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How do oil shocks affect the private equity investments? A thesis investigating the private investments in the Nordic oil sector.

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Preliminary master thesis

How do oil shocks affect the private equity investments? A thesis investigating the private investments in the Nordic oil sector.

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Name of supervisor:
Janis Berzins

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1.0 – Introduction

In 2015, 32.9% of the global energy consumption stemmed from oil and more than 56% stemmed from oil and natural gas (World Energy Council, 2016). For economies with net oil and gas export, such as Norway and Denmark, oil and gas prices are of great importance for the country's economy. In Norway, the oil sector accounted for 20% of the GDP and received 30% of the investments in 2014 (Norges Bank, 2015). Besides investments in publicly listed energy companies, the private equity (hereafter PE) sector has been active in acquiring and selling companies related to the oil and gas sector in recent years (Argentum, 2013). This sector has become a significant investment vehicle in both a global and Nordic context, as assets under management peaked USD 2.4 trillion globally in 2016 and EUR 63 billion in the Nordics in 2014.

Despite the rising importance of PE and the central position of the oil and gas sector in the Nordics, especially in Norway and Denmark, the academic research on the impact of oil prices on the PE sector is limited. Existing research focuses on the American energy market (Brown, Chan, Hu, & Zhang, 2016). Investors who are seeking to enter the Nordic energy market should have available information about PE's performance in the oil and gas sector and there is uncertainty of whether the existing limited research can be applied to a highly oil exposed and relatively younger PE market.

In relation to the downturns in oil prices in both 2008 and 2014, we believe it is natural for a long-term investor, with intentions of being exposed to the Nordic Energy market, to consider both public and private investment opportunities. Thus, we want to uncover whether there exist distinctive characteristics for the PE sector during oil price shocks that can be helpful during an investor's decision process. We believe this study can contribute to shed light on performance and dynamics during times of high volatility in the oil prices and possibly give insights to a relatively anonymous investment vehicle.

To uncover the impact of oil prices, we will first identify performance indicators that are relevant for our markets and dataset. This will be done using multiple linear regression, with IRR as the dependent variable. We will then empirically test for changes in these indicators pre- and post-oil price shocks, enabling us to test whether the shocks impact performance. Potential changes will then be examined to uncover

the directions of their impact on performance. Lastly, an investigation into the dynamics of the PE investments will help us understand whether the focus of PE funds is shifted towards increased or decreased investments during periods with high volatility in oil prices.

2.0 – Motivation

The objective of this thesis is to uncover the dynamics and capabilities of PE in the Nordic oil and gas sector, more specifically its capabilities and dynamics during periods of oil price shock. We study the Nordic region as one coherent market because of their similarities and historical ties (Spliid, 2013, p. 39). Their inhabitants perceive cross-border investments as less risky, resulting from the cultural ties and similarities among the countries, with values transcending the boundaries of language and culture (Spliid, 2013, p. 39). We want to identify the potential differences between the different investment alternatives PE, public equity, and direct investments. Our motivation is to obtain usable recommendations from an investors perspective, under the assumption that exposure to the Nordic energy sector is desired under such periods.

As argued by Sørensen (2009), oil is by far the most important commodity in the world, making oil price fluctuations an interesting study object. Existing research on the relation between oil prices and industry sectors show that price fluctuations affect the observed return in the Norwegian market (Bergholt & Larsen, 2016). Due to the dominant position of oil and gas related products in the Nordic economy, representing the greatest export of Norway and Sweden and the second largest export of Denmark, we find it likely that oil price shocks, such as in 2008 and 2014, impact both public and private equity. Thus, such price shocks represent favorable testing periods, due to the common external factor, and could enable us to detect specific characteristics related to each equity type. Such findings would enable investors to improve their allocation process.

This type of research could be interesting for a wide range of investors and not only current general and limited partners. Recently, institutional investors and sovereign wealth funds have shown increased interest for the investment vehicle (Financial Times, 2015). In Norway, this has also been a debated topic, as the Government

Pension Fund are currently seeking greater risk exposure (Dagens Næringsliv, 2014; Financial Times, 2017).

3.0 - Literature Review

In this section, following the structure of our research, we will start by focusing on the drivers of PE performance and the relevant literature. Furthermore, we discuss the relevant existing literature on PE and its oil price sensitivity. Finally, we discuss the performance of PE companies during times of distress.

3.1 – Drivers of Private Equity performance

A lot of research on the drivers of PE performance has been conducted, many of which have focused on either fund characteristics, macro variables or even General Partner (GP) characteristics (S. N. Kaplan & Schoar, 2005; Ljungqvist & Richardson, 2003; Phalippou & Gottschalg, 2009). Of relevance, the authors find that exits work as a proxy for the true performance, and that PE funds outperform the public equity market. Our focus, however is not on the fund level, as our objective is to capture the performance of PE as an investment class. A fund-level focus would arguably diversify and smoothen the risk, making both performance and dynamics harder to discover and analyze. While also having a larger sample and a more precise measure of performance through conducting our study on a deal-level, the performance on a fund-level is indeed explained by the performance of the components of such a portfolio of deals.

Research has been conducted on deal-levels, and interesting findings have been found regarding what drives PE performance. Achleitner, Braun, Engel, Figge, and Tappeiner (2010) study the value creation drivers on a deal-level in Europe, and find the main operational drivers to be EBITDA growth, free-cash-flow-to-firm growth and multiple expansion effects, and the combination effects of EBITDA growth and multiples expansion. Furthermore, the EBITDA growth can be split in to revenue growth and margin expansion, where revenue growth explains 79% of the value creation of the EBITDA growth. Additionally, the leverage effect creates 32% of the total value. They also find that value on deals with a value of less than EUR 100 mln are driven less by leverage and more by revenue growth than are deals with an enterprise value above this threshold. The latter findings support the size of the deal as a value driver. Finally, the authors study the effect of timing by looking at recessionary periods, and find that deals

with an entry-date during a recession, generate higher median returns due to higher use of leverage and a more significant multiple expansion.

Meerkatt et al. (2008) conduct similar studies on deal-data from the portfolio companies of 32 European PE firms, and find that the IRR for the investors stems from sales growth, improvement of EBIT margin, improvement of EBIT multiple and leverage effects, generating 46%, 10%, 21%, and 23% of the total IRR, respectively. Additionally, they find that the way PE creates value has shifted from being mostly due to leverage, to comprise much more of operational improvements. The authors argue that three capabilities separate the top-performers from their peers, namely networked access, domain expertise, and operational improvement, where, in addition to what has been mentioned, improvements in working capital has shown successful.

Achleitner, Braun, and Engel (2011) have done extensive research on drivers on deal-levels in Europe and North America, where they are covering deals of all sizes and entry and exit types. They find evidence that transactions with higher industry-adjusted sales growth during the holding period exhibit higher equity returns. Similar findings are found for the transactions with higher industry-adjusted operating margin improvements. Additionally, they find that transactions with higher industry-adjusted multiple expansions exhibit higher equity returns. Finally, more highly leveraged transactions exhibit higher equity returns. Achleitner et al. (2011) also argue that EBITDA serves as a good proxy for the cash flow, hence the change in sales and the change in $\frac{EBITDA}{Sales}$ are used to study the changes in operating performance's impact on equity returns during the holding-period.

Additionally, Acharya, Gottschalg, Hahn, and Kehoe (2013) find that deal margins, $\frac{EBITDA}{Sales}$, and deal multiple, $\frac{EBITDA}{Enterprise\ Value}$, of PE-owned firms, increase more than do the sector median, which is interpreted as a causal PE impact, as there is nothing inherent in the companies that would cause the relevant improvements other than them being acquired by a PE firm. The authors conclude that, like the conclusions of many of the authors mentioned above, that sales growth, EBITDA margin, and multiple improvement are important explanatory factors for abnormal performance.

Notably, several qualitative measurements have been used to explain PE performance, for instance the "human capital" of the general partner, as is done by Acharya et al. (2013). Furthermore, we will not make the distinction between different rounds of financing, as we are not focusing on the fund level. Another consequence of the latter, is that the research done on the fund level might not be interesting, due to the inherent differences between a portfolio/fund and deal-level investments. Studying deal-level investments allows to analyze the impact of oil-price shocks that might otherwise have been netted against other deals in the fund, depending on the mandate of the fund.

3.2 – The oil price sensitivity and the performance of investments

Brown et al. (2016) examine the relation between oil price volatility and both public and private equity in the energy sector in the U.S., and the risk and return of such investments. Focusing on the period from 1986 to 2010, inclusive, the authors find evidence suggesting that PE investments offer diversification benefits compared to that of the public equity and direct investments. PE investments are found to outperform both public equity and direct investments, with the latter performing the worst. On the other hand, an investor's preferences in terms of liquidity affects the investment choice. They find that investors with a strong liquidity preference would choose energy-focused public equities, whereas investors willing to tolerate lower liquidity and preferring diversification would benefit from allocating disproportionately to PE in the energy sector.

Additionally, the study finds that PE is less tightly related to oil prices and public equity returns, which is highly positively correlated with the oil price, and therefore offer additional diversification benefits (Brown et al., 2016, p. 5). Interestingly, the study stresses the importance of the different risk exposures, because it affects the risk-return profiles. Investing in PE encompasses more strategy-specific risks, making such investments less correlated with the oil price fluctuations, by nature. There is an inherent bias in measuring the correlation between PE and oil price fluctuations in that market values for PE is not observable, and not as frequently as its public counterpart. To mitigate this bias, the authors use a model proposed by Conner (2003) to approximate the cash flow structure of the PE fund, on a comparable basis to the public market index used, and calculate the final valuation of the "pseudo-fund". The direct alpha methodology (Gredil, Griffiths, & Stucke, 2014) is used to compare the

performance of the PE investments to the public equity investments. The method is an IRR-based annualized excess return, describing the PE's relative performance to the benchmark index.

Using a dataset of 189 PE funds in the US and adjusting for the biases mentioned, the authors find that PE firms exposed to the energy sector outperforms their counterparts in terms of the risk-return tradeoff. They conclude that the outperformance might be due to the real option structure of the PE fund; it functions like a portfolio of options rather than an option on a portfolio. This is a result of financial leverage, market timing, and flexibility in the portfolio companies.

3.3 – Shocks and the performance of investments

There is no doubt that times of financial distress impact investment opportunities and the performance of different investment alternatives. Despite the financial crisis, the activity in the Nordic PE industry reached record high levels of investments in 2010, unlike the PE industry in the rest of Europe, that remained well below its 2007 levels (Spliid, 2013). Focusing on the oil price shock in 2014, investments reached new records in Norway (Association, 2016), the country with the greatest oil activity in the region. BCG research also backs this anecdotal evidence. Their research, performed after 2008 financial crisis and more importantly the credit crunch, show that M&A opportunities are the second most important action for firms able to perform an acquisition (Gell, Kengelbach, & Roos, 2009). In addition to performance indicators, research into default during the financial crisis has been performed and indicates that PE backed firms have a lower default rate than listed peers (Thomas, 2010).

Opportunism during a crisis is a familiar concept, often related to cost cuts and the idea of turning bad times into a position of strength for firms that adapt quickly and effectively. Considering the anecdotal evidence and BCG's findings, an interesting question surface; *is crisis a time of opportunity for the PE industry?* Wilson, Wright, Siegel, and Scholes (2012) find that PE backed companies in the UK outperform both direct investments and listed peers. The studied PE backed companies obtain a greater return and growth than their peers both before, during and after the crisis. Furthermore, the return for these companies increased during the crisis, in difference from listed peers.

Turning our focus towards the Nordics, there is little published research focusing on the impact of crises on the PE industry. However, this subject has been a frequently visited topic for student theses. A Norwegian contribution that focuses on 36 PE backed companies in Norway suggests that these firms outperform comparable listed firms (Breyholtz & Saga, 2011). This finding is also supported by another contribution that also find significant higher growth and profitability for Norwegian PE backed firms before and during the crisis (Strandberg & Nilsen, 2012). Similar findings are documented for Danish PE backed firms, which also add the aspect of easily available capital as a contributor to the apparent outperformance by the PE backed firms (Lund-Nielsen, 2010).

Considering the research stated above, there are several parallels between that and what we intend to accomplish. On the other hand, there is little or no research like what we propose, namely to understand PE in relation to oil and gas. Oil and gas have a central position in the Nordics and the world, and the effect of oil price shocks has ripple effects throughout the economy. Due to this position and the lack of existing research, we intend to undertake the process of identifying the drivers of PE backed firms related to the oil and gas sector in the Nordics. We cannot know with certainty, that the profitability of these firms is driven by the same factors as that of other PE backed firms. The results from this analysis will enable us to measure the performance difference across assets types during the oil price crashes of 2008 and 2014. Not only could this research be useful in terms of understanding PE, but it can also contribute to the decision process of investors considering possibilities in the Nordic oil and gas sector.

4.0 - Theory

4.1 - Theories about PE ownership and value creation

4.1.1 - Agency theory and the reduction of agency costs through PE ownership

Agency theory was addressed as early as 1932, by Berle and Means (1932), arguing that the separation of ownership and control over a firm has an impact. Diverging interests between management and shareholders weakens the management's incentive to act purely in the best interest of the firm, while simultaneously increasing the costs due to monitoring and reporting (Myerson, 1982). Grossmann and Hart (1983) analyze the principal-agent problem, and conclude that, under the conditions of incomplete and

asymmetric information, moral hazard and conflicts of interest can occur when the interests of the principal and agent differ substantially.

The issue with incomplete and asymmetric information can be even more present under dispersed ownership, as is more often the case with non-PE firms. Thus, managers in public and non-PE private firms might avoid economically rational, but unpopular, tasks, such as firing employees, wage reduction, and negotiating optimal contracts with suppliers (Cumming, 2012). However, the magnitude of the agency problem depends on the degree of discretion in managerial decisions, the deviation from shareholder-optimal decisions and whether it is observable and can be sanctioned, and finally the lack of sufficient incentives between managers and owners (Berg & Gottschalg, 2005).

Research has found a link between reduced agency costs and improved performance, and between reduced agency costs and PE-owned firms (Cumming, Siegel, & Wright, 2007). S. Kaplan (1989) states that reduced agency costs rather than superior managerial information explain the operating changes in management buyout firms, hence increased value and performance are generated through improved incentives, rather than wealth transfers from employees or superior managerial information.

According to Berg and Gottschalg (2005) and Renneboog (2012) among others, the agency costs hypothesis can be divided into three subcategories; namely the free cash flow hypothesis, the incentive realignment hypothesis, and the control hypothesis.

4.1.2 - The incentive realignment hypothesis

Through the combination of increasing managers' incentives through ownership and followingly the increased personal costs of inefficiency, agency costs will be reduced (Michael C. Jensen, 1986; Michael C Jensen, 1989). By having a greater equity stake, better operating performance and investment decisions will be made (Michael C. Jensen & Meckling, 1976; Palepu, 1990). Secondly, due to their human capital being locked into the company coupled with the undiversifiable equity stake, a motivation to safeguard their position should be present (Thompson, Wright, & Robbie, 1992, p. 63).

In a PE firm, agency problems are believed to be reduced through compensation contracts linking performance and pay, and through increasing the manager's ownership, strengthening his incentives to act and think as a shareholder (Holmström, 1979; Michael C. Jensen & Meckling, 1976; Michael C. Jensen & Murphy, 1990). The

incentive realignment hypothesis states that the wealth gains of shareholders are largely the result of an incentive system aligning managers' interests with that of the investors'. By re-focusing equity holdings to largely include those with an active interest in the long-term growth, agency costs get reduced and economic efficiency increases (Prowse, 1998)

4.1.3 - The free cash flow hypothesis

The free cash flow is the excess cash flow of that required to fund all projects discounted at a relevant cost of capital. Managers have incentives to retain more free cash than is needed for growing the company to its optimal size, thus engaging in empire-building (Michael C. Jensen, 1986). This creates a misalignment between the interests of the shareholders and the managers. By putting constraints on the use of free cash flow through an increase in leverage, managers are forced to switch their focus towards honoring the firm's creditor obligations and paying out free cash flows: a mechanism increasing their discipline (Holthausen & Larcker, 1996; Michael C Jensen, 1989; Murphy, 1985). Consequently, investments in negative NPV projects and excessive retaining of free cash are omitted.

Followingly, the positive relationship between increased leverage and increased bankruptcy risk and managerial turnover makes the managers work harder while working in the best interest of the owner (Sanford J Grossman & Hart, 1982; Zwiebel, 1996). Increased debt also brings additional governance, and the debt supplying institutions have a comparative advantage due to the long-term stake and long experience (Thompson et al., 1992). Debt covenants and repayment requirements put limits on the operating budget of a buyout company (Montgomery & Baker, 1994) and provide clear constraints for the management (Baker & Wruck, 1989; Lichtenberg & Siegel, 1990). The free cash flow hypothesis therefore suggests that wealth gains for the owners are due to free cash flow commitments using debt.

4.1.4 - Control hypothesis

A dispersed shareholder base makes the individual shareholder better off by not contributing to the monitoring of the managers, creating a free-rider issue (Berle & Means, 1932; Schleifer & Vishny, 1986; Williamson, 1964). If careful monitoring and the right incentives are absent, managers might acquire too many companies, hire too

many employees and diversify activities, weakening the operational performance (Michael C. Jensen, 1986; Williamson, 1964).

Michael C. Jensen (1986); (1989) argued that PE firms are designed to reduce agency problems between dispersed owners and the manager of the firms, and finds that buyouts reduce agency costs, due to concentrated ownership increasing monitoring, increased leverage, and an improved incentive system between performance and pay. DeAngelo, DeAngelo, and Rice (1984, p. 373) argue that a leveraged buyout introduces third-party investors with a greater incentive to monitor management than dispersed owners of a public firm, creating a comparative advantage due to their specialization. The results can thus be a more intense control function, but also one of higher quality.

Additionally, since managers would be less reluctant to reveal information to their fellow owners, the asymmetric information issue can be reduced (Lazear, 2004; Opler & Titman, 1993). If however the manager refuses to increase its equity stake, as is often required by PE firms (Prowse, 1998, p. 29), it signals that not all relevant information has been disclosed (Tåg, 2012, p. 275). (Rogers, Holland, & Haas, 2002) study more than 2000 PE transactions, and find that the rigid managerial discipline PE firms exert on the business is their recipe of success. Furthermore, the authors state that, through a re-focusing of the business-objective on mid-long term growth, PE helps eliminate the short-termism of public firms and reduce the principal-agent problem prevalent in the relationship between many public firms and capital markets. They also find that top PE firms focus on the shareholders and act as unsentimental owners, whereas managers in public firms shift towards administration and serve more as mere employees.

4.1.5 - The parenting effect

Introduced by Goold (1991), the parenting advantage theory states that, when the corporate center, i.e. the PE firm, can provide parenting advantage to the subsidiaries outweighing the costs by the added organizational complexities, value is created. Berg and Gottschalg (2005, pp. 30-33) argue that PE firms help restore the entrepreneurial spirits that many acquired firms have lost, by releasing the managers of corporate bureaucracy and giving them the freedom of realizing innovative ideas. Additionally, PE firms generate value through constructive interaction and active management, and by careful selection of the management team (Berg & Gottschalg, 2005).

The parenting effect creates value through vertical synergies. Strategic guidance, transferable skills, management capabilities, financing expertise and the contribution of industry-specific expertise regarding market trends and key success factors are examples of such synergies (Cotter & Peck, 2001; Matthias, Ulrich, & Harald, 2012). PE firms often excel in implementing common service platforms and supervision and guidance (Hannus, 2015, p. 5). A study conducted by Boston Consulting Group in Europe finds that PE investors possess three important differentiating capabilities: networked access, sector expertise, and capacity to increase operational improvement (Meerkatt et al., 2008). The parenting effect states that PE firms' proprietary industry insight, synergies of controlling several similar businesses, and knowledge of turnarounds therefore work as value generating factors.

4.1.6 - Other interesting theories

In addition to the theories mentioned, there exist other relevant theories. The tax benefit hypothesis states that the typical increase in leverage constitutes an important source of wealth gains due to the increased tax shield (Renneboog, 2012). The wealth transfer hypothesis states that wealth is transferred from bondholders through an unexpected increase in the risk of investments, large increases in dividend payments, or an unexpected issue of debt (Renneboog, 2012). The theory of resource-based view suggests redeploying a bundle of valuable in-/tangible assets across businesses is the primary source of sustainable advantage, as long as the resources are valuable, rare, inimitable, and non-substitutable (Peteraf, 1993; Wernerfelt, 1984). It is reasonable to believe that it is exactly in acquisitions that resource bundles comply with the four criteria for obtaining a sustainable advantage, hence suggesting that PE buyouts create value through redeployment and transfer resources from the (parent) company, and from other portfolio companies (Hannus, 2015, p. 6).

4.2 – PE ownership in the oil industry and during shocks

The recent paper of Kaabia, Abid, and Mkaouar (2016) studies European stock markets from 2002 to 2014, and find that these markets are negatively and significantly affected by the recent crude oil shocks. A study from Norges Bank shows that oil price shocks affect net exporters of oil significantly through real exchange rates and value added in the petroleum, manufacturing and service sectors. This create a boom in all three sectors, where the greatest effect occurs in the oil sector (Bergholt & Larsen, 2016).

Fluctuations in the oil price has shown to affect real stock returns, and can also explain a lot of the fluctuations in real stock returns (Bjørnland, 2009; Gjerde & Saettem, 1999). Additionally, there has been evidence of volatility spillovers from crude oil volatility to stock markets in both oil-exporting countries and oil-importing countries (Wang & Liu, 2016).

Because of the mentioned impact of oil fluctuations on business sectors and the value-creation in countries (Bergholt & Larsen, 2016; Ramos & Veiga, 2013), coupled with the impact oil price volatility has shown on stock returns, and adding the theoretical framework of increased value generation through PE ownership due to reduction of agency costs, the parenting effect among others, we believe that PE can be a good source of wealth allocation during oil price shocks.

Our hypothesis is therefore the following:

H_1: *The performance of Nordic PE firms exposed to the energy sector is better than those of relevant peers, during oil price shocks*

To answer this, we first need to identify the drivers of the performance of PE firms in the energy sector. After the identification of the value drivers, we will conduct our main study and answer the research question. Finally, we will analyze the dynamics of the PE industry to explain why there is or is not a difference between the performance of PE firms and that of their peers.

5.0 – Methodology

When finding the drivers of PE performance, we will use 2 different approaches: multiple linear regressions and quantile regressions. The advantage of the latter is that it measures the median, and is therefore not sensitive to outliers (Valkama, Maula, Nikoskelainen, & Wright, 2013). Testing of significance will be conducted using t tests, F tests, and Wald tests. The purpose is to find what granger causes performance, which is measured using IRR. We will use t tests due to the non-asymptotic sample size. According to Stock and Watson (2012), if the sample size is greater than 80, the difference between the p value obtained using the student t distribution and the standard normal distribution never exceeds 0.002. The advantage of the F test is that it takes into consideration the losses of degrees of freedom since our distribution is not asymptotic,

but has a drawback due to the assumption of linearity in the restrictions. The drawback is solved by using a Wald test (formally also known as the delta method), but the limitation of the latter is that is assumes an asymptotic distribution, and its small-sample behavior can be erratic (Greene, 2012). Hence, both measures are used in combination.

Furthermore, while R^2 measures the goodness-of-fit, the adjusted one, $\bar{R}^2$ measures both the marginal benefits of the inclusion of an additional regressor, and the marginal costs due to additional parameter uncertainty (losses of degrees of freedom)(Greene, 2012, pp. 31-40). See appendix 1 for the formulas. We will conduct tests of the underlying assumptions of the model specifications, found in appendix 2 (Stock & Watson, 2012). After concluding and finalizing the preliminary study of the performance drivers, we will assume that the drivers are constant through time, and use the performance drivers that pass our criteria.

For testing the hypotheses, we are going to use an event study approach and follow the seven steps to conduct such a study, as described by (J. Y. Campbell, Lo, & MacKinlay, 1997). Barber and Lyon (1996) study operating performance and their study is thus considered relevant. They argue that three choices must be made in event studies on such measures. A measure of operating performance must be selected, a benchmark must be determined to measure and compare actual performance, and an appropriate statistical test must be chosen.

Technically, there are several methods that can be used to address the latter issue, two of which are tested by the authors. They are focusing on the parametric t statistics and compare its performance and relevance against the nonparametric Wilcoxon. The t statistics test if the mean abnormal performance of a firm in a year is equal to zero, whereas Wilcoxon tests the same, but using the median instead. Their results show that Wilcoxon are uniformly more powerful than is the t statistics, but that the t statistics are consistently more conservative, due to extreme observations. Campbell et. al (1997) argue that, when doing an event study, one must choose between using two parametric statistics, J_1 and J_2, where the relative power between the two depends on the sample data. If the true performance of the companies is likely to vary a lot due to different magnitude of volatility, J_1 is superior to J_2 (see appendix 3).

However, Barber and Lyon (1996) are testing operating performance on a sample U.S. based companies between 1977 and 1992, hence their research will only be used as a reference point for potential test methods. Notably, Campbell (1993) and Mackinlay (1997) argue that nonparametric tests should not be used in isolation, but in conjunction with parametric tests, as a robustness check. The latter author also argues that event studies is and will continue to be a valuable and widely used tool in finance.

Furthermore, Barber and Lyon (1996) also find that using levels of an industry comparison group with no pre-event study matching is problematic. The history of the firm relative to the benchmark will not be accounted for. In other words, if a firm is performing great in terms of operating performance before the event, and continues to do so after the event, it would seem to outperform the expected performance in the absence of the event. They propose solving this issue by measuring changes in the sample firms' performance relative to an industry benchmark.

6.0 – Data collection

Data and information from the PE sector are notoriously scarce and are considered to be a *black box*, reserved for insiders and invited investors. We intend to overcome this hurdle through the usage of portfolio companies held by PE firms, as these are obliged to report their financial statement in accordance with the national law. With the help from Argentum Centre for Private Equity at the Norwegian School of Economics, we have obtained a list of portfolio companies involved in the Nordic oil and gas sector, which we have extended with portfolio companies through our own research into investments by current and realized holdings of PE firms in the Nordics. We have used member lists from the Norwegian, Danish and Swedish venture capital and PE associations to identify funds in the Nordics and used their reported holdings to extend the list of potential portfolio companies. As of now, we have collected data from 35 portfolio companies, and we have identified approximately 150 potential companies involved in the Nordic oil and gas sector. The information has been retrieved using Proff Forvalt and financial statements from The Brønnøysund Register Centre.

Our project requires two levels of preparation of the portfolio company data due to the different nature of the event study and the performance indicator testing. Whereas the event study will be utilizing financial ratios and uncomplicated transformations of basic

accounting information, the performance indicator testing requires the calculation of the internal rate of return, IRR. Thus, we must collect data from additional sources. In addition to the information retrieved through financial statements, we must obtain follow-on funding performed by the PE funds and exit valuations. Such fund-specific information is available through subscription based services. We will use the Zephyr database and Thomson VentureXpert to obtain the follow-on and exit valuations for our portfolio companies. Furthermore, we are actively searching for an access point to the Margermarket deal database.

Oil price data is accessible through Thomson Reuters DataStream. We will extract the Brent Crude data as this is the preferred price reference for more than two thirds of the traded oil volume in the world (Kaabia et al., 2016, p. 646).

7.0 - The way forward

Data collection and preparation will be the main tasks in the period to come. Unorganized and unavailable data will be the main cause of this challenge. Furthermore, the results from the performance indicator testing will dictate the further development of the event study, hindering anything else than a chronological approach. We do however expect that the work will be feasible and in accordance with our displayed timeline.

Period (end)	**Task**
February	• Data collection for event study completed and sorted
March	• Retrieved detailed deal information from Zephyr and VentureXpert. • Calculation of IRR and performance indicator testing is finished and testing of initial hypothesis completed. • Event studies are started.
April	• First draft of event study and performance indicator analysis completed and interviews are performed
Mid May	• First draft of complete analysis finished
End May	• First complete draft
June/July/August	• Review for final draft / Delivery

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Appendix 1 – Statistical tests for performance drivers

F test, "junk regression" test:

$$IRR_i = \beta_0 + \beta_1 Driver_{1,i} + \beta_2 Driver_{2,i} + \cdots + \beta_{j,i} Driver_{j,i} + u_i$$

$$H_0: \beta_1 = \beta_2 = \cdots = \beta_j = 0$$

$$H_1: \beta_1 \neq 0 \; or \; \beta_2 \neq 0 \; \ldots \; or \; \beta_j \neq 0$$

$$Test\ statistic = \frac{RRSS - URSS}{URSS} * \frac{T-k}{m} \sim F(m, T-k)$$

Where:

- URSS = residual sum of squares from the unrestricted regression
- RRSS = residual sum of squares from the restricted regression
- m = number of restriction
- T = number of observations
- k = number of parameters to be estimated (the number of regressors plus the intercept)
- m and T-k are the two degrees of freedom parameters for the F distribution that is followed by the test statistic.
- The critical value is the value of the distribution with a given set of degrees of freedom

Once a chosen level of confidence/significance has been chosen (e.g. significance level of 1%, 2.5%, 5%), we compare our test statistic against the critical value.

If $|test\ statistic| > |Critical\ value|$, we reject H_0, meaning that we have statistical evidence on the chosen level of confidence supporting the rejection of H_0

The test can take different forms, depending on the construction of H_0. In addition to what is used in the formal derivation of the test procedure, examples of different versions of feasible null hypotheses are:

$$H_0: \beta_1 + \beta_2 = 1$$

$$H_0: \beta_2 = 1; \beta_3 = -1$$

This changes the number of restrictions. In the formal test, the relevant number is j, in the first example the number is 1, in the second the number is 2.

Wald Test (The Delta Method), the general test

- Assuming that we have a parametric model with five parameters, $\omega, \alpha, \beta, \nu$ and λ, and want to test the following hypothesis:

$$H_0: \omega = \alpha = 0$$

- Then what follows will be the derivation of the Wald test

$$\theta = (\omega, \alpha, \beta, \nu, \lambda)' \; ; g(\theta) = \begin{pmatrix} \omega \\ \alpha \end{pmatrix} \; s.t. \frac{\partial g'}{\partial \theta} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{pmatrix}$$

If $\sqrt{T}\left(\hat{\theta} - \theta\right) \sim \mathcal{N}(0, \Sigma)$, then the assumed asymptotic distribution

$\sqrt{T}\left(g\left(\hat{\theta}\right) - g(\theta)\right) \sim \mathcal{N}\left(0, \frac{\partial g'}{\partial \theta'} \Sigma \frac{\partial g'}{\partial \theta}\right)$, can be rewritten as

$\psi = T\left(g\left(\hat{\theta}\right) - g(\theta)\right)' \Omega^{-1} \left(g\left(\hat{\theta}\right) - g(\theta)\right) \sim \chi^2(n)$

Under H_0, ω and α are assumed uncorrelated, hence

$$\left(g\left(\hat{\theta}\right) - g(\theta)\right)' \left(\frac{\partial g'}{\partial \theta'} \frac{\Sigma}{\mathrm{T}} \frac{\partial g'}{\partial \theta}\right)^{-1} \left(g\left(\hat{\theta}\right) - g(\theta)\right) = \begin{pmatrix} \omega \\ \alpha \end{pmatrix}' \begin{pmatrix} \sigma_\omega^2 & 0 \\ 0 & \sigma_\alpha^2 \end{pmatrix}^{-1} \begin{pmatrix} \omega \\ \alpha \end{pmatrix}$$

$$= \left(\frac{\omega^2}{\sigma_\omega^2} + \frac{\alpha^2}{\sigma_\alpha^2}\right) \sim \chi^2(n)$$

Where:

- T is the number of observations
- θ is the parameter vector
- g is a continuous function of θ
- Σ is the asymptotic covariance matrix
- k is the number of restrictions on the parameter set
- ω and α are assumed uncorrelated
- n is the number of restrictions under the null hypothesis

Goodness-of-fit

$R^2 = \frac{ESS}{TSS} = corr(y_i, \hat{y}_i)^2$, ESS is the explained sum of squares, TSS is the total sum of squares. The statistic measures the linear fit of the model.

$\bar{R}^2 = 1 - \left[\frac{T-1}{T-k}(1 - R^2)\right]$. Penalizes for losses in degrees of freedom. The statistic has no bounds.

Appendix 2 – Model assumptions and adequacy tests

Underlying assumptions and diagnostic tests with the relevant regression models

1) The conditional error distribution has a mean of zero
    a. $E[u_i|X_{1i}, X_{2i}, \dots, X_{ki}] = 0$
    b. If violation of this assumption occurs, the model will suffer from omitted variable bias. Violation is present if and only if at least one of the included regressors is correlated with the omitted variable, and if the omitted variable is a determinant of the dependent variably, Y.
2) $(X_{1i}, X_{2i}, \dots, X_{ki}, Y_i), i = 1,2, \dots, n$ are independently and identically distributed
3) Large outliers are unlikely – a finite kurtosis for all regressors and Y
    a. $0 < E[X_{1i}^4] < \infty, \dots, 0 < E[X_{ki}^4] < \infty \; and \; 0 < E[Y_i^4] < \infty$
4) No perfect multicollinearity
    a. This is the case when one regressor can be written as a perfect linear function of another regressor.
    b. The mathematical problem arises because the issue creates a division by zero in the formulas for the coefficient. The coefficient of a regressor tells you the relative effect on Y by changing a regressor. If two regressors basicly are the same element, then intuitively it makes no sense to ask about the change in Y when you only change one regressor, that at the same time is supposed to not change.
    c. Problems include increased standard errors, leading to increased risk of inappropriate conclusions on statistical significance.
    d. Testing is done by inspecting the correlation among the regressors, and by inspecting the variance inflation factor.
    e. The solution is usually to drop one regressor or to collect more data.

Other notes:

- $Var(u_i|X_{1i}, X_{2i}, \dots, X_{ki}) = \sigma^2$: Homoscedasticity – the variance is constant
    - Assuming a constant variance when it is not, estimators become inefficient, but is still unbiased. Solution is by using Generalized Least Squares, if the source of heteroscedasticity is known, and Eicker-Huber-White heteroscedasticity-consistent standard errors otherwise.

    - Inspection of this will be done using White's test
- When assuming that OLS assumptions hold, homoscedasticity is present, and the errors are normally distributed, a Student t distribution should be used for statistical inference.
    - Jarque-Bera test testing for Normality in the error terms will be conducted
- Under the regression assumptions and for large samples, the OLS estimators are jointly normally distributed
- If irrelevant variable is included, coefficient estimates will be consistent and unbiased, but not efficient
- Omitting an important variable makes all coefficients biased, inconsistent and inefficient, unless there is no correlation between the excluded variable and the included ones

Appendix 3 - J_1 and J_2 statistica from Campbell et. Al (1997)

$$J_1 = \frac{\overline{CAR}(\tau_1,\tau_2)}{[\hat{\sigma}^2(\tau_1,\tau_2)]^{\frac{1}{2}}} \sim \mathcal{N}(0,1)$$

$$J_2 = \left(\frac{N(L_1-4)}{L_1-2}\right)^{\frac{1}{2}} \overline{SCAR}(\tau_1,\tau_2) \sim \mathcal{N}(0,1)$$