use monthly returns instead of daily when deriving volatility, where the latter would have been preferred. However, this is not considered a major issue.

Due to the lack of industry specific items and S&P domestic long-term issuer credit ratings in CCM, I had to import these from Capital IQ North America[18]. Both were imported to the main data set based on global company keys. I have only used S&P credit rating due to the lack of credit rating availability from the two other major agencies; Fitch and Moody's. Firms with missing information on credit ratings were removed from the sample, while firms with credit rating equal to zero were assigned as not having credit rating. All firms with credit rating of BBB- or greater were assigned as having investment grade.

Most of the macroeconomic data are obtained from The Federal Reserve Bank of St. Louis. Annual GDP growth for the group of seven[19], 10-year US treasury bill, 1-year US treasury bill, and Brent Crude Oil prices are all obtained from this source. The yearly change in MSCI World Index is obtained from MSCI databases. Yearly global capital expenditures for E&P companies are provided by the energy research company Rystad Energy (2018)[20]. Rystad Energy use publicly available data from a variety of sources[21], and are regularly going through company communications such as investor presentations. E&P capital expenditures

[17] Including the observation year
[18] Industry Specific Annual
[19] "The Group of Seven (G7) consists of Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. The OECD refers to G7 as the Major Seven" (Federal Reserve Bank of St. Louis, 2018b).
[20] Many thanks to Rystad Energy for providing necessary data.
[21] Company reports, government data, academic research and credible news articles

include all development costs related to facilities and drilling of wells. All historical numbers are estimated based on field project level activity reported by operators in their annual reports, and are based on reported cash flow numbers.

For a complete overview of data sources, data selection and variable construction, please see Appendix A.

Handling extreme outliers

Extreme outliers might arise due to inaccurate data sources, coding mistakes or missing accounting figures that causes financial ratios to be economically unlikely. Outliers might also be extreme cases that are not representative for the total sample, and could hence generate seriously misleading conclusions. As stated by Mjøs (2007, p. 63): "Observations which with reasonable certainty can be deemed extreme or directly inconsistent will not add value to the analysis." Due to the potential issues with extreme outliers it is prudent to deal with them in a controlled manner. Baker and Martin (2011) claim that there are three common methods used for handling extreme outliers; (*i*) rule of thumb, (*ii*) winsorization[22] and (*iii*) robust regressions. I have used two methods for handling extreme observations. First, I use rule of thumb on financial ratios that are perceived as "impossible", where the rule is that certain variables must lie within clearly defined intervals. For example, leverage ratios and tangibility must lie between zero and one. This is in accordance with Danis et al. (2014). Secondly, I have used winsorization[23], where I winsorize all firm-level continuous variables at a 1% level in both tails of the distribution. This is in accordance with Danis et al. (2014), Drobetz et al. (2013) and Eckbo and Kisser (2017). Macroeconomic variables and dummies are not winsorized, in accordance with Danis et al. (2014). Table 2 on the next page provides an overview of how the winsorization affected the dependent[24] and independent variables. For a complete descriptive table, please see Table 13 in Section VI.

[22] "Most extreme tails of the distribution are replaced by the most extreme value that has not been removed" (Eckbo, 2008, p. 173).
[23]. The winsorization has been done using STATA code *winsor*
[24] A description of dependent variables is presented in the following section.

Table 3 – Variables before and after winsorization for E&P observations

		Before winsorization		After winsorization	
	N	Mean	Median	Mean	Median
Leverage measures					
Market Leverage 1	1,565	0.23	0.20	0.23	0.20
Market Leverage 2	1,565	0.25	0.22	0.25	0.22
Book Leverage 1	1,565	0.28	0.28	0.28	0.28
Book Leverage 2	1,565	0.33	0.32	0.32	0.32
Firm Specific Factors					
Size (book)	1,565	2.94	3.01	2.94	3.01
Size (market)	1,565	3.10	3.18	3.10	3.18
Non-debt tax shield	1,565	0.09	0.08	0.09	0.08
Market-to-Book	1,565	1.36	1.11	1.34	1.11
Tangibility	1,565	0.74	0.81	0.74	0.81
Profitability	1,565	0.00	0.06	0.01	0.06
Risk	1,565	0.08	0.07	0.08	0.07
Industry M1 Leverage	1,565	0.21	0.21	0.21	0.21
Industry M2 Leverage	1,565	0.24	0.24	0.24	0.24
Industry B1 Leverage	1,565	0.28	0.30	0.28	0.30
Industry B2 Leverage	1,565	0.32	0.34	0.32	0.34
Reserve Life Ratio	1,001	26.06	7.89	14.06	11.24
Reserve Replacement Ratio	1,001	5.81	0.83	1.77	0.83
Proved Reserves Ratio	1,340	515,635.90	81,848.83	496,609.00	81,848.83

Measuring leverage

Before presenting the independent variables, it is important to define the leverage ratio and how it is measured. The current literature has several definitions of leverage to choose from, and there is no clear choice of measure from previous empirical research. In this study I have used two different definitions of leverage; (1) *Total-Debt-to-Assets*[25] and (2) *Total-Debt-to-Capital*[26].

Total debt is defined as total long-term debt plus total debt in current liabilities. Hence, debt is measured using both long-term and short-term debt, and reflects the interest-bearing liabilities. One potential issue with this definition is that it does not consider the offsetting

[25] In accordance with Faulkender and Petersen (2006), Frank and Goyal (2009), Drobetz et al. (2013) and Danis et al. (2014), among others.
[26] Rajan and Zingales (1995) argues that debt-to-capital better represents the effects of past financing decisions.

effect certain non-debt liabilities[27] has on assets (Baker & Martin, 2011). However, this is not considered to be a major issue for my study and is in line with previous empirical research[28].

Another important consideration is whether to use market or book values. The choice of using book or market leverage when studying capital structure determinants is ambiguous. Myers (1977) claims that a significant part of a firm's market value consists of the present value of future growth opportunities. He argues that managers prefer book over market leverage, since debt is better supported by assets-in-place. Graham and Harvey (2001) find evidence that firms do not rebalance their leverage ratio in response to stock market movements, which supports the use of book values. Another argument in favour of using book leverage is that market leverage is strongly volatile, and is dependent on factors outside of the firm's control (Fama & French, 2002).

Even though the use of book leverage has some advantages over market leverage, there are also some potential drawbacks. First, book values are simply accounting figures that are backward looking, and not reflecting the true economic value of a firm's assets. As put by Welch (2004), book value of equity is merely a "plug number", which can even be negative. Arguably, one would assume that management is forward looking when deciding the leverage policy, since they should be more concerned with the present and future. Second, firms typically use market-based leverage ratios when computing the WACC, and not book-value weights (Baker & Martin, 2011). Assuming that management attempts to minimize the cost of capital they should also seek to achieve an optimal capital structure. This assumption is supported by Bancel and Mittoo (2004), who finds in their study that about 70% of European managers agree to using debt to minimize the WACC.

Because of the unsettled dispute among academics, I have chosen to present my empirical results in both book and market values. The preferred way would be to use market values for both debt and equity when estimating the market leverage ratios. However, due to the lack of data availability on debt market values, as well as not all firms having market-traded debt, I have only used book value of debt in all leverage ratios. This gives four different independent variables to test[29]:

[27] Examples are trade credits and pension obligations.
[28] Drobetz et al. (2013), Danis et al. (2014) and Frank and Goyal (2015), among others.
[29] These leverage ratios are consistent with previous studies such as Frank and Goyal (2009), Drobetz et al. (2013) and Rajan and Zingales (1995), among others.

$$(1)\ Book\ Leverage\ 1 = \frac{Book\ Value\ of\ Total\ Debt}{Book\ Value\ of\ Total\ Assets}$$

$$(2)\ Book\ Leverage\ 2 = \frac{Book\ Value\ of\ Total\ Debt}{Book\ Value\ of\ Capital\ Employed}$$

$$(3)\ Market\ Leverage\ 1 = \frac{Book\ Value\ of\ Total\ Debt}{Market\ Value\ of\ Total\ Assets}$$

$$(4)\ Market\ Leverage\ 2 = \frac{Book\ Value\ of\ Total\ Debt}{Market\ Value\ of\ Capital\ Employed}$$

Dependent variables

Based on theory, survey results and my initial beliefs, I have chosen to study how a set of dependent variables – both firm-specific and macroeconomic – impact the choice of capital structure. These variables are presented individually below, starting with firm-specific variables.

(*i*) Firm-specific variables

1. Size

The size of a firm should be inversely related to bankruptcy risk, since small firms tend to be less diversified than larger firms. Larger firms also tend to have lower default risk and cash flow volatility. Hence according to the trade-off theory, larger firms should have relatively higher leverage due to lower bankruptcy costs.

The pecking order theory, on the other hand, predicts a negative relationship between firm size and leverage. Firm size can serve as a proxy for information asymmetry between management and the market. Large firms tend to be more closely monitored by analysts and rating agencies, which reduces the asymmetric information. Lower asymmetric information makes equity less expensive to issue, and consequently should lead to less debt financing. Size can also be a proxy for survivorship, where older and more mature firms tend to be more stable. This provides further support for a negative relation between size and leverage.

Previous empirical research has given miscellaneous results concerning firm size's effect on leverage. Titman and Wessels (1988) and Faulkender and Petersen (2006) find a negative relationship between size and leverage, which is consistent with the pecking order theory. However, Frank and Goyal (2009), Danis et al. (2014) and Shambor (2017) find a positive relationship between size and leverage, giving support to the trade-off theory. When reviewing survey results, Graham and Harvey (2001) find evidence suggesting that CFOs in large firms are more concerned with interest tax savings and credit rating when making capital structure decisions. They also find that the majority of larger firms have a tight or somewhat tight leverage ratio, in contrast to small firms. This indicates that CFOs in larger firms are more concerned with factors related to the trade-off theory.

As proxy for size I have used the logarithm of total assets, both in market and book values depending on chosen leverage measure. This proxy is in accordance with Drobetz et al. (2013), Faulkender and Petersen (2006), Frank and Goyal (2009) and Shambor (2017). I have used current values[30] to reflect how the current firm size affects leverage policy. Using current values is in accordance with Faulkender and Petersen (2006), Drobetz et al. (2013), Danis et al. (2014), and Shambor (2017).

Measure: $log(Total\ Assets_t)$

2. Tangibility

The tangibility of a firm's assets can serve as collateral for the firm's creditors. Fixed assets would hence give security to creditors in case of bankruptcy. Due to this security, higher tangibility makes debt less risky, and *vice versa*. Based on this argument, the trade-off theory predicts a positive relationship between tangibility and leverage.

When it comes to the pecking order theory, it predicts a negative relationship between tangibility and leverage. Higher tangibility reduces asymmetric information between management and the market, making equity less expensive to issue. Consequently, there should be less debt in firms with higher asset tangibility.

[30] Same observation year, as opposed to lagged values.

Previous empirical research[31] finds a positive relationship between tangibility and leverage, which is consistent with the trade-off theory.

As proxy for asset tangibility I have used net property, plant and equipment (PP&E) to total book assets[32]. I have chosen to not include stock ownerships and intangible assets such as patents since these may not represent the true level of collateral offered to debtors. This is in accordance with Faulkender and Petersen (2006), Frank and Goyal (2009), Drobetz et al. (2013), Danis et al. (2014), and Shambor (2017). Moreover, I have used current values to reflect how current asset tangibility affects leverage policy. Using current values of asset tangibility is in accordance with Faulkender and Petersen (2006), Drobetz et al. (2013), Danis et al. (2014), and Shambor (2017).

Measure: $Net\ PP\&E_t / Assets_t$

3. Non-Debt Tax Shield

The trade-off theory predicts that firms will try to minimize their tax payments by increasing leverage, and thus get the benefit of an interest tax shield. Hence it is expected that corporate tax rates and leverage are positively related. Due to the complexity of the tax code in the petroleum industry, I have chosen to focus on non-debt tax shields (NDTS) to identify tax considerations in capital structure policy. The use of NDTS as proxy for tax effects on leverage is according to previous empirical research[33]. The argument behind NDTS is that firms have other sources of tax deductions, such as depreciation costs, net operating loss carry forwards, and investment tax credits. DeAngelo and Masulis (1980) argue that these tax deductions are substitutes for the interest tax shield obtained from debt financing. Firms with large non-debt tax shields may hence not be able to fully take advantage of the interest tax shield. Consequently, there should be a negative relationship between non-debt tax shield and leverage according to trade-off theory.

Frank and Goyal (2009) find a positive relationship between NDTS and leverage for both market and book values. A possible explanation for this finding is that depreciation-to-assets

[31] Faulkender & Pettersen (2006), Frank & Goyal (2009), Drobetz et al (2013), Danis et al (2014), and Shambor (2017), among others.
[32] Among other, net PP&E includes investments in oil and gas properties at cost, seismic libraries, construction in progress, and exploration and development costs.
[33] Titman and Wessels (1988), Frank and Goyal (2009) and Shambor (2017), among others.

also can be a proxy for tangibility of assets (Baker & Martin, 2011). Shambor (2017), however, finds a negative relationship between NDTS and book leverage, which is consistent with theory that NDTS are substitutes for debt tax shields. Graham and Harvey (2001) find evidence suggesting that CFOs find taxes to be only moderately important in determining capital structure. The pecking order and market timing theory does not offer any predictions for NDTS.

I use current values to study if firms with more NDTS use less leverage, in accordance with Titman and Wessels (1988) and Shambor (2017).

Measure: $Depreciation_t / Assets_t$

4. Profitability

More profitable firms have a higher potential to fully benefit from the interest tax shield. They tend to have higher earnings, which increases the incentive to use debt financing to further benefit from the tax-deductible interest payments. In addition, they are expected to have lower bankruptcy costs due to lower defaulting risk. Profitable firms are also more likely to generate large amounts of free cash flows, which makes them more exposed to agency costs (Jensen, 1986). This can be mitigated by using debt financing. Thus, the trade-off theory predicts a positive relationship between profitability and leverage.

The pecking order theory, on the other hand, predicts that more profitable firms should have lower leverage. More profitable firms are expected to have better accessibility to retained earnings, which according to the theory is the preferred financing source. It is hence expected that firms with higher profitability use less debt financing.

Previous empirical research[34] find a negative relationship between profitability and leverage, which is consistent with the pecking order theory. However, profitability can be measured using different accounting items. Inkpen and Moffett (2011) claim that return on average capital employed (ROACE) is a common financial performance measure in the petroleum industry. Hence, I have used this measure as proxy for profitability. Similar proxy for profitability has been used in previous empirical research[35].

[34] Drobetz et al. (2013), Danis et al. (2014), and Shambor (2017), among others
[35] Drobetz et al. (2013), Danis et al. (2014), and Shambor (2017), among others

I use current values of profitability to study how current profitability affects firm leverage. This is in accordance with Faulkender and Petersen (2006), Drobetz et al. (2013), Danis et al. (2014), and Shambor (2017).

Measure: $EBIT_t$ / $Average\ Capital\ Employed_t$

5. Market-to-Book

Most of previous studies have used market-to-book as a proxy for future growth opportunities. Frank and Goyal (2009) argue that growth increases costs of financial distress, thus augmenting the costs of using debt. Jensen (1986) claims that firms with higher growth opportunities tend to have lower leverage since growth reduces the free cash flow problem. If the firm has several investment opportunities there is lower risk for management overspending on wasteful activities. In addition, debt financing can aggravate the conflicts between shareholders and debtholders in firms with high growth opportunities (Baker & Martin, 2011). Hence, according to the trade-off theory firms with higher growth opportunities should have lower leverage. In contrast, the pecking order theory predicts a positive relationship between leverage and growth opportunities since firms prefer to use debt rather than issue equity when investing in new projects.

One important consideration when using market-to-book is that it may serve as proxy for many other factors. For instance, it can be a proxy for a firm's expected profitability. This should lead to a positive relationship between leverage and market-to-book according to the trade-off theory, while the pecking order theory predicts a negative relationship. Market-to-book can also serve as an indicator for market timing since it is a proxy for equity over- and undervaluation. A higher market-to-book ratio can indicate overvalued equity, while lower market-to-book ratio can indicate that it is undervalued. If firms try to time the market, they would issue debt when the market-to-book ratio is perceived as low, and *vice versa* for high market-to-book ratios. Hence, the market timing theory predicts a negative relationship between market-to-book and leverage.

Previous empirical research find mixed results, but a major part of previous studies find market-to-book to be negatively related to leverage. Faulkender and Petersen (2006) and Danis et al. (2014) find a negative relationship between market-to-book and book leverage. However, Frank and Goyal (2009) and Drobetz et al. (2013) find different results depending

on the choice between book and market leverage. They find a positive relationship between market-to-book and book leverage but find opposite results for market leverage. When it comes to survey results, Graham and Harvey (2001) find that CFOs try to time the market, giving support to the market timing theory.

I use current values of market-to-book in my regression models to proxy for future growth opportunities. This is in accordance with Titman and Wessels (1988), Faulkender and Petersen (2006), Drobetz et al. (2013), and Danis et al. (2014).

Measure: $(Total\ Debt_t\ +\ Market\ Value\ of\ Equity_t)\ /\ Book\ Value\ of\ Assets_t$

6. Dividend payment status

Paying dividends reduces the funds available for managers to use on wasteful spending, and hence decreases the agency costs of free cash flow. Dividend payments can therefore function as a substitute to debt to reduce the agency cost. Hence, according to agency theory there should be a negative relation between dividend and leverage.

Frank and Goyal (2009) argue that firms paying dividends are less financially constrained and should find it relatively easier to raise external financing. This argument leads to a positive prediction by the pecking order theory. Drobetz et al. (2013), however, argue that the pecking order theory is ambiguous when it comes to dividend payment status. They claim that dividend-paying firms are subject to market monitoring, leading to reduced asymmetric information. This argument supports a negative relationship between dividend payment and leverage. Hence, the pecking order theory predicts both a positive and a negative relationship between dividend payers and leverage.

Frank and Goyal (2009) and Drobetz et al. (2013) find an inverse relation between dividend payers and leverage, providing support for both the pecking order and trade-off theory. Graham and Harvey (2001) find in their survey study that CFOs in dividend-paying firms are more concerned with financial flexibility, contradicting the prediction of the pecking order theory. This finding supports the predictions offered by the trade-off theory.

In accordance with Frank and Goyal (2009) and Drobetz et al. (2013) I use dummy variables equal to one if the firm pays dividends in a given year, and zero otherwise. I use current values of dividend payment status in accordance with Drobetz et al. (2013).

Measure: $dividend\ payer\ status_t\ (dummy)$

7. Industry leverage

The industry condition, measured by median industry leverage by four-digit SIC-code, might function as a benchmark to managers, and can also be a proxy for target leverage ratio (Frank & Goyal, 2009). A target leverage ratio gives support to the trade-off theory. Hence, the trade-off theory predicts a positive relationship between industry leverage and firm leverage.

According to Frank and Goyal (2009), industry condition should only matter if it serves as proxy for financing deficit. In that case, the pecking order theory predicts a positive relationship. They further explain that for the market timing theory, industry condition should only matter if valuations are correlated across firms in the same industry. Hence according to the market timing theory, a firms' leverage ratio should be positively related to industry leverage. When it comes to survey evidence, Graham and Harvey (2001) find little evidence suggesting that CFOs follow industry leverage.

Previous empirical findings suggest a positive relationship, in favour of all three theories. I use current values of median industry leverage to account for current industry conditions. This is in accordance with Danis et al. (2014).

Measure: $median\ industry\ leverage_t$

8. Lagged leverage ratio

I include the lagged dependent variable to test for a dynamic model. A positive relation between lagged leverage ratio and current leverage ratio is in accordance with the dynamic trade-off theory, where firms can deviate from their optimal leverage ratios in the short run. Another reason for including a lagged dependent variable is that it controls for unobserved variables that are difficult to account for in other ways (Wooldridge, 2016). It can also be used to measure the speed of adjustment to optimal leverage. However, I have chosen not to study the speed of adjustment due to the scope of this thesis.

Measure: leverage ratio$_{t-1}$

9. Credit rating

It is expected that a firm's access to debt markets should have an impact on capital structure. Faulkender and Petersen (2006) use whether a firm has a bond rating or not as an indication on access to debt markets. They find a positive relation between leverage and having credit rating. The explanation for this is that if firms have restricted debt markets they are expected to use equity markets for financing, *ceteris paribus*. However, firms with credit ratings have less information asymmetry since rating agencies reveals more information to the market that might not be available elsewhere. Thus, the pecking order theory offers two predictions for the relationship between credit ratings and leverage; both positive and negative.

Another consideration is the impact of having investment grade credit rating on capital structure. Having investment grade credit rating should give easier access to debt markets, since it gives a quality validation. However, this would reduce the riskiness of debt and should lead to an increase in leverage according to the trade-off theory. The pecking order theory offers the same prediction for investment grade; both positive and negative.

Further supporting Faulkender and Petersen (2006) results, Danis et al. (2014) also find evidence suggesting that credit rating and leverage are positively correlated. Graham and Harvey (2001) find evidence suggesting that credit rating is the second most important factor when determining capital structure, after financial flexibility.

I use current values of credit ratings to reflect the current debt market condition. This is in accordance with Faulkender and Petersen (2006) and Danis et al. (2014).

Measure: (i) $investment\ grade_t\ (dummy)$ *(ii)* $credit\ rating_t\ (dummy)$

10. Asset risk

The riskiness of a firm's cash flows tends to be positively related to financial distress costs. Higher cash flow volatility increases the risk of defaulting, leading to riskier debt. Higher earnings volatility also reduces the possibility to fully exploit the interest tax shield. The trade-off theory hence predicts a negative relationship between volatility and leverage.

The pecking order theory offers the same prediction as the trade-off theory. The debt market will demand higher returns from firms with high earnings volatility, leading to more expensive debt issues. Furthermore, since firm's with volatile cash flows try to avoid

foregoing positive-NPV projects or issuing risky securities to fund investments in times of low cash flow, they tend to hold lower leverage (Fama & French, 2002). This is also an indication of the desire to keep financial flexibility, as suggested by the survey study of Graham and Harvey (2001). However, higher risk increases the asymmetric information between managers and the market. This would lead to a positive relation between risk and leverage according to the pecking order theory.

Faulkender and Petersen (2006) and Drobetz et al. (2013) find a negative relationship between asset risk and leverage, providing evidence for both the trade-off and pecking order theory. Graham and Harvey (2001) find evidence suggesting that earnings volatility is the third most important factor according to CFOs.

A common measure of asset risk is the daily volatility of stock returns. However, as previously mentioned, I have used monthly stock returns instead. This choice is driven by the size of the data sample, which would not allow for efficient calculation of daily stock returns. To get a proxy for asset volatility, I have unlevered the volatility of monthly stock returns by multiplying by the observation's market equity ratio. This is in accordance with Faulkender and Petersen (2006), Frank and Goyal (2009), and Drobetz et al. (2013).

I use current values of implied asset risk to account for current business risk. This is in accordance with Faulkender and Petersen (2006) and Drobetz et al. (2013).

Measure: $(volatility\ of\ last\ 3\ years'\ monthly\ stock\ returns)\ *\ MVE_t/EV_t$

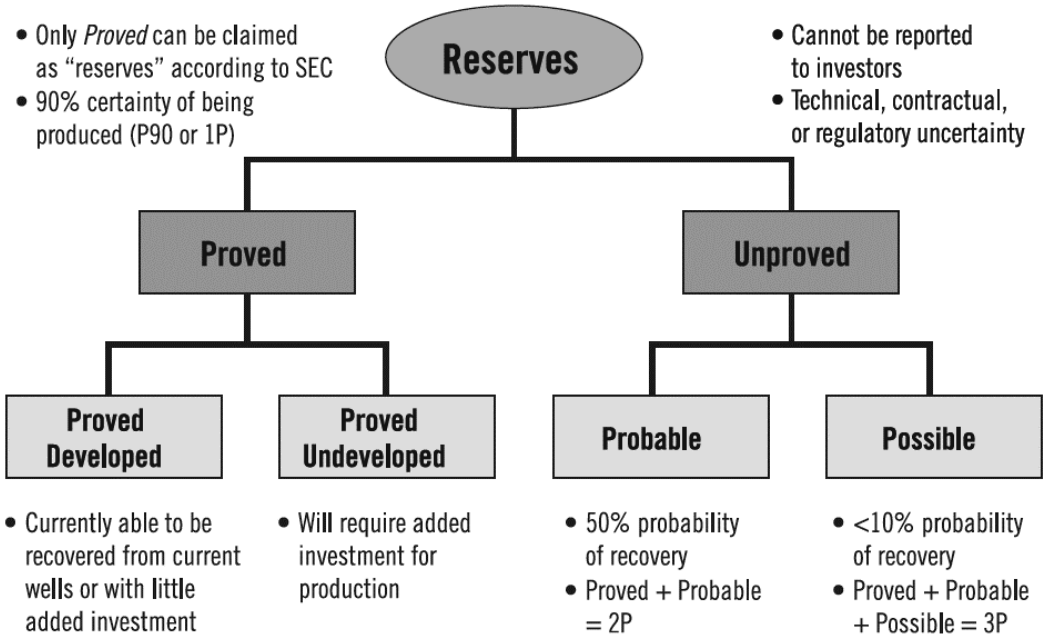
11. Petroleum reserves

The amount of petroleum reserves is considered a key figure in valuing E&P firms and may give an indication on future performance. It is hence expected that reserves should play a role in the determination of capital structure. Reserves are often categorized into three groups based on their probabilities; (*a*) Proven reserves (1P), (*b*) Proven and probable reserves (2P), and (*c*) Maximum reserves[36] (3P) (Downey, 2009). Proved reserves are petroleum reserves considered to have a 90% probability or higher to be recovered under the present technical and economic conditions. This probability is based on both a production and business valuation basis (Inkpen & Moffett, 2011). Probable reserves are reserves that have over 50%

[36] Proven Reserves + Probable Reserves + Possible Reserves

probability to be recovered, while possible reserves have between 10% and 50% probability of being recovered. These definitions are summarized in Figure 14 below.

Figure 14 - Petroleum Reserves Definition



Source: Inkpen and Moffett (2011, p. 100)

Proven reserves have higher probability of being produced, and hence these values are more certain. However, probable reserves are still expected to have value, which suggests that 2P reserves should be used in this study. Unfortunately, due to the lack of data availability I have focused on 1P reserves, rather than 2P. However, this is not considered a major issue, as Taylor-DeJongh, a financial advisory firm, claims the following about P1[37] reserves:

> "A company's ability to monetize its assets or to put forward significant collateral in the form of P1 reserves can greatly improve the risk profile and therefore improve the terms and availability of finance. Graduation from exploration-only to exploration and production is therefore highly advantageous not only from the public equity perspective, but also for improving access to debt".

(cited by Inkpen and Moffett (2011, p. 285))

[37] P1 reserves is also referred to as 1P reserves (Downey, 2009).

Wright and Gallun (2008) write that common reserves ratios in the petroleum industry are; (*i*) reserve replacement ratio[38], (*ii*) reserve life ratio[39], and (*iii*) average reserves per well[40]. Each of these are discussed separately below.

(*i*) The reserve replacement ratio is a common measure used by the market to measure E&P performance and is the ratio between added amount of petroleum reserves and produced volume in a given period. If the E&P firm desires to maintain a sustainable amount of reserves, it needs to find more petroleum reserves than it is currently producing. Hence, E&P firms should have a reserve replacement ratio equal to or greater than 1.

(*ii*) The reserve life ratio is a measure that approximates the number of years oil production could continue at the current rate, given that no new reserves were added (Wright & Gallun, 2008). It is hence a ratio that states the firm's sustainability.

(*iii*) The average-reserves-per-well ratio highlights, as the name describes, the amount of petroleum reserves per well. This ratio is used as an indication for future profitability. Due to the lack of well information I have used average-reserves-to-net-acreage as variable.

Since 1P reserves can function as collateral for debtholders it is probable that increased reserves should reduce the riskiness of debt. The trade-off theory hence predicts a positive relationship between petroleum reserves and leverage. The pecking order theory, however, predicts a negative relationship. E&P firms with relatively more petroleum reserves should have lower asymmetric risk, making equity less expensive to issue. Firms with larger amounts of 1P reserves should hence relatively use less debt financing. Both the trade-off and pecking order theory offer the same predictions if the chosen reserve ratios proxies expected future performance.

The chosen measure of total 1P reserves is based on the three major petroleum products; natural gas (NG), natural gas liquid (NGL) and crude oil. Since NG is presented in cubic feet (cf), I have converted it to barrels of oil equivalent (BOE[41]) using 6 to 1 as conversion rate.

[38] Annual reserve additions / Annual production
[39] Total proved reserves at beginning of year / Annual production
[40] Total proved reserves at beginning of year / Net wells
[41] BOE is used to compare petroleum reserves between entities that have differing amounts of oil and gas (Inkpen & Moffett, 2011).

Oil and NGL are already presented in barrels, where one barrel of oil or NGL is equal to one BOE. This approximation is in accordance with Wright and Gallun (2008).

To my knowledge, none of these ratios have been tested in previous empirical studies. I have chosen to use current values to study the effect of expected future performance on leverage policy. These variables will only apply to independent E&P firms since OFS firms have seldom ownership in petroleum reserves.

Measure: (i) $Reserve\ Replacement\ Ratio_t$*, (ii)* $Reserve\ Life\ Ratio_t$ *(iii)* $Average\ reserves\ per\ well_t$[42]

(*ii*) Macroeconomic variables

As mentioned in previous sections, the petroleum industry is heavily influenced by the macroeconomic environment. For instance, the supply and demand for oil and gas is closely related to business cycle (Inkpen & Moffett, 2011). Another consideration is macroeconomic effects on capital structure. Drobetz et al. (2013) claim that business cycle can affect capital structure through two channels; (*i*) the demand for capital, and (*ii*) the supply of capital. The demand for capital during poor macroeconomic conditions tends to be geared toward debt financing due to higher asymmetric information. Higher demand for debt financing during downturns is, however, met by reduced supply of capital due to "credit crunches" and "flight to quality".

By including macroeconomic factors, I seek to study how business cycle might affect capital structure decisions. Some of these factors, such as oil price and term spread, are lagged by one year to be within the firm's information set. Other macroeconomic variables serve as control variables used to control for factors that are not under the direct influence of management. Each of the macroeconomic factors are presented separately below.

12. Oil price

One of the primary top line risks for petroleum companies is the crude oil price. It is hence expected that the performance of crude oil has a major impact on the petroleum industry. For instance, E&P firms may choose to meet sudden changes in oil price with adjustments in their

[42] Total proved reserves at beginning of year / Net developed acreage

capital expenditures and production. In the event of reduced crude oil prices, they tend to reduce capital expenditures to maintain their financial flexibility. It is also perceived that E&P firms tend to increase oil and gas production to make up for the decline in oil price. Based on these insights, it is assumed that oil price performance plays an important part in determining capital structure.

Lower oil prices lead to reduced income, and consequently a potential loss of interest tax shield. This argument supports a positive relation between oil price movements and leverage according to the trade-off theory. Another perspective is that the oil price has an impact on the value of assets-in-place[43], decreasing its value during times of lower oil prices. The decrease in value of assets-in-place reduces the market value of the firm, as well as the collateral available to debtholders. The asymmetric information will thus increase for both debt- and equity holders, making external financing more expensive. However, the accessibility to retained earnings is expected to decline in periods with negative changes in oil prices. Since debt is preferred over equity, the pecking order theory hence predicts a negative relationship. Finally, crude oil price might also be a proxy for economic recessions or booms. In accordance to the market timing theory, this should result in a negative relation between oil price changes and leverage.

Since it is expected that management is future oriented when making decisions, it can be argued that crude oil futures should be used instead of current spot prices. Prices on oil futures would give a projection on future spot prices, and hence provide important information to decision makers. However, Alquist and Kilian (2010) show that futures prices as predictors tend to be less accurate than current spot prices. I have therefore used lagged spot prices for crude oil. According to Inkpen and Moffett (2011), the two most major crude oil benchmarks are WTI[44] and Brent Blend. They further claim that "Brent crude is used as the price benchmark for more than two-thirds of international sales" (Inkpen & Moffett, 2011, p. 375). I have therefore chosen to use Brent Blend as oil price benchmark for my study.

Previous empirical research tend to find a negative relationship between crude oil price and leverage. Lehn and Zhu (2016) studied E&P firms in the period 2011 to 2015, where they found evidence for increased production and leverage in the face of an oil price shock. This

[43] Such as petroleum reserves
[44] West Texas Intermediate

finding suggests a negative link between capital structure and crude oil prices. Drobetz et al. (2013) draws similar conclusions, finding a negative relationship between changes in Brent crude oil price and leverage. Drobetz et al. (2013) use current values oil price changes. In my study, however, I have chosen to use lagged values to reflect the firm's information set.

Measure: $log(Brent\ crude\ oil\ spot\ price_{t-1}\ /\ Brent\ crude\ oil\ spot\ price_{t-2})$

13. Term spread

The term spread, the difference between long-term and short-term interest rates, is often used as a business cycle indicator and is considered a reliable measure for forecasting future recessions and growth in economic output. Estrella and Trubin (2006) find evidence suggesting that an inversion of the term spread is associated with a followed economic recession. Negative term spreads are hence a credible signal for future recessions. The same conclusion is drawn by Dahlquist and Harvey (2001).

In economic recessions, firms tend to have lower earnings and may hence not take full benefit of the interest tax shield. Bankruptcy costs also tend to be higher due to the increased probability of defaulting on debt payments. If managers anticipate a future recession is approaching, it is reasonable to assume that they will determine the firm's capital structure accordingly. Thus, the trade-off theory predicts that lower term spread should lead to less leverage, indicating a positive relationship. Recessions and lower economic activity might, however, also reduce the amount of retained earnings to finance new investments. Consequently, in downturns firms are more likely to use debt financing. The pecking order theory thus predicts a negative relationship between term spread and leverage. The market timing theory offers the same prediction since recessions tend to give weaker stock returns and make stock markets more pessimistic. Hence, according to market timing theory leverage should be negatively related to term spread.

I have used the spread between U.S. 10-year and 1-year Treasury bills as measure for term spread. Since term spread is a leading indicator for future recessions, I have chosen to use lagged term spread in my regression models. This is in accordance with Frank and Goyal (2009) and Drobetz et al. (2013), who find a negative relationship between lagged term spreads and leverage.

Measure: $(10\ year\ US\ Treasury\ Bill_{t-1}) - (\ 1\ year\ US\ Treasury\ Bill_{t-1})$

14. Stock market condition

Stock market condition is expected to have an impact on capital structure decisions. Periods of high stock market returns would lead to lower market leverage due to higher equity values. According to the trade-off theory, firms will rebalance their leverage to move up to the optimal debt level by issuing more debt (Frank & Goyal, 2009). The trade-off theory hence predicts a positive relationship between stock market performance and leverage. The pecking order theory, on the other hand, suggests that in periods with poor market performance firms are reluctant to issue equity. Due to the adverse selection between managers and the market, an equity issue following poor market performance may further decrease the equity value. Hence according to pecking order theory market performance is negatively related to leverage. The market timing theory offers the similar predictions, suggesting that when the market is favourable it is better to issue equity. Hence in times with higher market returns firms will rather issue equity than debt, leading to an inverse relationship between market return and leverage.

Welch (2004) finds evidence for a strong positive relation between stock market returns and market leverage in the long run. In the short run, however, firms tend to follow a market timing behaviour. These findings support the dynamic trade-off theory, where firms can deviate from their optimal leverage ratios in the short run. Drobetz et al. (2013) and Frank and Goyal (2009), however, find a negative relationship between stock market returns and market leverage, providing support for the pecking order and market timing theory.

As a measure for current stock market condition I have used the current values of the MSCI World index, which is a common proxy for the market portfolio. This is in accordance with Drobetz et al. (2013).

Measure: $log(MSCI\ World\ Index_t / MSCI\ World\ Index_{t-1})$

15. GDP growth

Higher economic activity tends to bring higher profits, leading to lower financial distress costs and higher potential to fully benefit from the interest tax shield. Hence, according to the trade-off theory there should be a positive relationship between GDP growth and leverage. The pecking order theory, however, predicts a negative relationship since accumulated retained earnings tend to be higher in economic upturns. Since managers prefer to use

retained earnings to finance new investments, they will issue less debt in economic upturns. The same prediction is offered by the market timing theory since equity markets tend to be more favourable in economic upturns. This gives management the incentive to time the market; rather issuing equity than debt in periods with high GDP growth.

Since GDP is a coinciding indicator, I have chosen to use current values to measure business cycle. Since over 90% of my observations are headquartered in a Group of Seven (G7) country, I have chosen to use GDP growth in G7 as measure for GDP growth. This is in accordance with Drobetz et al. (2013). Frank and Goyal (2009) and Drobetz et al. (2013) both find a positive relationship between GDP growth and leverage, providing support for the trade-off theory.

Measure: annual G7 GDP $growth_t$

16. E&P Capital Expenditures

Global E&P capital expenditures is used as a proxy for E&P activity and is a useful market indicator for all activities directly related to oil and gas. Higher capital expenditures tend to be promoted by more investment opportunities, as well as more optimistic expectations about the future. The trade-off theory hence predicts a negative relation between E&P spending and leverage since firms with higher investment opportunities tend to be less affected by the agency cost of free cash flow. The market timing theory offers the same prediction as the trade-off theory. Since E&P firms tend to decrease their capital expenditures during downturns, it is preferable to issue debt since the market might be relatively more pessimistic. In periods with positive market outlooks, indicated by higher E&P capital expenditures, firms will rather issue equity than debt. Consequently, there should be a negative relation between E&P expenditures and leverage according to the market timing theory. The pecking order theory, in contrast to the two other theories, predicts a positive relation. Since firms prefer to use debt financing for their investments, they will issue more debt to finance their capital expenditures.

To my knowledge, global E&P capital expenditures has not been tested in previous empirical research. However, Frank and Goyal (2009) studies capital expenditures to total assets on firm level, where they find a negative relationship. This finding supports both the trade-off and market timing theory.

I use current values of change in E&P spending to reflect the current business cycle of the petroleum industry.

Measure: $log(E\&P\ capital\ expenditures_t / E\&P\ capital\ expenditures_{t-1})$

Summary

The following subsection summarizes theory predictions and findings from previous empirical studies. An overview of the theory predictions is provided by Table 4 below. Table 5 gives an overview of results from previous empirical research based on both book and market values.

Table 4 - Theory predictions

	Theory Predictions		
	Trade-Off Theory	Pecking Order Theory	Market Timing Theory
Firm Specific Factors			
Size	+	-	
Market-to-Book	+/-	+/-	-
Profitability	+	-	
Non-Debt Tax Shield	-		
Dividend Payer	-	+/-	
Risk	-	+/-	
Tangibility	+	-	
Industry Leverage	+	+	+
Leverage Ratio$_{t-1}$	+		
Credit Rating	+	+/-	
Investment Grade	+	+/-	
Replacement Ratio	+	-	
Reserve Life Ratio	+	-	
Proved Reserves	+	-	
Macroeconomic Factors			
Oil$_{t-1}$	+	-	-
Term Spread$_{t-1}$	+	-	-
MSCI	+	-	-
GDP G7	+	-	-
E&P CAPEX	-	+	-

"+" indicates a positive relationship between the independent variable and leverage. "-" indicates a negative relationship between the independent variable and leverage. Blank cells indicate that the theory does not offer any predictions.

Table 5 - Previous empirical research

	Titman & Wessel (1988)	Faulkender & Pettersen (2006)	Frank & Goyal (2009)	Drobetz et al (2013)	Danis et al (2014)	Shambor (2017)
Size	-**	-***	+***		+**	+***
Market-to-Book		-***	+**/-***	+***/-***	-***	
Profitability	-***	-***	-***	-**	-***	-***
NDTS			+***			-***
Dividend Payer			-***			
Tangibility		+***	+***	+***	+***	+***
Risk		-***		-***		
Industry Leverage			+***		+***	
Credit Rating		+***	+**/-***		+***	
Investment Grade			+**/-***			
GDP			+***	+*		
Term spread			-***	-***/-*		
MSCI				-***		
Firm Fixed Effects	No	Yes	No	Yes	No	No
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	NA	59,562	180,552	1,005	191,015	4,181
Sample Industry	US Industrial Companies	Non-financial Global Publicly Traded Companies	Non-financial US Publicly Traded Companies	Global Shipping Companies	Non-financial Global Publicly Traded Companies	Global Oil and Gas Companies
Time period	1974-1982	1986-2000	1950-2003	1992-2010	1994-2011	2000-2015

"+" indicates a positive relationship between the independent variable and leverage. "-" indicates a negative relationship between the independent variable and leverage. Empty cells are either not tested or insignificant. If two signs are given in a specific cell, the left sign applies to book leverage and right sign for market leverage. "NA" indicates that the information was not available.

** Statistical significance at 10% level.*

*** Statistical significance at 5% level.*

**** Statistical significance at 1% level.*

Based on theory predictions, previous empirical research and personal perceptions, I have the following hypotheses for each variable: size (+), market-to-book (-), profitability (-), NDTS (-), dividend payer (-), tangibility (+), risk (-), industry leverage (+), leverage ratio$_{t-1}$ (+), credit rating (+), investment grade (+), reserve life ratio (-), reserve replacement ratio (-), proved reserves (-), oil (+), GDP (+), term spread (-), MSCI (+), E&P Capex (+).

"Exploration for oil always costs money; production of oil always makes money."

– Anonymous

V. METHODOLOGY

Section V presents the methodology used for this study. I start by presenting three main estimation methods for panel data analysis. I continue by providing results from a set of multiple linear regression assumption tests. Finally, I present the most appropriate regression method based on these test results.

Regression estimation methods

The three most common methods that are used for panel data analysis are; (*1*) Pooled OLS regression[45], (*2*) Fixed Effects estimation, and (*3*) Random Effects estimation. Each of these are presented separately below.

(1) Pooled OLS regression

Ordinary Least Squares (OLS) regression seeks to reduce the distance between fitted values and residuals by minimizing the residual sum of squares (RSS). Pooled OLS regression is a multiple linear regression (MLR) used to analyse panel data.

(*2*) Fixed Effects estimation

Fixed Effects (FE) estimation is used to control for entity specific effects that are constant over time, which is one of its main advantages. This method views the unobserved factors as consisting of both constant and time-varying factors (Wooldridge, 2016). Considering a model with this assumption gives the following regression equation:

[45] I assume that the reader is familiar with panel data and the use of OLS regression estimation, so I will hence not present this in detail.

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + a_i + u_{it}, \qquad t = 1,2,\dots,T \qquad (3)$$

Where;

y_{it} is the dependent variable for firm *i* at time *t*

β_0 is the intercept

β_k is the parameter associated with x_{itk}

a_i is the unobserved firm effect (fixed effect)

u_{it} is the idiosyncratic error term (time-varying error)

By averaging equation 4 for each firm over time we get the following equation:

$$\bar{y}_i = \beta_1 \bar{x}_{i1} + \beta_2 \bar{x}_{i2} + \cdots + a_i + u_i, \qquad t = 1,2,\dots,T \qquad (5)$$

FE estimation allows arbitrary correlation between the unobserved factor (a_i) and all the independent variables (x_{it_j}) (Wooldridge, 2016). The goal of using FE estimation is to eliminate the unobserved effect (a_i) due to this potential correlation. FE estimation hence controls for heterogeneity in firm characteristics by removing the unobserved effect (Wooldridge, 2016). This is done using equation 5, which leads to the following FE equations:

$$y_{it} - \bar{y}_i = \beta_1(x_{it1} - \bar{x}_{it1}) + \beta_2(x_{it2} - \bar{x}_{it2}) + \cdots + \beta_k \ddot{x}_{itk} + u_{it} - \bar{u}_{it}, \quad t = 1,2,\dots,T \qquad (6)$$

or

$$\ddot{y}_{it} = \beta_1 \ddot{x}_{it1} + \beta_2 \ddot{x}_{it2} + \cdots + \beta_k \ddot{x}_{itk} + \ddot{u}_{it}, \quad t = 1,2,\dots,T \qquad (7)$$

As we can observe from equation 7, the unobserved factor (a_i) is removed. One limitation with FE estimation, however, is that it does not allow for dependent variables that are

constant over time. Another limitation is that the estimation results are very sensitive to violations of the assumptions when the number of observations, N, is small and the number of time periods, T, is large (Wooldridge, 2016). For instance, FE estimation for dynamic panel data models could be biased due to endogeneity problems. This issue tends to be more severe when the number of time periods, T, is relatively small compared to cross-sectional observations.

(*3*) Random Effects estimation

Random Effects (RE) estimation has most of the same assumptions as FE estimation, however with some important differences. Like FE estimation, RE estimation views the error term as consisting of an unobserved factor (a_i) and a time-varying error (u_{it}). However, in contrast to FE, RE estimation assumes that the unobserved effect (a_i) is uncorrelated with all independent variables (x_{itj}). The regression equation using RE estimation is thus as follows:

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \cdots + \beta_k x_{itk} + a_i + u_{it} \qquad (8)$$
$$Cov(x_{itj}, a_i) = 0\,, t = 1,2, \dots T; j = 1,2, \dots, k$$

An advantage of using RE estimation is that it allows for exploratory variables that are time-invariant, which contrasts with FE estimation. When it comes to the properties of the RE estimator when N is small and T is large it is largely unknown (Wooldridge, 2016). A disadvantage of RE estimation, however, is that if the unobserved effect (a_i) actually *is* correlated with any of the independent variables (x_{itj}), the regression model is biased. Hence, the advantages of FE estimation are the disadvantages of RE estimation, and *vice versa*. When choosing between these two methods it is therefore important to consider each method's strengths and limitations.

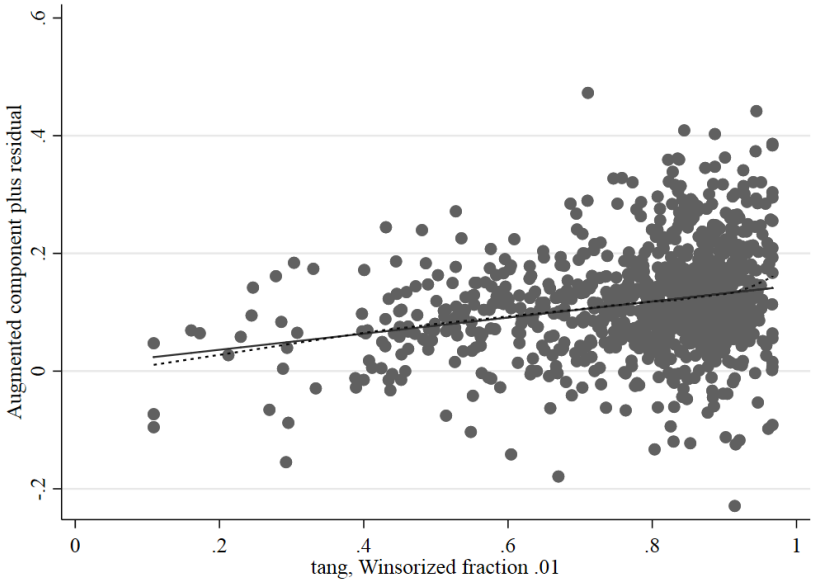
Test of MLR assumptions

In this subsection I test whether the multiple linear regression (MLR) assumptions are satisfied or not. Based on the test results I will conclude if I should use FE or RE estimation rather than Pooled OLS in my study. All MLR assumptions are presented in Appendix D.

Assumption 1 - Linearity

I test the assumption of linearity of each variable using *acprplot* in STATA – a command that graphs an augmented component-plus-residual plot, as described by Mallows (1986). Augmented component-plus-residual plot is a common method used to analyse linearity. Figure 15 below presents the result for the variable *tangibility*.

Figure 15 - Linearity between market leverage and tangibility



The dotted line in Figure 15 shows the actual relationship between market leverage and tangibility, while the solid line shows a linear relationship. As we can observe, the two lines are almost identical, giving support for a linear relationship. This assumption is hence found fulfilled for market leverage and tangibility. The relationships between all dependent and independent variables that are not presented here are also found to be in line with assumption 1.

Assumption 2 - Random sampling

The data sample is based on randomly selected E&P firms from CRSP/Compustat Merged. Assuming that my sample does not deviate from the population, the assumption of random sampling is fulfilled.

Assumption 3 - No perfect collinearity

I use a correlation matrix to check for multicollinearity between variables[46]. According to Johannessen, Tufte, and Christoffersen (2004) there might be indications of multicollinearity if the correlation between two independent variables is greater than 0.7. I have hence chosen to treat all correlation coefficients of 0.7 or above as having high or very high correlation. If any variables have a correlation above this level, they are treated as indicators of multicollinearity. Table 6 provides my definitions of correlation degrees.

Table 6 - Degree of correlation

Degree of correlation	Coefficients
Very high	0.9 or above
High	Between 0.70 and 0.89
Moderate	Between 0.40 and 0.69
Low	Between 0.20 and 0.39
Very low	0.19 or under

This table presents my own definitions of correlation degrees based on coefficient intervals.

Based on the correlation matrix, no variables appear to be too highly correlated. However, this method is dependent on how I chose to interpret the correlation coefficients. In accordance with Drobetz et al. (2013), I have used a VIF[47]-test to supplement the test of multicollinearity. As cut-off value I have set VIF-value of 10. A VIF-value over this level would conclude a multicollinearity problem. Table 7 on the next page shows the result from the regression model using Market Leverage 1 as dependent variable.

[46] For the correlation matrix, please see Appendix K.
[47] Short for "Variance inflation factor". For a detailed overview of VIF-test, please see Wooldridge (2016).

Table 7 - VIF-test result

Variable	VIF
Size	4.39
E&P capex	3.40
Credit rating	2.77
Industry leverage	2.45
Investment grade	2.29
Proved reserves to net acreage	2.28
Oil_{t-1}	1.77
Asset risk	1.73
Leverage $Ratio_{t-1}$	1.71
Profitability	1.46
G7 GDP	1.45
Term $Spread_{t-1}$	1.40
Dividend payer	1.39
Tangibility	1.37
NDTS	1.34
Market-to-Book	1.30
MSCI	1.30
Reserve life ratio	1.24
Reserve replacement ratio	1.11
Mean VIF	**1.90**

Notes: VIF-test of regression with OLS estimation using Total-Debt-to-Market-Value-of-Assets as dependent variable.

As we can see from Table 7, none of the chosen variables are near the cut-off value of 10. Moreover, the mean VIF of 1.90 is far away from this threshold. Based on these results I conclude that there is no multicollinearity problem in the model. The same conclusion applies for all four leverage measures.

Assumption 4 – Zero conditional mean

According to Wooldridge (2016), the assumption of zero conditional mean is violated if there exist omitted variables that are correlated with one or more of the independent variables. It is likely that there are other explanatory variables that I have not included in my regression model, either due to lack of data availability or ignorance. Due to this possible issue, it is plausible that this assumption is violated.

Assumption 5 - Homoskedasticity

When testing for heteroskedasticity I have used both White's test[48] and Breusch-Pagan Lagrange Multiplier test[49]. The results are presented in the two tables below.

Table 8 - White's test results

Source	***chi2***	***df***	***Prob>chi2***
Heteroskedasticity	417.27	195	0.0000
Skewness	62.03	19	0.0000
Kurtosis	12.77	1	0.0004
Total	492.07	215	0.0000

Notes: This table presents the results from a White's test using Total-Debt-to-Market-Value-of-Assets as dependent variable.

Table 9 - Breusch-Pagan Lagrange Multiplier test results

Model	***chi2***	***Prob>chi2***
Total-Debt-to-Market-Value-of-Assets	118.55	0.0000
Total-Debt-to-Market-Value-of-Capital	115.21	0.0000
Total-Debt-to-Assets	25.64	0.0000
Total-Debt-to-Capital	30.82	0.0000

Notes: This table presents the results from a Breusch-Pagan Lagrange Multiplier test for all four leverage measures.

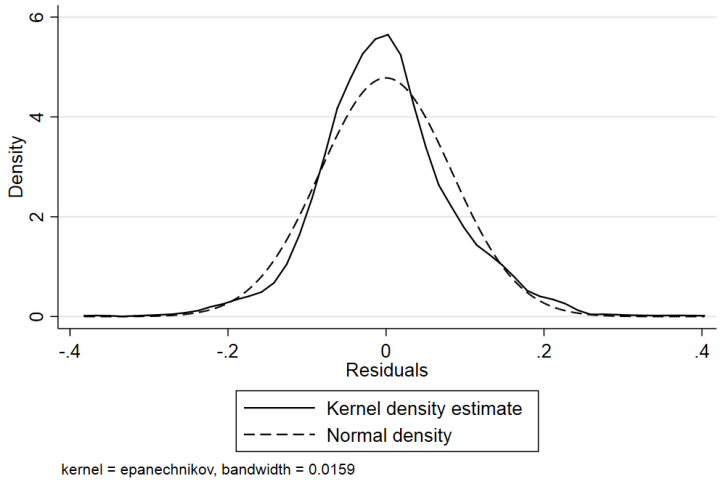
As we can see from the test results in Table 8 and Table 9, the null hypotheses of homoskedasticity has been violated, leading to the conclusion that the error terms in the panel data are heteroskedastic. The same conclusion has been made for all four leverage measures.

Assumption 6 - Normality

I have tested normality for each regression model using *kdensity* in STATA, a command that plots a univariate kernel density estimation. The STATA output is presented in Figure 16. The solid line shows the distribution of the error terms, while the dotted line shows the normal distribution.

[48] Using *estat imtest* in STATA.
[49] Using *estat hettest* in STATA.

Figure 16 - Kernel density test



Based on Figure 16 it seems that the regression model is close to being normally distributed. To provide further insight I have used *pnorm* and *qnorm* in STATA, testing normal distribution using a standardized normal probability plot and a quantile normal distribution plot. The results are shown in Figure 17 and Figure 18 below, which further supports the initial assumption of normal distribution.

Figure 17 - Standardized normal probability plot (pnorm)

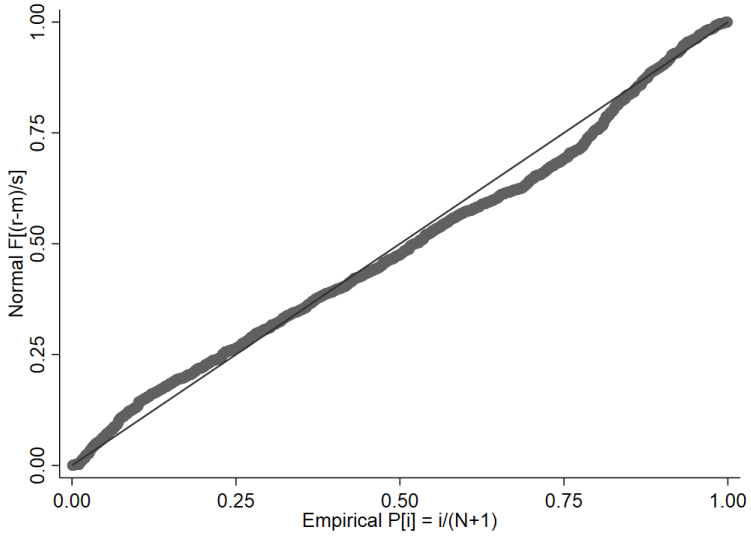
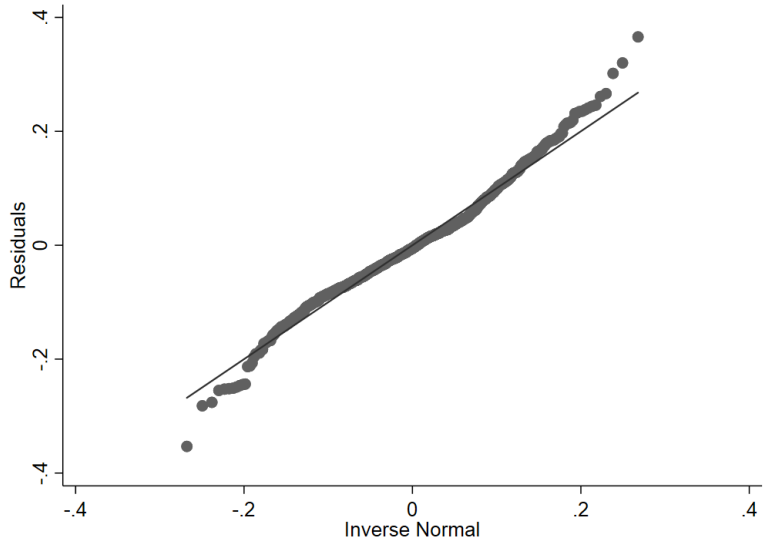


Figure 18 - Quantiles of regression model against quantiles of normal distribution (qnorm)



As a final test for normality I have used *sktest*[50] in STATA to test for skewness and kurtosis. Based on the results in Table 10, I conclude that the null hypothesis concerning normally distributed residuals is rejected.

Table 10 – Skewness and kurtosis test results

Dependent variable	***obs***	***Pr(Skewness)***	***Pr(Kurtosis)***	***adj. chi2***	***Prob>chi2***
Market Leverage 1	1,001	0.0018	0.0000	31.28	0.0000
Market Leverage 2	1,001	0.0000	0.0000	45.67	0.0000
Book Leverage 1	1,001	0.0000	0.0000	56.62	0.0000
Book Leverage 2	1,001	0.0000	0.0000	60.06	0.0000

Notes: This table presents a skewness and kurtosis test for residuals in all four regression models.

According to Wooldridge (2016), we can use the central limit theorem to conclude for asymptotic normal distribution as long as the sample is large enough. With 978 observations I perceive the number of observations as satisfactory for this conclusion. Consequently, and based on the overall results of my normality tests, I conclude that the assumption of normality

[50] Equivalent to the Jarque-Bera test for normality

is fulfilled. All other regression models not presented here have been tested for normality and found to lead to the same conclusion.

Assumption 7 - Serial correlation

For serial correlation I have used a Wooldridge test in STATA. The Wooldridge test searches for serial correlation in the panel data and has the null hypothesis that there is no serial correlation. Table 11 provides the results obtained from STATA.

Table 11 - Wooldridge test results

Model	***F***	***Prob>F***
Total-Debt-to-Market-Value-of-Assets	84.10	0.0000
Total-Debt-to-Market-Value-of-Capital	86.78	0.0000
Total-Debt-to-Assets	58.34	0.0000
Total-Debt-to-Capital	32.72	0.0000

Notes: This table presents the Wooldridge test results for all four regression models.

As shown in Table 11, the null hypothesis of no autocorrelation has been rejected. Hence there is serial correlation in the panel data, which is in violation of assumption 7.

Summary and choice of regression model

Based on all test results I find evidence that some of the MLR assumptions are violated. The assumptions that are considered fulfilled are the assumptions of normality, no perfect collinearity, linearity and random sampling. The assumptions about homoscedasticity, zero conditional mean and no serial correlation, on the other hand, are considered violated. This finding leads to the conclusion that I should use either FE estimation or RE estimation in my regression analysis. To determine the choice of estimation method I use the Hausman test. If the Hausman test rejects the null hypothesis, it is taken that FE estimation is the appropriate method to use (Wooldridge, 2016). Table 12 presents the results from the Hausman test.

Table 12 - Hausman test results

Model	Chi2	Prob>Chi2
Total-Debt-to-Market-Value-of-Assets	189.76	0.0000
Total-Debt-to-Market-Value-of-Capital	135.30	0.0000
Total-Debt-to-Assets	790.52	0.0000
Total-Debt-to-Capital	225.70	0.0000

Notes: This table presents Hausman test results for all four regression models.

As we can deduct from the results in Table 12, the FE method should be used over RE for all leverage measures. I am therefore using FE estimation in my study, giving the following regression model[51]:

$$\begin{aligned} l\ddot{e}v_{it} = {} & \beta_1 l\ddot{e}v_{it-1} + \beta_2 s\ddot{\imath}ze_{it} + \beta_3 ta\ddot{n}g_{it} + \beta_4 mk\ddot{t}bk_{it} + \beta_5 \imath nd\ddot{l}ev_{it} + \beta_6 ri\ddot{s}k_{it} \\ & + \beta_7 d\ddot{\imath}v_{it} + \beta_8 rat\ddot{\imath}ng_{it} + \beta_9 \imath nvg\ddot{r}ade_{it} + \beta_{10} pr\ddot{o}f_{it} + \beta_{11} nd\ddot{t}s_{it} \\ & + \beta_{12} rl\ddot{\imath}fe_{it} + \beta_{13} rrep\ddot{l}ace_{it} + \beta_{14} pro\ddot{v}edr_{it} + \beta_{15} epc\ddot{a}pex_{it} \\ & + \beta_{16} m\ddot{s}c\imath_{it} + \beta_{17} gd\ddot{p}g7_{it} + \beta_{18} o\ddot{\imath}l_{it-1} + \beta_{19} tspr\ddot{e}ad_{it-1} + \ddot{u}_{it}, \end{aligned}$$

$$t = 1999, \dots, 2016 \qquad (9)$$

As mentioned previously, there are some potential challenges of using FE estimation that should be considered. A widely used alternative to the FE method is to use the system Generalized Methods of Moments (GMM) model, developed by Blundell and Bond (1998). The GMM model accounts for endogeneity and firm fixed effects, and hence removes the potential bias of using FE. However, I have chosen to use FE estimation over system GMM to be able to compare regression results with previous empirical findings. By including macroeconomic variables as independent variables helps mitigate the endogeneity problem. However, I do not assume that this inclusion will solve the problem of endogeneity. Nonetheless, since I study 19 dependent variables over an 18-year period per model I do not perceive this as a major problem for my study.

[51] Variable names are provided in Appendix A.

"My formula for success is rise early, work late and strike oil."

– John Paul Getty, oil billionaire and founder of Getty Oil

VI. EMPIRICAL ANALYSIS

Section VI contains my empirical analysis. I start with exploring the data sample; presenting descriptive statistics and historical trends. Second, I present and discuss the regression results from my regression models. Finally, I provide a summary of all my empirical findings.

Exploratory data analysis

Before proceeding with the regression analysis, I find it necessary to describe my data set to the reader with the intention of providing deeper insights. While presenting a description of my data sample I have chosen to compare my results to Shambor (2017), being the previous research closest to my study. Table 13 on the next page provides core statistics of the sample E&P firms. As we can observe, the median *Total-Debt-to-Assets* ratio is 0.28 and 0.20 for book and market leverage, respectively. Shambor (2017) found in his study of oil and gas firms a median book leverage ratio of 0.23, which is relatively close. When it comes to *Total-Debt-to-Capital* ratio, I find median values of 0.32 and 0.22 for book and market leverage, respectively. Both leverage measures have the approximately the same standard deviation.

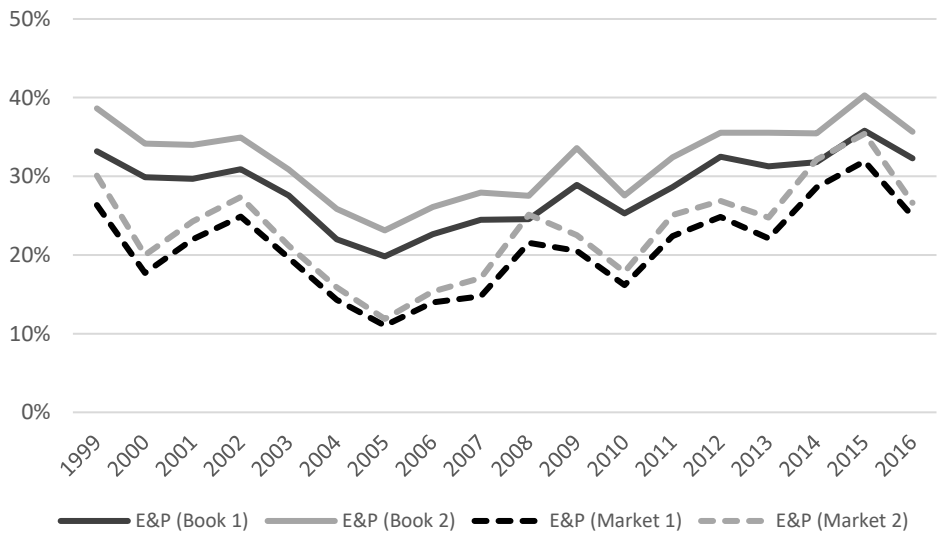
Table 13 - Descriptive statistics of variables for E&P firms

Variables	N	SD	mean	Min	p25	p50	p75	Max
Book leverage 1	1565	0.18	0.28	0.00	0.15	0.28	0.41	0.85
Book leverage 2	1565	0.20	0.33	0.00	0.18	0.32	0.46	0.96
Market leverage 1	1565	0.17	0.23	0.00	0.09	0.20	0.32	0.85
Market leverage 2	1565	0.20	0.25	0.00	0.11	0.22	0.36	0.95
Size book	1565	1.01	2.94	0.47	2.17	3.01	3.68	5.25
Size market	1565	1.00	3.10	0.36	2.38	3.18	3.84	5.36
NDTS	1565	0.05	0.09	0.00	0.05	0.08	0.11	0.64
Market-to-Book	1565	0.85	1.36	0.24	0.85	1.11	1.52	22.88
Tangibility	1565	0.18	0.74	0.00	0.66	0.81	0.88	0.99
Profitability	1565	0.24	0.00	-3.77	-0.03	0.06	0.13	0.75
Asset risk	1565	0.04	0.08	0.02	0.05	0.07	0.10	0.42
Dividend payer	1565	0.50	0.48	0.00	0.00	0.00	1.00	1.00
MSCI	1565	0.20	0.04	-0.52	-0.06	0.09	0.18	0.29
G7 GDP	1565	0.02	0.02	-0.04	0.01	0.02	0.03	0.04
Oil_{t-1}	1565	0.13	61.10	12.71	28.39	61.61	96.94	111.65
E&P CapEx	1565	0.07	0.03	-0.13	0.02	0.06	0.08	0.12
Term $spread_{t-1}$	1565	1.33	1.81	-0.61	1.37	1.73	2.90	3.67
Investment grade	1565	0.39	0.19	0.00	0.00	0.00	0.00	1.00
Credit rating	1565	0.50	0.48	0.00	0.00	0.00	1.00	1.00
Reserve life ratio	1001	14.64	26.06	0.00	7.89	11.24	15.10	5,616.50
Replacement ratio	1001	7.48	5.81	-1,344.83	-0.59	0.83	2.54	3744.33
Reserves ratio	1340	1,024,195	515,635	0.00	11,922	81,848	416,136	1,120,0000

Notes: All firm-level continuous variables are winsorized at the upper and lower 1% level.

Figure 19 below presents the historical trend in both median book and market leverage for independent E&P firms. All four leverage ratios appear to have a positive trend since 2005, only suffering some minor drops after both the financial and oil price crisis. A similar trend has been seen in Lips (2018), who finds the lowest book leverage to be approximately 20% in the third quarter of 2005. He claims that the larger use of debt financing resulted from quantitative easings, low interest rates and investors searching for yield after the financial crisis. Lips (2018) further adds that the rising commodity prices until mid-2014, and consequently higher expected returns, also contributed to increased debt usage. Lehn and Zhu (2016) claim that the increase in leverage prior to the oil price crisis is partly due to finance investments in hydraulic fracturing technology[52].

Figure 19 - E&P median book vs market leverage over time



Source: Data obtained from CRSP/Compustat Merged

Firm size has a median of above 3, indicating that most observations have asset values over $1 billion. This is significantly lower than the sample collected by Shambor (2017). Another major difference is the median tangibility. I find a tangibility of 0.81, which is significantly higher than the tangibility ratio observed by Shambor (2017), who found a tangibility of 0.54 for oil and gas firms. The reason for a higher tangibility might be connected to differences in

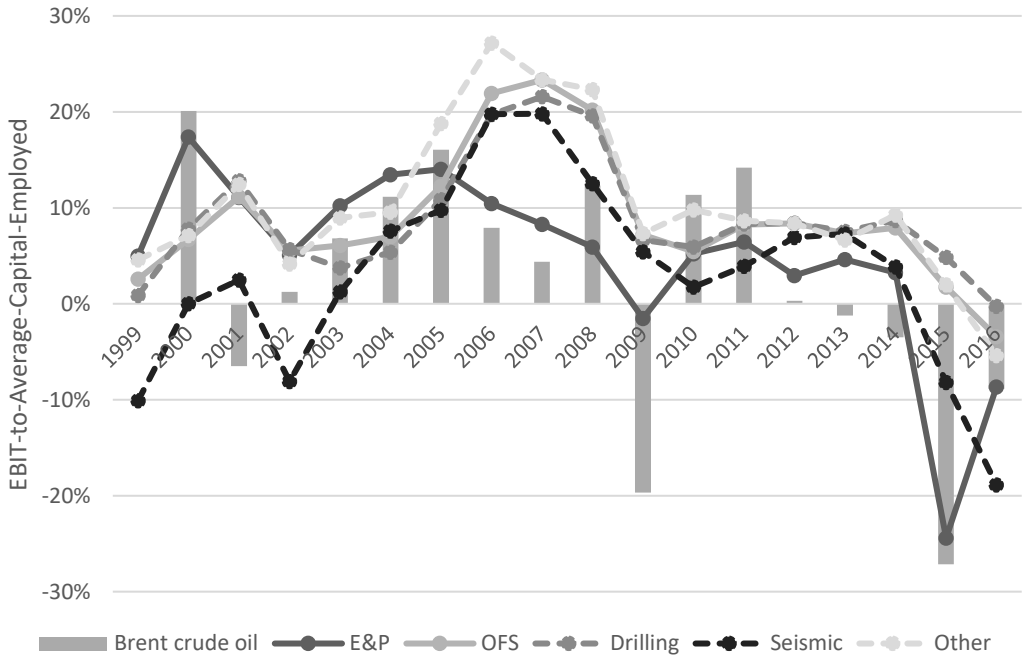
[52] Hydraulic fracturing usually involves using sand mixed with water to increase the flow of oil and gas when extracting from underground rock formations (Wright & Gallun, 2008).

firm size. Both size measures and tangibility have the lowest standard deviation in my data sample.

The mean value of 0.48 for credit rating indicates that approximately half of the firm-year observations have a credit rating by Standard & Poor's. Furthermore, 19% percent of the observations have an investment grade rating, and half of the observations have payed dividend during the chosen time period. Another observation is that both average and median market-to-book are above 1, indicating that most of the observations signal positive growth opportunities. However, a standard deviation of 0.85 implies that there are large deviations between observations on average.

Profitability has a median of 0.06, suggesting a modest profitability for most observations. The variable has, however, the largest standard deviation relative to mean compared to all other variables. A possible explanation is the cyclical nature of the petroleum industry, which makes profitability more volatile. Figure 20 provides the median ROACE for E&P and OFS firms in the period 1999-2016. As we can observe, the profitability has decreased significantly after the latest oil crisis for all sectors. A similar drop is also observed after the financial crisis. Common for both time periods is that they were impacted by major falls in Brent crude oil prices, which suggests that there is a link between oil price performance and profitability. ROACE in OFS seems to be more volatile than in E&P, although E&P suffered a more severe drop in profitability in 2015. In the OFS sector it appears that seismic providers have the most volatile ROACE.

Figure 20 - Median ROACE for E&P and OFS to yearly Brent crude oil changes

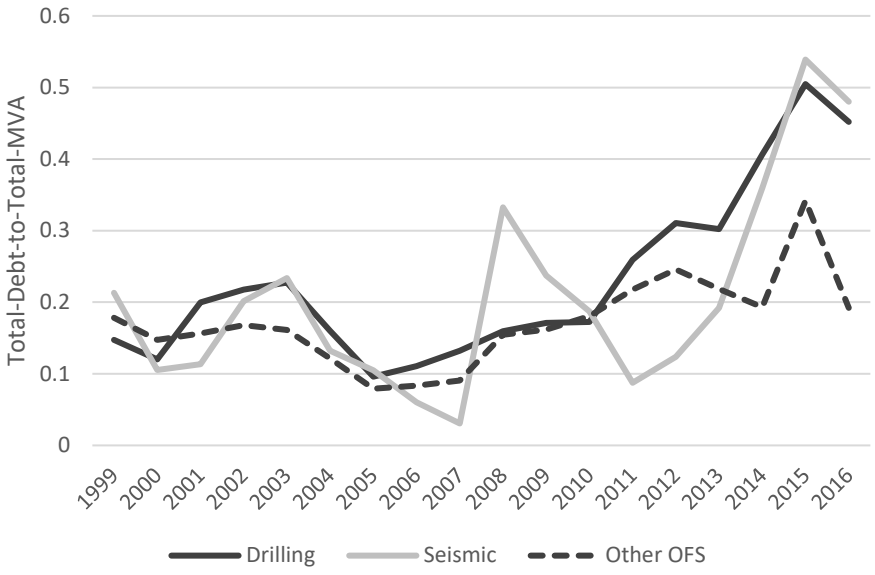


Source: Data obtained from CRSP/Compustat Merged

Median reserve life ratio is over 11 years, approximately 2-3 years higher than average for large firms according to Wright and Gallun (2008). Median reserve ratio of 81,848 BOE per net acreage indicates that half of my observations have petroleum reserves of over 80,000 BOE per net acreage. Median reserve replacement ratio under 1 indicates that over half of the observations have produced more volume than reserves added, which is a negative performance indicator. Both reserve life ratio and reserve ratio are some of the variables with highest standard deviation relative to mean.

As mentioned previously, the OFS sector consists of several subsectors. Figure 21 shows historical median *Total-Debt-to-Market-Value-of-Assets* ratio for OFS firms according to their four-digit SIC code. Seismic seems to have had more volatile leverage ratios, having large spikes in 2008 and 2011. However, this might be due to a lower number of firm year observations. As we can observe, all three subsectors within OFS have had increased leverage since 2005.

Figure 21 – Median market leverage in OFS



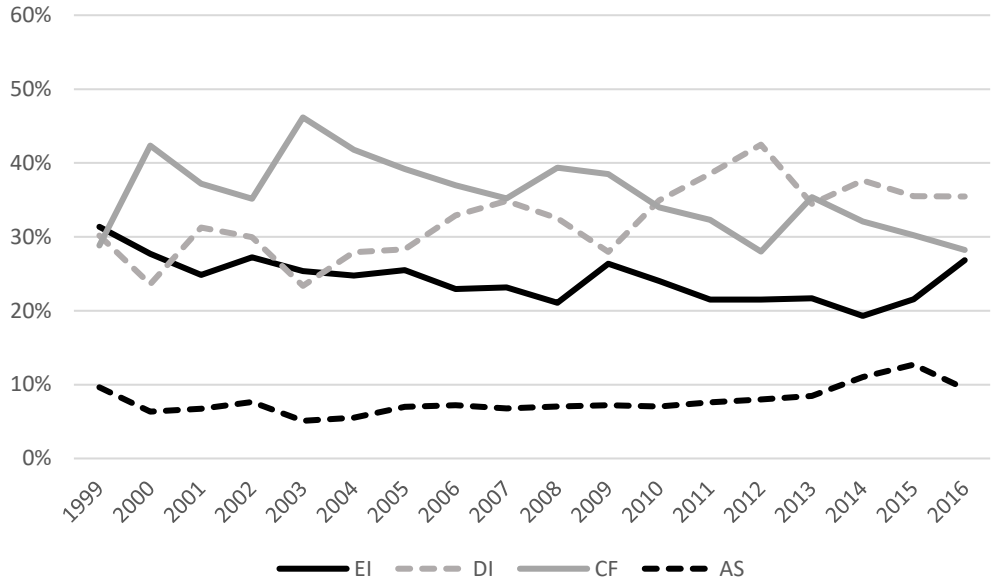
Source: Data obtained from CRSP/Compustat Merged

A final insight into my data sample is the historical funding of each sector. Figure 22 and 23 presents the average funding ratios by source for E&P and OFS firms, respectively. Each financing alternative has been divided by the sum of all four sources, and all observations are equally weighted. As we can see in Figure 22, average debt issues (DI) have increased since 1999 to the rest of the funding sources. It did, however, sustain a drop during the financial crisis. An explanation for the increase since then might be quantitative easings. The average equity issues (EI) have had a sharp increase since 2014, which might be due to reduced access to debt markets. Figure 22 further suggests that E&P firms are no longer using internally generated earnings (CF) as primary funding source, which is replaced by debt financing. Other sources – change in working capital, change in cash balance, and sale of assets (AS) – have been relatively stable during the last years.

Similar deductions can be made for OFS firms, although with some differences. It appears that the OFS sector has been more dependent on internal financing than the E&P sector in the period between 2003 and the beginning of the financial crisis. As observed in Figure 23, the sharp decline in internal financing seems to have been replaced by debt financing. However, internally generated earnings still appear to be the major funding source, in contrast to E&P. The increase in other sources (AS) after 2009 and 2015 might be due to increased divestures

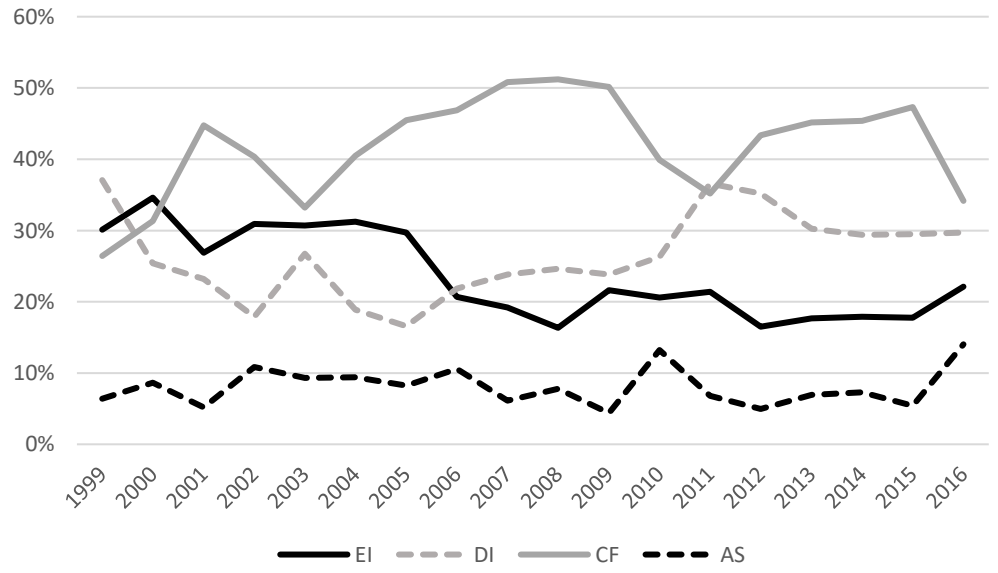
and sale of assets followed by market crisis. Similar to E&P, the OFS sector tend on average to use less external equity as financing source.

Figure 22 - Average funding ratios by source for E&P



Source: Data obtained from CRSP/Compustat Merged. Inspired by Eckbo and Kisser (2017).

Figure 23 - Average funding ratios by source for OFS



Source: Data obtained from CRSP/Compustat Merged. Inspired by on Eckbo and Kisser (2017).

Fixed effects estimation results

In this subsection I present my regression results. First, I present the results for E&P firms. Second, I present the results for OFS firms, and compare them with the results for E&P. Lastly, I present an overview of my most important findings. All regressions are estimated using FE method[53], where I include year dummies in my regression models. The FE estimation is done using cluster-robust statistics[54] in STATA, making the standard errors robust against both autocorrelation and heteroskedasticity.

Exploration & Production

Table 14 on the next page provides the results from my regression models for E&P firms. The overall models have decent explanatory power ranging between 0.5 to 0.6, which is not surprising since I have included a great number of regressors. However, when dropping all insignificant variables, the explanatory power is within the same range. Another observation is that some measures of leverage offer higher explanatory power.

Firm size is positively related to book leverage with a significance level of 1% for both book leverage measures. An explanation could be that large firms are more diversified and are less exposed to bankruptcy costs. Due to the level-log relation, the coefficient of 0.08 can be interpreted as 1% increase in firm assets will on average increase leverage with about 0.0008 percentage points. The finding of a positive relation is in accordance with Frank and Goyal (2009), Danis et al. (2014) and Shambor (2017), and is in line with the trade-off theory.

Market-to-book is negatively related to both market and book leverage. The variable has a significance level of 1% and 5% for market and book leverage, respectively. An explanation could be that market-to-book proxies for growth opportunities, which gives support to the trade-off theory. Another potential explanation could be that market-to-book proxies for expected profitability, suggesting a negative relation according the pecking order theory. A negative relation might also be due to a market timing attempt by the management. Hence, a negative relation supports all three main theories, and is in accordance with Faulkender and Petersen (2006), Frank and Goyal (2009), Drobetz et al. (2013) and Danis et al. (2014).

[53] Within group
[54] Using *vce(cluster id)*

Table 14 - Regression results for E&P

	Total-Debt-to-Market-Value-of-Assets	*Total-Debt-to-Market-Value-of-Capital*	*Total-Debt-to-Assets*	*Total-Debt-to-Capital*
Intercept	-0.75***	-1.56***	-0.96***	-1.14*
Firm Specific Factors				
Size	0.04	0.03	0.08***	0.09***
NDTS	-0.06	-0.02	-0.02	0.09
Market-to-Book	-0.06***	-0.06***	-0.01**	-0.01
Profitability	-0.12***	-0.13***	-0.22***	-0.27***
Tangibility	0.14***	0.13**	0.12**	0.08
Asset risk	-0.19	-0.19	-0.14	-0.11
Dividend payer	-3e-03	-0.9e-03	-5.4e-03	-4.0e-03
Industry Leverage	1.08***	2.16***	0.34	0.67
Leverage $_{t-1}$	0.48***	0.47***	0.52***	0.49***
Investment Grade	2.6e-03	4.2e-03	1.1e-03	2.9e-03
Credit Rating	0.06***	0.07***	0.03**	0.03**
Reserve Life	2.2e-04	4.2e-04	1.9e-04	0.9e-04
Reserve Replacement	1.1e-03***	1.4e-03***	0.8e-03*	1.1e-03**
Proved Reserves	-1.0e-08	-6.6e-09	-3.9e-08***	-4.0e-08***
Macroeconomic Factors				
Oil_{t-1}	-0.71	-2.10**	-0.94**	-1.15*
Term spread $_{t-1}$	0.09*	0.26**	0.11***	0.12**
MSCI	0.26	0.73**	0.45***	0.46***
GDP G7	12.51***	18.09***	17.17***	17.78***
E&P CAPEX	0.80*	1.72**	0.98**	1.08*
Firm Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
Year Fixed Effect	*Yes*	*Yes*	*Yes*	*Yes*
Adjusted R^2	*0.57*	*0.57*	*0.54*	*0.50*
Observations	*1,001*	*1,001*	*1,001*	*1,001*

Notes: The regression includes unreported year dummies.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Profitability is found to be negatively related to leverage, and is significant at the 1% level for all leverage measures. An explanation could be that more profitable firms have higher accessibility to retained earnings. This result is a serious contradiction to the trade-off theory, which has been known as the profits-leverage puzzle. However, it is in accordance with all presented previous empirical findings and strongly supports the pecking order theory.

NDTS does not seem to impact capital structure in E&P firms. A reason for not finding a tax effect might be due to taxation differences across countries or inappropriate measure of NDTS. Other insignificant variables are reserve life ratio, asset risk, dividend payer and investment grade.

Asset tangibility, measured as net-PP&E-to-assets, is positively related to all leverage measures except *Total-Debt-to-Capital*. An explanation could be that tangible assets function as collateral for creditors, consequently reducing expected costs of bankruptcy. A coefficient of 0.14 suggests that an increase of one percentage-point in net-PP&E-to-assets will on average increase leverage ratio by 0.0014. This finding is in accordance with all presented previous empirical findings and supports the trade-off theory.

If the E&P firm has an S&P long term issuer credit rating it tends on average to have higher leverage. The variable has a significance level of 1% and 5% for market and book leverage, respectively. A possible explanation for this could be better access to debt markets and reduced debt risk, which gives support to both the trade-off and pecking order theory. This is in accordance with Faulkender and Petersen (2006), Drobetz et al. (2013), and Danis et al. (2014).

Reserve replacement ratio, measured as added reserves to production, is positively related to leverage. The variable is significant for all leverage measures. As previously mentioned, reserve life is a proxy for firm sustainability, and is thus in accordance with the trade-off theory. When it comes to proved-reserves-to-net-acreage, it is found to be negatively related to book leverage with a significance level of 1% for both measures. This finding supports the pecking order theory. The opposite signs might be due to one or both of the variables proxies for anything other than future performance or collateral.

The median industry leverage is positively related to market leverage with a significance level of 1% for both measures. This is in accordance with Frank and Goyal (2009) and Danis et al. (2014), and suggests that E&P firms use industry leverage as benchmark for target capital structure. This finding provides support for the trade-off theory. However, a possible explanation could be that industry leverage proxies for a set of omitted variables. If industry leverage serves as a proxy for financing deficit this would give support to the pecking order theory. Another possibility is that if valuations are correlated across firms in the same industry, then a positive relation between industry leverage and firm leverage would support the market timing theory. Furthermore, I find evidence for a positive relation between

previous year's leverage and current leverage ratio, which is significant for all four leverage measures. This finding supports a dynamic trade-off theory. Similar to industry leverage, this result might also be due to controlling for omitted variables.

Based on the overall results for macroeconomic variables it appears that leverage in E&P firms is pro-cyclical. Most macroeconomic variables are significant using both market and book leverage for E&P firms. However, they seem to provide very low explanatory power to the model. Frank and Goyal (2009) and Drobetz et al. (2013) also found macroeconomic variables to add low explanatory power. One exception to the pro-cyclical tendency of leverage is the negative relation with lagged Brent oil price changes, which supports the pecking order and market timing theory. This exception might, however, be due to the linkage with firm profitability. Due to the level-log relation, a coefficient of -2.10 can be interpreted as 1% increase in lagged Brent crude oil price will on average decrease leverage with about 0.021 percentage points. An explanation for this result might be that increased oil price increases margins, and consequently increases expected profitability and retained earnings.

In contrast to previous studies, I find that lagged term spread has a positive relationship with leverage. This result suggest that E&P firms tend to decrease their leverage when a possible future recession might arise. An explanation could be that E&P firms seek to avoid future bankruptcy costs, which provides support to the trade-off theory.

When it comes to yearly changes in MSCI World Index it is positively related to leverage, further indicating that leverage is pro-cyclical. This gives support to the trade-off. However, a positive relation contradicts the findings of Drobetz et al. (2013).

Change in G7 GDP is positively related to leverage for E&P firms, and is statistically significant at a 1% level for all leverage measures. This finding is in accordance with Frank and Goyal (2009) and Drobetz et al. (2013), and gives support to the trade-off theory.

Change in E&P capital expenditures is positively related to leverage for all leverage measures. This indicates that E&P firms tend to increase their leverage to fund their investments, and provides support for the pecking order theory.

To summarize all the empirical findings for my E&P sample, I provide an overview of significant determinants and the most accurate theory in Table 15.

Table 15 - Summary of significant capital structure determinants for E&P

	Total-Debt-to-Market-Value-of-Assets	*Total-Debt-to-Market-Value-of-Capital*	*Total-Debt-to-Assets*	*Total-Debt-to-Capital*
Firm Specific Factors				
Size			+***	+***
Market-to-Book	-***	-***	-**	
Profitability	-***	-***	-***	-***
Tangibility	+***	+**	+**	
Industry Leverage	+***	+***		
$Leverage_{t-1}$	+***	+***	+***	+***
Credit Rating	+***	+***	+**	+**
Reserve Replacement	+***	+***	+*	+**
Proved Reserves			-***	-***
Macroeconomic Factors				
Oil_{t-1}		-**	-**	-*
Term $spread_{t-1}$	+*	+**	+***	+**
MSCI		+**	+***	+***
GDP G7	+***	+***	+***	+***
E&P CAPEX	+*	+**	+**	+*
Most accurate theory	*Trade-off /Pecking*	*Trade-off /Pecking*	*Trade-off /Pecking*	*Trade-off /Pecking*

Notes: Empty cells are insignificant.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Oilfield Services

Table 16 on the next page presents the results from my regression for OFS firms. I use all variables except for E&P petroleum reserve ratios since OFS firms do not own petroleum reserves. The overall models have decent explanatory power, but there is relatively larger difference between using market and book leverage compared to E&P. Similar to E&P, the regression models with highest explanatory power are the ones using market leverage as dependent variables.

As we can observe from Table 16, the capital structure determinants of OFS firms are similar to E&P. Leverage in both sectors appears to be determined by market-to-book (-), profitability (-), tangibility (+), credit rating (+), industry leverage (+) and lagged leverage ratio (+).

Table 16 - Regression results for OFS

	Total-Debt-to-Market-Value-of-Assets	*Total-Debt-to-Market-Value-of-Capital*	*Total-Debt-to-Assets*	*Total-Debt-to-Capital*
Intercept	0.37*	0.57**	0.44	0.32
Firm Specific Factors				
Size	0.02	-0.01	0.03	-0.01
NDTS	-0.74***	-0.81***	-0.72***	-0.98***
Market-to-Book	-0.04***	-0.04***	0.01	0.01
Profitability	-0.03	-0.12	-0.12**	-0.18**
Tangibility	0.13***	0.18***	0.19***	0.15***
Asset risk	-0.01	-0.01	0.35	0.59*
Dividend payer	0.02**	0.02	0.02*	0.03**
Industry Leverage	0.17*	0.21**	0.29**	0.40**
Leverage $_{t-1}$	0.58***	0.48***	0.55***	0.54***
Investment grade	-0.03	-0.05*	-0.01	-0.02
Credit Rating	0.03*	0.04**	0.01	0.01
Macroeconomic Factors				
Oil_{t-1}	0.91***	1.13***	0.43	0.78*
Term $spread_{t-1}$	-0.09***	-0.12***	-0.05	-0.09*
MSCI	-0.42***	-0.52***	-0.15	-0.2*
GDP G7	-4.67	-6.72*	-0.85	-5.42
E&P CAPEX	-1.00***	-1.15***	-0.42	-0.75
Firm Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
Year Fixed Effect	*Yes*	*Yes*	*Yes*	*Yes*
Adjusted R^2	*0.68*	*0.63*	*0.48*	*0.44*
Observations	*618*	*618*	*618*	*618*

Notes: The regression includes unreported year dummies.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Although capital structure determinants in the two sectors are mostly alike there are also some differences. For instance, firm size does not appear to determine capital structure for OFS firms. A major difference between E&P and OFS, however, is the strong significance of NDTS for OFS firms. NDTS is negatively related to leverage for both book and market measures, with a significance level of 1% for all leverage measures. When splitting OFS by

subsector, the variable still appears to be a major determinant[55]. A possible explanation is that OFS firms are more concerned with tax benefits of using debt. This result supports the trade-off theory, and is consistent with the findings of Shambor (2017). However, a negative relation contradicts the findings of Frank and Goyal (2009). Another major difference is that leverage appears to be counter-cyclical for OFS firms. However, when splitting OFS by subsector, the significance of macroeconomic variables almost disappears. This finding might nonetheless be due to fewer observations. Leverage is negatively related to changes in global E&P capex, which suggests that OFS firms tend to reduce their leverage in periods with increased E&P spending. This finding provides support for the trade-off and market timing theory. Changes in MSCI index is also proved to be negatively related to leverage, in accordance with Drobetz et al. (2013). An explanation could be that OFS firms choose to rather issue equity when stock markets are more favourable in an attempt to time the market. Interestingly, the only exception to the counter-cyclical tendency of leverage is the positive relation with lagged Brent oil price changes. As previously mentioned, this exception is also present for E&P firms, although with opposite sign.

There are also other differences in capital structure determinants between E&P and OFS, although with weak significance. Asset risk is found to be positively related to leverage for OFS, but only with a significance level of 10% for *Total-Debt-to-Capital*. Being credit rated as investment grade provides a negative coefficient with only a significance level of 10% for *Total-Debt-to-Market-Value-of-Capital*. Furthermore, I find evidence for a significant positive relation between dividend payment and leverage, which was not significant for E&P firms.

To summarize all the empirical findings for my OFS sample, I provide an overview of significant determinants for OFS and the most accurate theory in Table 17.

[55] Regression results for each subsector in OFS is presented in Appendix I and J.

Table 17 - Summary of significant capital structure determinants for OFS

	Total-Debt-to-Market-Value-of-Assets	*Total-Debt-to-Market-Value-of-Capital*	*Total-Debt-to-Assets*	*Total-Debt-to-Capital*
Firm Specific Factors				
NDTS	-***	-***	-***	-***
Market-to-Book	-***	-***		
Tangibility	+***	+***	+***	+***
Profitability			-**	-**
Risk				+*
Dividend payer	+**		+*	+**
Investment grade		-*		
Credit Rating	+*	+**		
Industry Leverage	+*	+**	+**	+**
$Leverage_{t-1}$	+***	+***	+***	+***
Macroeconomic Factors				
Oil_{t-1}	+***	+***		+*
Term $spread_{t-1}$	-***	-***		-*
MSCI	-***	-***		-*
GDP		-*		
E&P Capex	-***	-***		
Most accurate theory	*Trade-off /Pecking*	*Trade-off /Pecking*	*Trade-off /Pecking*	*Trade-off /Pecking*

Notes: Empty cells are insignificant.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Summary of capital structure insights

This subsection summarizes all my empirical findings. Most of my results are robust and significant independent of chosen regression model. However, the regression models using market values appear to be more suitable in explaining leverage ratio. Furthermore, measuring leverage based on total debt over assets rather than capital employed offers better model performance. This conclusion applies to both E&P and OFS. To summarize all my empirical findings, I present a summary of significant capital structure determinants for both sectors in Table 18 on the next page.

Table 18 - Summary of significant capital structure determinants

	E&P	OFS	Theory (E&P)	Theory (OFS)
Firm Specific Factors				
Size	+	+	Trade-off	Trade-off
Market-to-Book	-	-	All three	All three
Profitability	-	-	Pecking order	Pecking order
Non-Debt Tax Shield		-		Trade-off
Tangibility	+	+	Trade-off	Trade-off
Risk		+		Pecking Order
Dividend payer		+		Pecking Order
Industry Leverage	+	+	All three	All three
$Leverage_{t-1}$	+	+	Trade-off	
Credit Rating	+	+	Trade-off/Pecking	Trade-off/Pecking
Investment Grade		-		Pecking Order
Reserve Replacement	+	NA	Trade-off	NA
Proved Reserves	-	NA	Pecking Order	NA
Macroeconomic Factors				
Oil_{t-1}	-	+	Pecking/Market	Trade-off
$Term\ Spread_{t-1}$	+	-	Trade-off	Pecking/Market
MSCI	+	-	Trade-off	Pecking/Market
GDP G7	+	-	Trade-off	Pecking/Market
E&P CAPEX	+	-	Pecking Order	Trade-off/Market
Most accurate theory			*Trade-off/Pecking*	*Trade-off/Pecking*

It appears that the trade-off is the most accurate theory in explaining capital structure determinants for E&P firms, although the pecking order theory is fairly close. Shambor (2017), on the other hand, finds that the pecking order theory is the most accurate for oil and gas firms, followed closely by the trade-off theory. As previously mentioned, a serious violation of the trade-off theory is the negative coefficient of profitability, and that NDTS is insignificant. These results give stronger support for the pecking order theory.

For OFS firms it appears that the pecking order theory performs slightly better that the trade-off theory. These findings suggest that E&P firms are more concerned with balancing the trade-offs of using debt financing, while OFS firms are more concerned with the cost of financing due to asymmetric information. When it comes to the market timing theory, it appears to be the least accurate for both sectors. However, it still provides some accuracy and is more prominent in the OFS sector relative to E&P. This finding suggests that OFS firms are more concerned with attempting to time the market.

An interesting finding is that all macroeconomic variables have opposite effect on leverage in E&P and OFS. As mentioned, the leverage in E&P is pro-cyclical, while leverage in OFS appears to be counter-cyclical. A possible explanation for this difference in leverage policy might be due to different positions in the petroleum value chain. Due to long contract durations, it is assumed that the OFS sector experience a lagging effect relative to the E&P sector. OFS firms might hence not recover immediately after a macroeconomic downturn compared to E&P.

As a final comment I want to make the reader aware of potential flawed conclusions. My study may contain faulty inferences caused by oversimplifications or other suboptimal choices. All conclusions should hence be interpreted with reason.

"Competition is the keen cutting edge of business, always shaving away at costs."

– Henry Ford, business magnate and founder of Ford Motor Company

VII. CONCLUSION

The main goal of this thesis is to study how a set of firm-specific and macroeconomic variables affect the capital structure of publicly traded independent E&P firms over the period 1999 to 2016. In addition, the study aims at finding potential differences in capital structure determinants between E&P and OFS companies.

Starting from a large set of dependent variables, I end up with six core firm-specific factors that determine capital structure in E&P firms. The most significant determinants are tangibility (+), profitability (-), market-to-book (-), credit rating (+), reserve replacement ratio (+), and lagged leverage ratio (+). These results are robust to the use of book and market leverage. For OFS firms, the most significant determinants of capital structure are tangibility (+), non-debt tax shields (-), median industry leverage (+), and lagged leverage ratio (+). My empirical findings suggest the following stylized facts:

- E&P firms with higher market-to-book ratio tend to use less leverage.
- E&P firms with higher petroleum reserve replacement ratio tend to use more leverage.
- E&P and OFS firms with higher asset tangibility tend to use more leverage.
- E&P firms with higher profitability tend to use less leverage.
- E&P and OFS firms use lagged leverage ratio as benchmark for current leverage ratio.
- E&P firms with S&P credit rating tend to use more leverage.
- OFS firms with higher non-debt tax shields tend to use less leverage.
- Leverage in E&P firms tends to be pro-cyclical, while in OFS firms it tends to be counter-cyclical.

Based on my empirical findings it seems that none of the theories are fully able to predict capital structure in the petroleum industry. However, both the trade-off and pecking order theory provide a decent performance in predicting capital structure in both sectors. There is also evidence supporting the market timing theory, although it has the weakest accuracy. My findings hence suggest a divided use of corporate financial theory in practice.

"Financial statements are like fine perfume: to be sniffed but not swallowed."

– Abraham J. Briloff, American professor of Accounting

VIII. CRITICISM AND SUGGESTIONS FOR FURTHER RESEARCH

This study, as with all others, is subject to criticism. Unfortunately, some shortcuts and simplifications had to be made due to the scope of the thesis and lack of available information. For instance, I am not using market values of debt when measuring market leverage. This could lead to potential misleading results when analysing market leverage. Another potential issue with my study is that credit ratings are only provided by Standard and Poor's. A preferable alternative would be to use credit ratings from all three major credit agencies. Furthermore, some variables are measured in a non-optimal way. For instance, volatility is measured using monthly rather than daily stock returns. Industry specific ratios have also been simplified due to the lack of complete industry specific balance sheet items. Lastly, the petroleum industry is subject to complex accounting standards, which have not been accounted for in this study. The study of taxation effect on capital structure has also been simplified due to complex taxation policies and differences across countries.

For future research I have several suggestions that might add further knowledge. For instance, analysing the speed of adjustment to target capital structure to test for a dynamic trade-off theory would provide more insights. Another interesting study would be to include how real options affect capital structure, which is a common valuation method in the petroleum sector. Finally, the impact of the latest oil price crisis on capital structure would also be an area for future exploration. A possible procedure could be to do a difference-in-difference regression using the start of the oil price crisis as time of treatment. However, this thought is left for future research.

IX. BIBLIOGRAPHY

Alquist, R., & Kilian, L. (2010). What do we learn from the price of crude oil futures? *Journal of Applied Econometrics, 25*(4), 539-573. doi:10.1002/jae.1159

Baker, H. K., & Martin, G. S. (2011). *Capital Structure and Corporate Financing Decisions : Theory, Evidence, and Practice* (Vol. v.15). Chichester: Wiley.

Baker Hughes. (2018). *Worldwide Rig Counts - Current & Historical Data*. Retrieved from: *http://phx.corporate-ir.net/phoenix.zhtml?c=79687&p=irol-rigcountsintl*

Baker, M., & Wurgler, J. (2002). Market Timing and Capital Structure. *Journal of Finance, 57*(1), 1-32. doi:10.1111/1540-6261.00414

Bancel, F., & Mittoo, U. (2011). Financial flexibility and the impact of the global financial crisis. *International Journal of Managerial Finance, 7*(2), 179-216. doi:10.1108/17439131111122157

Bancel, F., & Mittoo, U. R. (2004). Cross-Country Determinants of Capital Structure Choice: A Survey of European Firms. *Financial Management, 33*(4), 103-132.

Bender, R., & Ward, K. (2008). *Corporate Financial Strategy* (3rd ed.): Elsevier Butterworth-Heinemann.

Berk, J., & DeMarzo, P. M. (2014). *Corporate finance* (3rd ed., Global ed., [Special ed.]. ed.). Boston: Pearson.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*(1), 115-143. doi:10.1016/S0304-4076(98)00009-8

Copeland, T. E. (2013). *Financial Theory and Corporate Policy* (4th rev. ed.). Boston: Pearson Addison-Wesley.

Dahlquist, M., & Harvey, C. R. (2001). Global Tactical Asset Allocation. Retrieved from doi:http://dx.doi.org/10.2139/ssrn.795376

Danis, A., Rettl, D. A., & Whited, T. M. (2014). Refinancing, profitability, and capital structure. *Journal of Financial Economics, 114*(3), 424-443. doi:10.1016/j.jfineco.2014.07.010

DeAngelo, H., & Masulis, P. W. (1980). Optimal Capital Structure Under Corporate and Personal Taxation. *Journal of Financial Economics, 8*, 3-29.

Downey, M. (2009). *Oil 101*. S.l.: Wooden Table Press.

Drobetz, W., Gounopoulos, D., Merikas, A., & Schröder, H. (2013). Capital structure decisions of globally-listed shipping companies. *Transportation Research Part E, 52*, 49-76. doi:10.1016/j.tre.2012.11.008

Eckbo, B. E. (2008). *Handbook of corporate finance : empirical corporate finance* (1st ed. Vol. 2). Amsterdam: North-Holland.

Eckbo, B. E., & Kisser, M. (2017). Tradeoff Theory and Leverage Dynamics of High-Frequency Debt Issuers. Retrieved from doi:http://dx.doi.org/10.2139/ssrn.2234435

Estrella, A., & Trubin, M. (2006). The Yield Curve as a Leading Indicator: Some Practical Issues. *Current Issues in Economics and Finance, 12*(5), 1-7.

EY. (2017). *Oilfield services consolidation - Transforming the value chain*. Retrieved from http://www.ey.com/Publication/vwLUAssets/ey-oilfield-services-consolidation/$FILE/ey-oilfield-services-consolidation.pdf

Fama, E., & French, K. (2002). Testing Trade-Off and Pecking Order Predictions About Dividends and Debt. *The Review of Financial Studies, 15*(1), 1-33.

Faulkender, M., & Petersen, M. A. (2006). Does the Source of Capital Affect Capital Structure? *The Review of Financial Studies, 19*(1), 45-79. doi:10.1093/rfs/hhj003

Federal Reserve Bank of St. Louis. (2018a). *Crude Oil Prices: Brent - Europe*. Retrieved from: https://fred.stlouisfed.org/series/DCOILBRENTEU

Federal Reserve Bank of St. Louis. (2018b). *Gross Domestic Product by Expenditure in Constant Prices: Total Gross Domestic Product for the Group of Seven*. Retrieved from: https://fred.stlouisfed.org/series/NAEXKP01G7A659S

Frank, M. Z., & Goyal, V. K. (2009). Capital Structure Decisions: Which Factors Are Reliably Important? *Financial Management, 38*(1), 1-37. doi:10.1111/j.1755-053X.2009.01026.x

Frank, M. Z., & Goyal, V. K. (2015). The Profits- Leverage Puzzle Revisited. *Review of Finance, 19*(4), 1415. doi:https://dx.doi.org/10.2139/ssrn.1863629

Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: evidence from the field. *Journal of Financial Economics, 60*(2), 187-243. doi:10.1016/S0304-405X(01)00044-7

Inkpen, A. C., & Moffett, M. H. (2011). *The global oil & gas industry : management, strategy & finance*. Tulsa, Oklahoma: PennWell.

Jensen, M. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *The American Economic Review, 76*(2), 323-329.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305-360. doi:10.1016/0304-405X(76)90026-X

Johannessen, A., Tufte, P. A., & Christoffersen, L. (2004). *Forskningsmetode for økonomisk-administrative fag* (3rd ed.). Oslo: Abstrakt forl.

Kraus, A., & Litzenberger, R. H. (1973). A STATE- PREFERENCE MODEL OF OPTIMAL FINANCIAL LEVERAGE. *Journal of Finance, 28*(4), 911-922. doi:10.1111/j.1540-6261.1973.tb01415.x

Lehn, K., & Zhu, P. (2016). Debt, Investment and Production in the U.S. Oil Industry: An Analysis of the 2014 Oil Price Shock. Retrieved from doi:http://dx.doi.org/10.2139/ssrn.2817123

Lips, J. (2018). Debt and the Oil Industry – Analysis on the Firm and Production Level Retrieved from https://ssrn.com/abstract=3026063

Mallows, C. L. (1986). Augmented Partial Residuals. *Technometrics, Vol. 28*(No. 4), 313-319. doi:10.2307/1268980

Miller, M. H. (1977). DEBT AND TAXES *. *Journal of Finance, 32*(2), 261-275. doi:10.1111/j.1540-6261.1977.tb03267.x

Mjøs, A. (2007). *Corporate Finance : capital structure and hybrid capital.* (Doctoral dissertation). Norwegian School of Economics and Business Administration, Retrieved from https://brage.bibsys.no/xmlui/handle/11250/164212

Modigliani, F., & Miller, M. H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *The American Economic Review, 48*(3), 261-297.

Modigliani, F., & Miller, M. H. (1963). Corporate Income Taxes and the Cost of Capital: A Correction. *The American Economic Review, 53*(3), 433-443.

Mohn, K., & Osmundsen, P. (2011). Asymmetry and uncertainty in capital formation: an application to oil investment. *Applied Economics, 43*(28), 4387-4401. doi:10.1080/00036846.2010.491460

Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics, 5*(2), 147-175. doi:10.1016/0304-405X(77)90015-0

Myers, S. C. (1984). The Capital Structure Puzzle. *Journal of Finance, 39*(3), 574-592. doi:10.1111/j.1540-6261.1984.tb03646.x

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics, 13*(2), 187-221. doi:10.1016/0304-405X(84)90023-0

Norsk Petroleum. (2018). Direct and indirect petroleum related activity. Retrieved from https://www.norskpetroleum.no/en?attachment_id=17560

Occupational Safety and Health Administration. (2018). SIC Division Structure. Retrieved from https://www.osha.gov/pls/imis/sic_manual.html

Rajan, R. G., & Zingales, L. (1995). What Do We Know about Capital Structure? Some Evidence from International Data. *Journal of Finance, 50*(5), 1421-1460. doi:10.1111/j.1540-6261.1995.tb05184.x

Rystad Energy (Producer). (2018). Ucube database. [Information about the database: https://www.rystadenergy.com/Products/EnP-Solutions/UCube]

S&P Dow Jones Indices. (2018a). *S&P Oil & Gas Equipment & Services Select Industry Index*. Retrieved from: https://us.spindices.com/indices/equity/sp-oil-gas-equipment-select-industry-index

S&P Dow Jones Indices. (2018b). *S&P Oil & Gas Exploration & Production Select Industry Index*. Retrieved from: https://us.spindices.com/indices/equity/sp-oil-gas-exploration-production-select-industry-index

Shambor, A. Y. (2017). The Determinants of Capital Structure: Empirical Analysis of Oil and Gas Firms during 2000-2015. *9*(1). doi:https://doi.org/10.5296/ajfa.v9i1.9359

Titman, S., & Wessels, R. (1988). The Determinants of Capital Structure Choice. *Journal of Finance, 43*(1), 1-19. doi:10.1111/j.1540-6261.1988.tb02585.x

U.S. Energy Information Administration (Producer). (2017). International Energy Outlook 2017. [PowerPoint slides] Retrieved from https://www.eia.gov/outlooks/ieo/pdf/0484(2017).pdf

U.S. Energy Information Administration. (2018). *Petroleum (annual)*. Retrieved from: https://www.eia.gov/beta/international/data/browser

Welch, I. (2004). Capital Structure and Stock Returns. *Journal of Political Economy, 112*(1), 106. doi:10.1086/379933

Wooldridge, J. M. (2016). *Introductory econometrics : a modern approach* (6th ed.). Australia: Cengage Learning.

Wright, C. J., & Gallun, R. A. (2008). *Fundamentals of oil & gas accounting* (5th ed.). Tulsa, Oklahoma: PennWell.

X. APPENDICES

Appendix A – Definition of variables

	Definition	Source	Mnemonics / Calculation
Firm-specific variables			
b1lev	Ratio of long- and short-term debt to total book assets	CRSP/Compustat Merged	$(dltt_t + dlc_t) / at_t$
b2lev	Ratio of long- and short-term debt to capital employed	CRSP/Compustat Merged	$(dltt_t + dlc_t) / (at_t - lct_t)$
m1lev	Ratio of long- and short-term debt to market value of assets	CRSP/Compustat Merged	$(dltt_t + dlc_t) / (at_t - ceq_t + csho_t * prcc\_f_t)$
m2lev	Ratio of long- and short-term debt to market value of capital employed	CRSP/Compustat Merged	$(dltt_t + dlc_t) / (at_t - ceq_t + csho_t * prcc\_f_t - lct_t)$
sizeb	Logarithm of total book assets	CRSP/Compustat Merged	$\log(at_t)$
sizem	Logarithm of market value assets	CRSP/Compustat Merged	$\log(at_t - ceq_t + csho_t * prcc\_f_t)$
tang	Ratio of net property, plant and equipment to total book assets	CRSP/Compustat Merged	$ppent_t / at_t$
mktbk	Ratio of total debt plus MVE to total book assets	CRSP/Compustat Merged	$(dltt_t + dlc_t + prcc\_f_t * csho_t) / at_t$
prof	Ratio of operating income before depreciation to average capital employed	CRSP/Compustat Merged	$oibdp_t / (at_t – ceq_t + csho_t * prcc\_f_t - lct_t)$
div	Dummy variable where =1 if dividend greater than 0, and =0 if otherwise	CRSP/Compustat Merged	=1 if $dv_t>0$
invgrade	Dummy variable where =1 if long-term credit rating is higher than CCC^+, and =0 if otherwise	Capital IQ North America	=1 if $splticrm_t$ is equal to or higher than BBB-
rating	Dummy variable where =0 if long-term credit rating is equal to zero or missing, =1 if otherwise	Capital IQ North America	=0 if $splticrm_t$ is missing or equal to zero, otherwise =1
risk	Unlevered volatility of monthly stock returns based on last 36 months	CRSP/Compustat Merged	$\sigma_{36months} * (csho_t * prcc\_f\_t) / (csho_t * prcc\_f\_t + dltt_t + dlc_t)$
indb1lev	Industry median book leverage 1	CRSP/Compustat Merged	-
indb2lev	Industry median book leverage 2	CRSP/Compustat Merged	-
indm1lev	Industry median market leverage 1	CRSP/Compustat Merged	-
indm2lev	Industry median market leverage 2	CRSP/Compustat Merged	-
$b1lev_{t-1}$	Lagged book leverage 1	CRSP/Compustat Merged	$b1lev_{t-1}$

Appendix A – Definition of variables (Continued)

	Definition	Source	Mnemonics / Calculation
$b2lev_{t-1}$	Lagged book leverage 2	CRSP/Compustat Merged	$b2lev_{t-1}$
$m1lev_{t-1}$	Lagged market leverage 1	CRSP/Compustat Merged	$m1lev_{t-1}$
$m2lev_{t-1}$	Lagged market leverage 2	CRSP/Compustat Merged	$m2lev_{t-1}$
rlife	Reserve life ratio	Capital IQ North America	$(ogtprng_t + ogtprngl_t + ogtproil_t) / (ogpng_t + ogpngl_t + ogpoil_t)$
rreplace	Reserve replacement ratio	Capital IQ North America	$ogtprng_t - ogtprng_{t-1} + ogtprngl_t - ogtprngl_{t-1} + ogtproil_t - ogtproil_{t-1}) / (ogpng_t + ogpngl_t + ogpoil_t)$
provedr	Total proved reserves in thousand BOE to net acreage	Capital IQ North America	$(ogtprng_t + ogtprngl_t + ogtproil_t) / (ogndacr_t + ognuacr_t)$
EI	Equity issues	CRSP/Compustat Merged	$sstk_t$
DI	Debt issues	CRSP/Compustat Merged	$dltis_t + max[dlcch_t,0]$
CF^+	Positive operating cash flow	CRSP/Compustat Merged	$max[oancf_t,0]$
AS	Other sources	CRSP/Compustat Merged	$I^- + \Delta C^-$
I^-	Asset sale	CRSP/Compustat Merged	siv + min[ivstch,0] + min[ivaco,0] + sppe
ΔC^-	Draw-down of Cash balance	CRSP/Compustat Merged	max[chech*(-1),0]
Macroeconomic variables			
$tspread_{t-1}$	Lagged spread between 10-year US Treasury and 1-year US Treasury	Federal Reserve of St. Louis	$DGS10_{t-1} - DGS1_{t-1}$
gdpg7	GDP growth of Group of Seven countries	Federal Reserve of St. Louis	$G7OCFGDR_t$
oil_{t-1}	Logarithm of lagged yearly change in Brent crude oil price	Federal Reserve of St. Louis	$log(oil_{t-1} / oil_{t-2})$
epcapex	Logarithm of annual change in global E&P capital expenditures	Rystad Energy	$log(E\&P\ capex_t / E\&P\ capex_{t-1})$
msci	Logarithm of annual MSCI World Index return	MSCI Database	$log(msci_t / msci_{t-1})$

Appendix B – Compustat mnemonics

Mnemonic	Description
dltt	Long-term debt
dlc	Debt in current liabilities
at	Total assets
lct	Current liabilities
ceq	Common equity
csho	Common shares outstanding
prcc_f	Stock price
ppent	Property, plant and equipment (net of depreciation)
oibdp	Operating income before depreciation
dv	Cash dividends
splticrm	S&P domestic long-term issuer credit rating
ogtprng	Total proved NG reserves
ogtprngl	Total proved NGL reserves
ogtproil	Total proved oil reserves
ogpng	Total NG production
ogpngl	Total NGL production
ogpoil	Total oil production
ogndacr	Net developed acreage
ognuacr	Net undeveloped acreage
sstk	Sale of common and preferred stock
dltis	Long-term debt issuance
dlcch	Current debt changes
oancf	Operating activities net cash flow
siv	Sale of investments
ivstch	Change in short-term investments
ivaco	Other investing activities
sppe	Sale of property
chech	Change in cash and cash equivalents

Appendix C – Sample selection

Sample restriction	Observations	Firms
Initial CRSP/COMPUSTAT (CCM) sample	**3,197**	**393**
(E&P)	*(2,391)*	*(309)*
(Oilfield Service)	*(806)*	*(84)*
- Observations with missing book values and not meeting rule of thumb requirements	**-221**	**-4**
(E&P)	*(-179)*	*(-2)*
(Oilfield Service)	*(-42)*	*(-2)*
- Observations with missing information on S&P credit rating	**-225**	**-28**
(E&P)	*(-177)*	*(-22)*
(Oilfield Service)	*(-48)*	*(-6)*
- Observations with missing E&P industry specific book items	**- 304**	**- 80**
(E&P)	*(-304)*	*(-80)*
(Oilfield Service)	*NA*	*NA*
- Observations with other issues*	**- 264**	**-37**
(E&P)	*(-166)*	*(-14)*
(Oilfield Service)	*(-98)*	*(-23)*
= Final CRSP/COMPUSTAT (CCM) sample	**2,183**	**244**
(E&P)	*(1,565)*	*(191)*
(Oilfield Service)	*(618)*	*(53)*

**E.g. having less than three firm-year observations*

Appendix D – Multiple Linear Regression (MLR) Assumptions

This part contains all assumptions used for my regression analysis. Assumptions 1 through 6 concerns the MLR model. Under assumptions 1 through 5, the MLR model is said to be BLUE[56] (Wooldridge, 2016). The seventh assumption is made due to time series.

Assumption 1 - Linearity

One key assumption when using a MLR regression model is that the model is linear in the parameters $\beta_0, \beta_1, \dots, \beta_k$ (Wooldridge, 2016). This means that there must be a linear relation between the dependent variable and the independent variables, giving the following population model:

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k + u$$

Assumption 2 - Random sampling

The second assumption is that the sample contains random observations *n*, $((x_{i1}, x_{i2}, \dots, x_{ik}, y_i): i = 1,2, \dots, n)$ given the population model in assumption 1 (Wooldridge, 2016).

Assumption 3 - No perfect collinearity

The third assumption is that the independent variables in the sample are not constant, and that there is no exact linear relationship between them (Wooldridge, 2016). That is, none of the independent variables are an exact liner combination of the other independent variables. If that is the case, it is said that the model suffers from perfect collinearity. If two or more independent variables are strongly correlating it is called multicollinearity. However, it is important to note that the independent variables can correlate as long as there is no perfect correlation[57].

[56] Best Linear Unbiased Estimator
[57] Correlation coefficient near -1 or 1

Assumption 4 - Zero conditional mean

The fourth assumption is that the error term, *u*, has an expected value of zero given any values of the independent variables (Wooldridge, 2016). That is, none of the independent variables are correlated with the error term, *u*.

$$E(u|x_1, x_2, \dots, x_k) = 0$$

Assumption 5 - Homoskedasticity

The fifth assumption is that the error term, *u*, has the same variance given any value of the independent variables (Wooldridge, 2016).

$$Var(u|x_1, x_2, \dots, x_k) = \sigma^2$$

Assumption 6 - Normality

The sixth and assumption for MLR is that the error term, *u*, is normally distributed with mean zero and variance σ^2.

$$u \sim N(0, \sigma^2)$$

Assumption 7 - Serial correlation

The seventh and final assumption is that there is no serial correlation in the data sample. Serial correlation arises when the error term, *u*, correlates across time, and is hence only a problem for time series data.

$$Corr(u_t, u_s) = 0, for\ all\ t \neq s$$

Appendix E – SIC code descriptions

Major Group	Industry Group	SIC Code	Explanation
13 – Oil and Gas Extraction	131 – Crude Petroleum And Natural Gas	1311 – Crude Petroleum and Natural gas	Establishments primarily engaged in operating oil and gas field properties.
	132 – Natural Gas Liquids	1321 – Natural Gas Liquids	Establishments primarily engaged in producing liquid hydrocarbons from oil and gas field gases.
	138 – Oil And Gas Field Services	1381 – Drilling Oil and Gas Wells	Establishments primarily engaged in drilling wells for oil or gas field operations for others on a contract or fee basis.
		1382 – Oil and Gas Field Services, Not Elsewhere Classified	Establishments primarily engaged in performing geophysical, geological, and other exploration services for oil and gas on a contract or fee basis.
		1389 – Oil and Gas Field Services, Not Elsewhere Classified	Establishments primarily engaged in performing oil and gas field services, not elsewhere classified, for others on a contract or fee basis.
29 – Petroleum Refining And Related Industries	291 – Petroleum Refining	2911 – Petroleum Refining	Establishments primarily engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, and lubricants, through fractionation or straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes.

Four-digit SIC codes are highlighted in grey.

Source: Descriptions obtained from Occupational Safety and Health Administration (2018)

Appendix F – Acronyms and abbreviations

GDP	……	Growth Domestic Product	NG	……	Natural Gas
EIA	……	Energy Information Administration	NGL	……	Natural Gas Liquids
OFS	……	Oilfield Service	MVA	……	Market Value of Assets
MLR	……	Multiple Linear Regression	OLS	……	Ordinary Least Squares
E&P	……	Exploration and Production	MM	……	Miller Modigliani
SIC	……	Standard Industrial Classification	ITS	……	Interest Tax Shield
DiD	……	Difference-in-Difference	Capex	……	Capital Expenditures
CCM	……	CRSP/Compustat Merged		……	

Appendix G – Regression with and without macroeconomic variables (Market leverage)

	E&P			
	(1)	**(2)**	**(3)**	**(4)**
Intercepts	-0.75**	-1.24***	-1.56***	-0.59**
Firm Specific Factors				
Size	0.04	0.04	0.03	0.03
NDTS	-0.06	-0.06	-0.02	-0.02
Market-to-Book	-0.06***	-0.06***	-0.06***	-0.06***
Tangibility	0.14***	0.14***	0.13**	0.13**
Profitability	-0.12***	-0.12***	-0.13***	-0.13***
Risk	-0.19	-0.19	-0.19	-0.19
Dividend payer	-2.8e-03	-2.8e-03	-0.9e-03	-0.9e-03
Investment grade	2.6e-03	2.6e-03	4.0e-03	4.0e-03
Credit Rating	0.06***	0.06***	0.07***	0.07***
Industry Leverage	1.08***	4.70***	2.16***	2.10***
Lagged Leverage	0.48***	0.48***	0.47***	0.47***
Reserve Life Ratio	2.2e-04	2.2e-04	4.1e-04	4.1e-04
Reserve Replacement Ratio	1.1***	1.1***	1.14***	1.14***
Proved Reserves	-1.0e-08	-1.0e-08	-6.5e-09	-6.5e-09
Macroeconomic Factors				
Oil			-2.10**	
Term spread	0.09*		0.26**	
MSCI			0.73**	
GDP	12.51**		18.09**	
E&P Capex	1.03*		2.57**	
Firm Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
Year Fixed Effect	*Yes*	*Yes*	*Yes*	*Yes*
Adjusted R^2	*0.57*	*0.57*	*0.57*	*0.56*
Observations	*1,001*	*1,001*	*1,001*	*1,001*

Regression models for E&P firms using fixed effect estimation. Model (1) and (2) uses Total-Debt-to-Market-Value-of-Assets as dependent variable. Model (3) and (4) uses Total-Debt-to-Market-Value-of-Capital as dependent variable. Only model (1) and (3) contains macroeconomic variables. Empty cells indicate that the variable is not included in the model.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Appendix H – Regression with and without macroeconomic variables (Book leverage)

	E&P			
	(1)	**(2)**	**(3)**	**(4)**
Intercepts	-0.96***	-3.99***	-1.14*	-2.46***
Firm Specific Factors				
Size	0.12***	0.12***	0.13***	0.13***
NDTS	-0.02	-0.02	0.09	0.09
Market-to-Book	-0.01**	-0.01**	-0.01	-0.01
Tangibility	0.12**	0.12**	0.08	0.08
Profitability	-0.22***	-0.22***	-0.27***	-0.27***
Risk	-0.14	-0.14	-0.11	-0.11
Dividend payer	-0.01	-0.01	-4.0e-03	-4.0e-03
Investment grade	1.1e-03	1.1e-03	2.9e-03	2.9e-03
Credit Rating	0.03**	0.03**	0.03**	0.03**
Industry Leverage	0.34	11.45***	0.67	6.07***
Lagged Leverage	0.52***	0.52***	0.49***	0.49***
Reserve Life Ratio	1.9e-04	1.9e-04	0.9e-04	0.9e-04
Reserve Replacement Ratio	0.8e-03*	0.8e-03*	1.1e-03**	1.1e-03**
Proved Reserves	-3.9e-08***	-3.9e-08***	-4.0e-08***	-4.0e-08***
Macroeconomic Factors				
Oil	-0.94**		-1.15*	
Term spread	0.11***		0.12**	
MSCI	0.45***		0.46***	
GDP	17.17***		17.78***	
E&P Capex	1.15**		1.54*	
Firm Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
Year Fixed Effect	*Yes*	*Yes*	*Yes*	*Yes*
Adjusted R^2	*0.54*	*0.54*	*0.50*	*0.50*
Observations	*1,001*	*1,001*	*1,001*	*1,001*

Regression models for E&P firms using fixed effect estimation. Model (1) and (2) uses Total-Debt-to-Assets as dependent variable. Model (3) and (4) uses Total-Debt-to-Capital as dependent variable. Only model (1) and (3) contains macroeconomic variables. Empty cells indicate that the variable is not included in the model.

** Statistical significance at 10% level.*

*** Statistical significance at 5% level.*

**** Statistical significance at 1% level.*

Appendix I – Regression for each subsector in OFS for market leverage

	(1)			(2)		
	Drilling	Seismic	Other OFS	Drilling	Seismic	Other OFS
Intercept	0.03	-0.14	0.59	-0.12	-0.14	0.96
Firm Specific Factors						
Size	0.01	0.14	5.0e-04	0.02	-0.44	-0.02
Market-to-Book	-0.05***	0.01	-0.01*	-0.07***	0.01	-0.01
Profitability	-0.07	-0.31	-0.09	-0.07	-0.43**	-0.20*
NDTS	-1.42***	-0.57***	-1.01*	-1.46***	-0.78***	-1.11*
Dividend Payer	0.02	0.01	0.02	0.02	0.01	0.02
Risk	-0.63	-0.07	0.01	-0.57	1.20**	0.03
Investment Grade	-0.03	0.15***	-0.04	-0.04	0.19**	-0.04
Credit Rating	0.02	-0.02	0.04	0.02	-0.02	0.05
Tangibility	0.06	0.11	0.20*	0.03	0.23*	0.11
Industry Leverage	0.36**	-0.44	0.18	0.46**	0.55	0.01
Lagged Leverage	0.63***	0.45***	0.51***	0.58***	0.32***	0.48***
Macroeconomic Factors						
Oil	-3.0e-03	0.46	1.39	-0.20	0.46	2.04
Term Spread	4.0e-03	-0.04	-0.14	0.03	-0.04	-0.20
MSCI	-0.11	-0.12	-0.55	-0.02	-0.12	-0.77
GDP G7	5.96	2.19	-9.02	10.17	2.19	-13.2
E&P CAPEX	0.10	-0.58	-1.36	0.49	-0.58	-2.0
Firm Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year Fixed Effect	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Adjusted R^2	*0.75*	*0.62*	*0.57*	*0.71*	*0.66*	*0.55*
Observations	*303*	*89*	*226*	*303*	*89*	*226*

Model (1) uses Total-Debt-to-Market-Value-of-Assets as dependent variable. Model (2) uses Total-Debt-to-Market-Value-of-Capital as dependent variable. Empty cells are insignificant.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Appendix J – Regression for each subsector in OFS for book leverage

	(1)			(2)		
	Drilling	Seismic	Other OFS	Drilling	Seismic	Other OFS
Intercept	-0.21	-0.14	0.03	-0.14	-0.14	-61.03
Firm Specific Factors						
Size	0.10**	0.14**	0.03	0.12**	0.14**	-0.04
Market-to-Book	0.01	0.01	0.01*	0.01	0.01	0.02**
Profitability	-0.24**	-0.28**	-0.16*	-0.66*	-0.28**	-1.98***
NDTS	-0.71**	-0.56*	-1.45***	-0.26**	-0.41	-0.32**
Dividend Payer	0.01	0.01	0.02	0.01	0.01	0.02
Risk	-0.23	1.04*	0.89***	-0.07	1.48*	1.61***
Investment Grade	-0.01	-0.01	-0.02	-0.01	-0.01	-0.03
Credit Rating	-0.01	-0.02	-0.02	-0.02	-0.02	0.04
Tangibility	0.15*	0.11	0.30**	0.11	-0.02	0.27*
Industry Leverage	-0.29	-0.44	0.68	-0.44	-0.44	84.5
Lagged Leverage	0.54***	0.34***	0.51***	0.55***	0.34***	0.48***
Macroeconomic Factors						
Oil	0.20	0.46	1.11*	0.46	0.46	-72.6
Term Spread	-0.02	-0.04	-0.13*	-0.04	-0.04	7.51
MSCI	-0.06	-0.12	-0.54*	-0.41	-0.12	16.07
GDP G7	2.98	2.18	-3.03	2.19	2.18	782.70
E&P CAPEX	-0.30	-0.58	-0.47	-0.58	-0.58	107.68
Firm Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year Fixed Effect	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Adjusted R^2	*0.57*	*0.41*	*0.44*	*0.52*	*0.35*	*0.43*
Observations	*303*	*89*	*226*	*303*	*89*	*226*

This table provides my regression models for each subsector using book values. Each subsector is divided according to SIC-code. Model (1) uses Total-Debt-to-Assets as dependent variable. Model (2) uses Total-Debt-to-Capital as dependent variable. Empty cells are insignificant.

** Statistical significance at 10% level.*

*** Statistical significance at 5% level.*

**** Statistical significance at 1% level.*

Appendix K – Correlation matrix

	Book leverage 1	Book leverage 2	Market leverage 1	Market leverage 2	Size (book)	Size (Market)	NDTS	Market-to-Book
Book leverage 1	**1.00**							
Book leverage 2	**0.98*** **	**1.00**						
Market leverage 1	**0.87*** **	**0.83*** **	**1.00**					
Market leverage 2	**0.83*** **	**0.82*** **	**0.98*** **	**1.00**				
Size (book)	0.07***	0.07***	0.08***	0.08***	**1.00**			
Size (Market)	0.03*	0.03*	-0.01	-0.02	**0.99*** **	**1.00**		
NDTS	0.09***	0.09***	0.08***	0.08***	-0.16***	-0.17***	**1.00**	
Market-to-Book	-0.21***	-0.21***	-0.46***	-0.49***	-0.22***	-0.06***	-0.08***	**1.00**
Tangibility	0.29***	0.22***	0.29***	0.24***	-0.05**	-0.08***	0.30***	-0.12***
ROACE	-0.15***	-0.15***	-0.19***	-0.19***	0.30***	0.32***	-0.19***	0.07***
Risk	0.07***	0.09***	0.11***	0.12***	-0.60***	-0.61***	0.11***	0.03
Dividend Payer	-0.02	-0.02	-0.02	-0.02	0.48***	0.49***	-0.11***	-0.07***
MSCI	-0.01	-0.02	-0.07***	-0.09***	0.04*	0.06***	-0.03*	0.09***
G7 GDP	-0.01	0.00	-0.05***	-0.06***	-0.09***	-0.07***	-0.04*	0.11***
Oil	-0.09***	-0.08***	-0.13***	-0.14***	-0.05**	-0.03	-0.04**	0.09***
E&P CapEx	-0.17***	-0.15***	-0.24***	-0.24***	-0.06***	-0.02	-0.11***	0.16***
Investment Grade	-0.10***	-0.08***	-0.13***	-0.13***	0.64***	0.64***	-0.16***	-0.05***
Credit Rating	0.29***	0.27***	0.27***	0.24***	0.64***	0.62***	-0.03	-0.20***
Term Spread	0.04*	0.03	0.08***	0.08***	0.11***	0.08***	0.02	-0.12***
Industry Median Book Leverage 1	0.26***	0.21***	0.32***	0.28***	-0.17***	-0.20***	0.19***	-0.12***
Industry Median Book Leverage 2	0.25***	0.22***	0.31***	0.29***	-0.11***	-0.15***	0.16***	-0.15***
Industry Median Market Leverage 1	0.22***	0.19***	0.37***	0.35***	0.00	-0.06***	0.16***	-0.26***
Industry Median Market Leverage 2	0.21***	0.18***	0.36***	0.36***	0.04**	-0.03	0.14***	-0.29***
Lagged Book Leverage 1	**0.84*** **	**0.82*** **	**0.72*** **	**0.68*** **	0.06***	0.03	0.09***	-0.18***
Lagged Book Leverage 2	**0.81*** **	**0.82*** **	**0.69*** **	**0.67*** **	0.06***	0.03*	0.09***	-0.18***
Lagged Market Leverage 1	**0.76*** **	**0.74*** **	**0.80*** **	**0.78*** **	0.05**	-0.02	0.10***	-0.35***
Lagged Market Leverage 2	**0.72*** **	**0.72*** **	**0.78*** **	**0.78*** **	0.04**	-0.03	0.10***	-0.36
Reserve Life Ratio	-0.03	-0.02	0.02	0.04	-0.14***	-0.15***	-0.30***	0.03***
Reserve Replacement Ratio	-0.06*	-0.05	-0.09***	-0.09***	-0.07**	-0.05	-0.22***	0.14***
Proved Reserves to Net Acreage	-0.18***	-0.16***	-0.15***	-0.13***	0.60***	0.61***	-0.15***	-0.08***

The table shows the correlation between dependent, independent, firm-specific and macroeconomic variables. All firm-specific continuous variables are winsorized at the 1% upper and lower level.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Appendix L – Correlation matrix (continued)

	Tangibility	ROACE	Risk	Dividend Payer	MSCI	G7 GDP	Oil	E&P CapEx
Tangibility	**1.00**							
ROACE	-0.08***	**1.00**						
Risk	0.04**	-0.31***	**1.00**					
Dividend Payer	-0.01	0.19***	-0.42***	**1.00**				
MSCI	0.00	0.01	-0.08***	0.01	**1.00**			
G7 GDP	0.00	0.12***	-0.03	-0.02	0.04*	**1.00**		
Oil	-0.03*	0.18***	-0.05***	-0.02	-0.15***	-0.20***	**1.00**	
E&P CapEx	-0.06***	0.31***	-0.07***	-0.04**	-0.15***	0.14***	0.63***	**1.00**
Investment Grade	-0.14***	0.18***	-0.43***	0.42***	0.00	0.01	-0.03	-0.04**
Credit Rating	0.05***	0.12***	-0.35***	0.26***	0.02	-0.04*	-0.05**	-0.07***
Term Spread	0.01	-0.13***	0.00	0.03*	0.12***	-0.42***	-0.02	-0.20***
Industry Median Book Leverage 1	0.28***	-0.33***	0.12***	-0.06***	-0.01	0.06***	-0.31***	-0.52***
Industry Median Book Leverage 2	0.18***	-0.29***	0.09***	-0.03	0.02	0.05***	-0.32***	-0.60***
Industry Median Market Leverage 1	0.18***	-0.30***	0.02	0.01	-0.09***	-0.16***	-0.34***	-0.59***
Industry Median Market Leverage 2	0.13***	-0.27***	0.01	0.04*	-0.14***	-0.19***	-0.34***	-0.59***
Lagged Book Leverage 1	0.27***	-0.01	0.09***	-0.01	0.02	0.04*	-0.08***	-0.12***
Lagged Book Leverage 2	0.20***	0.01	0.11***	-0.01	0.02	0.04*	-0.07***	-0.10***
Lagged Market Leverage 1	0.26***	-0.11***	0.17***	-0.02	0.08***	-0.01	-0.16***	-0.25***
Lagged Market Leverage 2	0.21***	-0.10***	0.19***	-0.02	0.08***	-0.02	-0.16***	-0.25***
Reserve Life Ratio	0.02	-0.15***	0.13***	-0.06*	0.02	0.01	0.01	0.03
Reserve Replacement Ratio	0.02	0.08***	0.05	-0.04	-0.01	0.05	0.04	0.13***
Proved Reserves to Net Acreage	-0.21***	0.18***	-0.35***	0.28***	0.00	-0.02	-0.02	-0.02

The table shows the correlation between dependent, independent, firm-specific and macroeconomic variables. All firm-specific continuous variables are winsorized at the 1% upper and lower level.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

Appendix M – Correlation matrix (continued)

	Investment Grade	Credit Rating	Term Spread	Industry Median Book Leverage 1	Industry Median Book Leverage 2	Industry Median Market Leverage 1	Industry Median Market Leverage 2	Lagged Book Leverage 1
Investment Grade	**1.00**							
Credit Rating	0.55***	**1.00**						
Term Spread	0.00	0.05**	**1.00**					
Industry Median Book Leverage 1	-0.08***	0.02	0.08***	**1.00**				
Industry Median Book Leverage 2	-0.05***	0.02	0.08***	**0.94*** **	**1.00**			
Industry Median Market Leverage 1	-0.02	0.07***	0.25***	**0.81*** **	**0.81*** **	**1.00**		
Industry Median Market Leverage 2	-0.01	0.07***	0.24***	**0.74*** **	**0.78*** **	**0.98*** **	**1.00**	
Lagged Book Leverage 1	-0.09***	0.31***	0.02	0.20***	0.18***	0.14***	0.11***	**1.00**
Lagged Book Leverage 2	-0.08***	0.28***	0.01	0.15***	0.14***	0.10***	0.09***	**0.98*** **
Lagged Market Leverage 1	-0.13***	0.28***	0.09***	0.25***	0.24***	0.23***	0.21***	**0.88*** **
Lagged Market Leverage 2	-0.13***	0.25***	0.09***	0.21***	0.22***	0.21***	0.20***	**0.84*** **
Reserve Life Ratio	-0.06*	-0.11***	0.00	0.00	0.00	0.01	0.01	-0.06*
Reserve Replacement Ratio	-0.05*	-0.10***	-0.09***	-0.12***	-0.13***	-0.14***	-0.13***	-0.09***
Proved Reserves to Net Acreage	0.46***	0.23***	0.02**	-0.32***	-0.21***	-0.17***	-0.08***	-0.17***

The table shows the correlation between dependent, independent, firm-specific and macroeconomic variables. All firm-specific continuous variables are winsorized at the 1% upper and lower level.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*

	Lagged Book Leverage 2	Lagged Market Leverage 1	Lagged Market Leverage 2	Reserve Life Ratio	Reserve Replacement Ratio	Proved Reserves to Net Acreage
Lagged Book Leverage 2	**1.00**					
Lagged Market Leverage 1	**0.85*** **	**1.00**				
Lagged Market Leverage 2	**0.83*** **	**0.98*** **	**1.00**			
Reserve Life Ratio	-0.04	0.00	0.01	**1.00**		
Reserve Replacement Ratio	-0.08***	-0.13***	-0.13***	0.13***	**1.00**	
Proved Reserves to Net Acreage	-0.15***	-0.15***	-0.13***	0.00	-0.05*	**1.00**

The table shows the correlation between dependent, independent, firm-specific and macroeconomic variables. All firm-specific continuous variables are winsorized at the 1% upper and lower level.
** Statistical significance at 10% level.*
*** Statistical significance at 5% level.*
**** Statistical significance at 1% level.*