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

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Acknowledgement

The master thesis represents the culmination of our studies at BI Norwegian Business School, as part of the Master of Science in Business and Quantitative Techniques for Economics and Management programs. Private equity as a topic has given a very interesting and rewarding research experience, but has also represented a challenging task. This process has enabled us to obtain a greater understanding of an interesting research area and industry. The combination of theory, research and interviews has given us a more complete understanding than what we expected before initiating this process. There are several individuals we would like to thank for the help and support we have been given. First and foremost, we would like to thank our supervisor, Associate Professor Janis Berzins at BI Norwegian Business School's Department of Finance, for advice and guidance throughout the process. We would also extend our gratitude to the private equity professionals and investment bankers that have given us the opportunity to discuss the industry and our findings. Among these generous people are Andreas Marø from HitecVision, Eivind Saga from Hercules Capital, Thor Olav Egeland from Statoil Energy Ventures, Bjørn Erik Reinseth from Foinco, Lars Thoresen, and several unnamed individuals that cannot be mentioned due to confidentiality. Data collection for the private equity industry is notoriously demanding. Hence, we would like to thank Carsten Bienz from the Argentum Centre for Private Equity at NHH and the Centre for Corporate Governance Research at BI Norwegian Business School, for access to their databases. This gave us a good starting point for our research. Furthermore, we would like to thank all parties that have contributed to our thesis, but is not mentioned. Discussion partners are invaluable during this process, and we are very grateful for all the help we have received.

1.0 – Abstract

In this thesis, we explore the relative performance of private equity owned portfolio companies in the Nordic oil and gas sector, during the recent oil price shocks. Our research has identified the drivers of performance of these portfolio companies, uncovered characteristics of these drivers during oil price shocks, and we have applied theory and performed interviews to explain our findings through reasoning. We have compared the performance of 51 portfolio companies with that of both public and non-private equity backed private companies, and have uncovered consistent results for the oil price shock of 2008 and 2014. Our results indicate that portfolio companies have a unique sales growth outperformance, before, during and after oil price shocks, when compared to both public and non-private equity backed private companies. Through a series of interviews, we have found support for our reasoning regarding these distinct and consistent patterns. We believe private equity firms can both strategically and financially support their portfolio companies in a way that leads to superior growth. On average, portfolio companies' sales growth, outperforms public and private companies by almost 40 percentage points the year after an oil price shock. In addition, the private equity firms' focus leads to relatively lower EBITDA margins and current ratios compared to public and private peers, respectively. We believe these results predominantly originates from an increased monitoring effort towards portfolio companies, a willingness to provide growth capital, and an ability to provide favorable loans to portfolio companies, during oil price shocks.

2.0 – Introduction

Investors in the oil and gas sector have over the past ten years experienced two of the greatest oil price shocks in history. Funds invested in the Nordic stock market are likely to be exposed to such oil price downturns, as researchers have found a relation between stock price volatility, GDP development and oil price shocks in the Nordic countries (Ratti & Park, 2008), and especially in Norway (Bjørnland & Thorsrud, 2014). An investor seeking to enter the Nordic oil and gas sector can choose between a range of different investment vehicles, such as energy focused funds, publicly listed companies, energy focused private equity, and direct investments in private companies.

Despite the importance of oil and gas in the region and the abundance of investment opportunities, the academic research into the relative performance of these investment vehicles is limited. Furthermore, the Nordic region has experienced a considerable growth in raised private capital, and since 2014 more than EUR 10 billion of private capital has been raised annually (Preqin, 2017). The growing importance of private equity and the position of oil and gas in the region, lay an interesting foundation for further research.

Existing research into energy focused private equity does only consider the North-American market (Brown, Chan, Hu, & Zhang, 2017). In difference from North-America, Nordic oil and gas extraction is predominantly offshore based, and land drilling is not common. Considering the shale oil boom in North-America, and the important role of private equity in this development (Maugeri, 2013), the applicability and relevance of these findings for the Nordic region are questionable. Furthermore, to our knowledge, there is no existing research into the specific drivers of performance in the oil and gas sector. We find this surprising, as the sector has industry specific margins and metrics that are utilized for valuation (Howard & Harp, 2009). Even more surprising, is the lack of research into the relative performance of investment vehicles during oil price shocks, considering the recent history. Contributing to fill this void, we compare the performance of Nordic private equity investments with public equity and direct investments in private companies, during the oil price shocks of 2008 and 2014. Hence, we ask the following research question: "*What is the relative performance of private equity in the Nordic oil and gas sector during oil price shocks?"*

Measuring the performance across the different investment vehicles is complicated, due to liquidity differences and different reporting standards for public and private equity. This difficulty was managed by focusing on the shared drivers of performance. Existing literature on the drivers of private equity performance does not consider oil and gas deals exclusively, nor does it test if the drivers are shared with the compared investment vehicle. We approached this identification process utilizing cross-sectional OLS regressions, with the equity internal rate of return as the dependent variable. The same approach was utilized for public equity, with the holding period yield as a dependent variable. Comparing these results, we selected the shared drivers of performance and we also performed a 50^{th} percentile quantile (hereafter median) regression, to add robustness and improve the validity of our findings.

The findings from our driver identification process was used as performance measures in an investigation into the relative performance of oil and gas focused private equity, public equity, and direct investments in private companies. Focusing on the oil price shocks of 2008 and 2014, we used accounting data to construct the performance measures for private equity portfolio companies involved in the oil and gas sector, and for similar public and private companies. Using the performance measures from 51 portfolio companies, 51 public companies and 286 privately owned companies, we performed a series of Wilcoxon Signed-Rank tests to find significant differences in median values of the performance indicators. The tests were conducted for one year before, during, and one year after each oil price shock.

Our findings indicate that there are three shared drivers of performance across the investment vehicles, namely the s*ales growth* (+), *EBITDA margin expansion* (+) and the *current ratio expansion* (+). Utilizing these drivers in our relative performance study, we find that private equity firms can significantly impact their portfolio companies. Throughout the oil price shocks, the portfolio companies consistently experienced superior sales growth, compared to the other investment vehicles. This outperformance equates almost 40 percentage points the year after the oil price shock, compared to public and private companies. We also find that public equity outperforms private equity in terms of EBITDA margins. Decomposing the margin, we find that private equity's underperformance is mainly driven by the significantly higher sales growth combined with a stagnated EBITDA level. Lastly, we find that portfolio

companies tolerate a lower current ratio compared to private peers, even during the oil price shock. Relevant theory on operational improvements by private equity firms and our findings, laid the foundation for interviews with private equity professionals and investment bankers. Having conducted a series of interviews and reviewed relevant theory, we have established reasoning for our results. We believe our findings predominantly originates from an increased monitoring effort towards the management of portfolio companies, a willingness to provide growth capital, and an ability to provide favorable loans to portfolio companies, during the oil price shocks.

3.0 – Motivation

Investors, such as sovereign wealth funds, pension funds and family offices, can invest sizable amounts. With access to a wide spectrum of investment opportunities, such investors must either choose one or several strategies, to obtain diversification and the appropriate risk profile. Including new investment vehicles, such as private equity (Hereafter PE), can contribute to better diversification (Ennis & Sebastian, 2005). The benefits of including PE to a portfolio of assets have also been a debated topic in the Nordic region. The Norwegian government has requested a new review of the impact of PE on the portfolio of the Government Pension Fund of Norway (Hovland, 2017). An important aspect of this review is related to the risk and the potential returns from such investments.

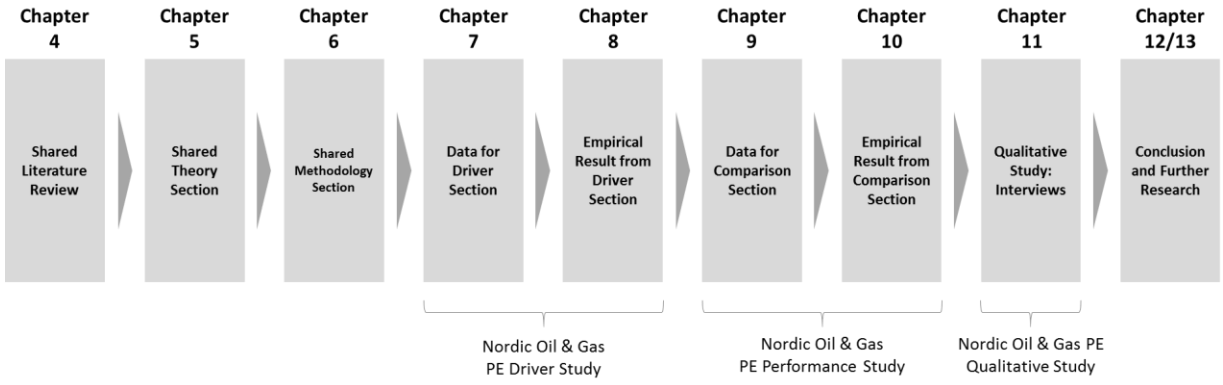
By understanding how PE performs during oil price shocks and the relative performance to other investment vehicles, our results can contribute to better asset allocation for potential limited partners that seek to enter the Nordic oil and gas sector. Besides the benefits for limited partners, our investigation can be of interest to general partners, as it contributes to a greater understanding of what benefits they offer investors during oil price shocks. Furthermore, the findings enable general partners to measure the impact of their strategies and tactics during oil price shocks. (Please refer to appendix 1 and 2 for an overview of the structure of a PE fund)

This paper contributes to existing literature through a geographical extension of existing energy PE research, further exploration of the impact of oil price shocks on investment vehicles, and offers a broad overview of oil and gas related PE in the Nordics. To the authors' knowledge, there exist no similar research on the impact of oil price shocks on the PE industry, nor does it exist similar research on the relative performance of investment vehicles during such periods.

This thesis proceeds as follows. Chapter 4 is a shared literature review, for which relevant theories for both the driver and the performance study are presented. Chapter 5 reviews related theories for PE performance and the relative performance during periods of shocks. Chapter 6 presents the methodology for both quantitative studies. Chapter 7 and 8 are only related to data collection and empirical results from the performance driver study. Chapter 9 and 10 conclude the relative performance study,

by presenting the data collection process and the empirical results. Chapter 11 summarizes the main findings from our qualitative study, for which we discuss the general attitude towards oil price shocks and our findings with PE professionals and investment bankers. Chapter 12 and 13 conclude upon the findings from the three studies, before providing suggestions for further research. The complete overview is presented in the figure below (Please refer to appendix 7 for a complete overview of the research process).

Figure 1 – Thesis structure
This figure presents the structure of this thesis, with sectional specifications. The three studies represent independent sections of the thesis, whereas the remaining chapter, namely number 4, 5, 6, 12 and 13 comprise the shared information of the studies.



4.0 - Literature Review

In this section, existing literature on the drivers of PE performance is covered, before focusing on literature regarding PE performance against comparable investment vehicles.

4.1 – Literature on the drivers of PE performance

Numerous research papers have focused on drivers of PE performance, many of which have focused on either fund characteristics, macro variables or even general partner characteristics (Acharya, Gottschalg, Hahn, & Kehoe, 2013; S. N. Kaplan & Schoar, 2005; Ljungqvist & Richardson, 2003; Phalippou & Gottschalg, 2009).

Studying performance on a portfolio company level is considered appropriate for our research. Detailed accounting information enables us to obtain a more comprehensive understanding of PE's contribution to, and impact on, the portfolio companies. Furthermore, this enables us to study portfolio companies in the oil and gas sector that are owned by PE firms with portfolio companies in several sectors. This would not be possible using fund level data, as the performance would be aggregated across all portfolio companies.

Research conducted on PE performance at a portfolio company level have identified drivers of performance and, of particular interest to our study, improvements in the operating performance of these portfolio companies originating from PE involvement (S. Kaplan, 1989; S. N. Kaplan & Strömberg, 2009). Studies in Europe and North America have found evidence of sales growth being a main driver of PE performance (Acharya et al., 2013; Achleitner, Braun, & Engel, 2011; Achleitner, Braun, Engel, Figge, & Tappeiner, 2010; Meerkatt et al., 2008). A paper surveying 79 PE firms with USD 750 billion in assets under management, reveals that all of the PE investors surveyed considered sales growth as the most important driver of return (Gompers, Kaplan, & Mukharlyamov, 2016, p. 27).

Some research has also found EBITDA growth to be a performance driver (Achleitner et al., 2010). Furthermore, EBITDA margin expansion, meaning the improvement in EBITDA over sales, from PE entry to exit, is found to be a PE performance driver in numerous studies (Acharya et al., 2013; Achleitner et al., 2011; Achleitner et al., 2010).

Closely related results were obtained by Meerkatt et al. (2008), who studied 32 European PE firms and found EBIT margin improvements to be a driver of IRR.

Leverage has also been identified as an operating driver of PE performance (Achleitner et al., 2011; Achleitner et al., 2010; Meerkatt et al., 2008). Notably, a study in Europe finds that leverage is a more important value driver for deals above EUR 100 million, and sales growth to be more important for deals below this value (Achleitner et al., 2010). Additionally, operational improvements are found to be more important than leverage for PE performance in general (Achleitner et al., 2010, pp. 20-21). Researchers argue that value creation has shifted with time, from predominantly stemming from leverage, towards primarily resulting from operational improvements (Meerkatt et al., 2008).

Asset turnover has also been used as a measure of operating performance, studying buyout IPOs (Murray, Niu, & Harris, 2006). Growth in the free cash-flow-to-firm and cash flows has also shown to be operational drivers (Achleitner et al., 2010; S. Kaplan, 1989).

4.2 – Literature on PE performance during shocks

There is no doubt that times of financial distress impact investment opportunities and the performance of different investment vehicles. Rhodes and Stelter (2009) argue that many companies fail to see the opportunities hidden in economic downturns, and that firms can capitalize on downturns by exploiting less savvy rivals. However, the companies' own vulnerabilities must be assessed and minimized, such as maximizing the companies' cash position, as a lack of liquidity also affects the ability to make smart investments in the future (Rhodes & Stelter, 2009). The authors also highlight the importance of protecting the existing business and to decisively improve the core operations. They argue that companies with a tentative and early response to downturns typically overreact later (e.g. through excessive cost cutting), resulting in an expensive recovery when the economy rebounds.

Wilson, Wright, Siegel, and Scholes (2012) find that portfolio companies in the UK outperform both direct investments and listed peers. The studied portfolio companies obtained a greater return and growth than their peers before, during and after the 2008 Financial Crisis. Furthermore, the return og these companies increased during 2008, in

difference from their listed peers. Achleitner et al. (2010) study the effect of timing by looking at recessionary periods, and find that PE deals with an entry-date during a recession, generate higher median returns due to higher use of leverage and a more significant multiple expansion. In addition to studying performance indicators, research into default during the financial crisis has been performed, and indicates that portfolio companies have a lower probability of bankruptcy (Thomas, 2010).

Turning our focus towards oil price shocks, a study by Brown et al. (2017) examines the relation between oil price volatility and both public and private equity in the U.S. energy sector. The authors find that PE firms exposed to the energy sector outperform their peers in terms of the risk-return tradeoff. Compared to public equity, PE firms are better at reducing losses during oil price decreases. Surprisingly, this lower oil price correlation does not apply for times with rising oil prices, as PE returns are more strongly correlated with the rising oil price than that of public equity. Hence, they find evidence that PE offers investors an opportunity to obtain a better capitalization on rising oil prices and a buffer against falling oil prices. They suggest that long-term investors in the American oil and gas sector can obtain superior return from investing in PE, but urges short-term investors to consider the tradeoff between return and liquidity.

Currently, there are few studies of the Nordic PE performance, both during financial crisis and oil price shocks. However, the PE performance during financial crises has been a frequently visited topic for student theses. A Norwegian contribution focusing on 36 portfolio companies in Norway during the Financial Crisis, suggests that these outperform comparable listed companies (Breyholtz & Saga, 2011). Similar findings are documented for Danish portfolio companies, in a thesis that also adds the aspect of easily available capital as a contributor to the apparent outperformance (Lund-Nielsen, 2010). These findings are inconsistent with another contribution, that finds significantly higher growth, but lower profitability for Norwegian portfolio companies during the crisis (Strandberg & Nilsen, 2012).

Unlike previous research and thesis contributions, we intend to undertake the process of identifying the drivers of PE performance from investing in the Nordic oil and gas sector. Such performance drivers might be different from the findings in earlier studies,

due to differences in valuation multiples (Howard & Harp, 2009) and the region. Consequently, previous literature is merely a reference, and is not directly relatable to our study.

5.0 – Theory

Theories related to the impact of PE firms' involvement can broadly be divided into two categories, dependent upon the origin of the portfolio companies' performance. The division relates to whether PE firms have the ability to select high quality companies in the first place, resulting in higher performance than comparable companies in the future, or whether it is their active participation that impacts the portfolio companies. These abilities are often referred to as screening and monitoring, where the former refers to the firms' ability to find quality companies, and the latter refers to the firms' impact on those companies (Bernstein, Giroud, & Townsend, 2016).

Even though both theories will be revisited systematically when applying reasoning in our empirical findings, the following sections will highlight theories related to PE firms' monitoring abilities, rather than screening. This is due to the focus on explaining the general partners abilities to change the portfolio companies during the holding period (monitoring), rather than looking at the history of the companies and the inherent characteristics (screening).

What follows is a subchapter highlighting theories addressing PE performance in portfolio companies, followed by a subchapter shedding light on theories explaining how and why PE might perform differently than peers during oil price shocks.

5.1 – Theory on the drivers of PE performance

By focusing on the monitoring abilities of PE firms, studying performance through the operating improvement in their portfolio companies, we direct the attention towards theories on agency costs, the parenting effect, tax benefits, wealth transfers, and resource-based views.

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

Agency theory was first addressed by Berle and Means (1932), arguing that the separation of ownership and control over a company has an impact. Diverging interest of management and owners weakens the former's incentive to act in the best interest of the company, leading to increased monitoring and reporting costs (Myerson, 1982). This can lead to moral hazard and conflicts of interest under incomplete and asymmetric information, and is commonly referred to as the agent-principal problem (Grossman & Hart, 1983). Incomplete and asymmetric information can be even more present under dispersed ownership, which can lead to owners feeling powerless or

thinking that they are better off letting other owners do the monitoring. Listed companies typically have a dispersed ownership base, spurring managers to avoid economically rational decisions. For instance, unpopular tasks, such as firing employees and negotiating optimal contracts with suppliers are not addressed rationally (Cumming, 2012, p. 275).

Interestingly, research has found a link between reduced agency costs and improved performance and a link between reduced agency costs and PE-owned firms (Cumming, Siegel, & Wright, 2007). A result of the latter might be that reduced agency costs explain the positive operating changes during PE ownership. This is supported by the research on management buyouts by S. Kaplan (1989), suggesting that increased deal value and performance is a result of improved incentives, rather than a result of wealth transfers from employees or due to superior managerial information.

The magnitude of agency problems depends on the degree of discretion in managerial decisions, the lack of sufficient incentives for the managers, the deviation from shareholder-optimal decisions and whether it is observable and can be sanctioned (Berg & Gottschalg, 2005). According to researchers, hypotheses on agency costs can be divided into the incentive realignment hypothesis, the free cash flow hypothesis and the control hypothesis (Berg & Gottschalg, 2005; Renneboog, 2012).

The incentive realignment hypothesis states that wealth gains of owners are largely the result of incentive systems aligning the interests of managers and owners. Firstly, such an incentive system reduces agency costs due to the increased personal cost for managers from making inefficient decisions (Michael C. Jensen, 1986; Michael C Jensen, 1989). Greater equity stakes for managers should thus result in a better operating performance and investment decisions (Michael C. Jensen & Meckling, 1976; Palepu, 1990). Secondly, the combination of managers having an un-diversifiable equity stake and having their human capital locked in the company, should give them an incentive to safeguard their position (Thompson, Wright, & Robbie, 1992, p. 63).

PE firms are believed to reduce agency costs through compensation contracts, linking performance and pay and realigning manager incentives, thus make them act and think as shareholders (Holmström, 1979; Michael C. Jensen & Meckling, 1976; Michael C.

Jensen & Murphy, 1990). By only including management with an active equity interest in the company's long-term growth, PE firms should reduce agency costs and increase economic efficiency (Prowse, 1998). Additionally, managers would arguably be less reluctant to reveal information to their fellow owners, and the asymmetric information issue can be reduced (Lazear, 2004; Opler & Titman, 1993).

The free cash flow hypothesis suggests that wealth gains of owners are largely a result from the increased free cash flow commitments using debt. The free cash flow is the free cash less the required amount to fund all projects at the relevant cost of capital (Michael C. Jensen, 1986, p. 323). As company size often affects managers salary and power (Murphy, 1985), managers have an incentive to engage in empire-building by retaining free cash in excess of what is needed for the optimal company size (Michael C. Jensen, 1986). The interest misalignment between the two parties can be reduced by putting constraints on the free cash flow use, through increasing the leverage in the company, and incurring financial costs and recurring commitments.

PE firms engaging in leveraged buyouts are believed to reduce agency costs, through generating a disciplinary mechanism exchanging debt for equity, forcing managers to switch their focus towards honoring the firm's creditor obligations (Holthausen & Larcker, 1996; Michael C Jensen, 1989; Murphy, 1985; Renneboog, 2012). Debt covenants and repayment requirements put limits on the operating budget of the acquired company (Montgomery & Baker, 1994), and provide clear constraints for the management (G. P. Baker & Wruck, 1989; Lichtenberg & Siegel, 1990). Consequently, investments in negative net present value (hereafter NPV) projects and the retaining of excess free cash is omitted. Furthermore, research done by Grossman and Hart (1982); Zwiebel (1996) find that increased leverage leads to increased bankruptcy risk and managerial turnover, thus managers are incentivized to work harder and at the best interest of the owners, in order avoid bankruptcy and to retain their position.

The control hypothesis, on the other hand, suggests that wealth gains of owners are largely a result of an improved monitoring system imposed on the management team. 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). Thus, absence of careful

monitoring and good incentives weakens the operational firm performance and might attract managers to engage in empire-building (Michael C. Jensen, 1986; Williamson, 1964).

Renneboog (2012) argues that a highly concentrated equity ownership gives investors strong incentives to monitor management, consequently reducing the issue with incomplete and asymmetric information. PE firms have an incentive to acquire a large equity stake to ensure the opportunity to impact and implement changes in the companies. By monitoring and influencing the management, they can reduce empire-building and agency costs (Renneboog, 2012).

Interestingly, due to the wide range of opportunities to reduce asymmetric and incomplete information, Michael C. Jensen (1986); (1989) argues that PE firms are designed to reduce agency costs.

In conclusion, the takeaway from the three hypotheses is that PE firms have the ability to reduce agency costs, due to improved incentive systems, increased leverage and increased monitoring. Another interesting aspect, is the additional monitoring of management through leverage. The additional debt brings on additional governance from creditors with a comparative advantage stemming from their long experience of being a creditor and their long-term stake (Thompson et al., 1992). The PE perspective of the latter is addressed by DeAngelo, DeAngelo, and Rice (1984, p. 373). They argue that a leveraged buyout introduces specialized third-party investors, that not only creates a more intense control function, but also one of higher quality.

A study of 2000 PE firm transactions indicates that it is the rigid managerial discipline that PE firms exert on the portfolio company that is the PE firms' recipe for success (Rogers, Holland, & Haas, 2002). Furthermore, the authors state that PE firms help eliminate the short-termism of listed companies and reduce the principal-agent problem prevalent in many public companies and capital markets. This is because PE firms can ensure a re-focusing of the business-objective on mid- to long-term growth. In contrast to managers in public firms, that often take on administrative roles and serve as mere employees, the authors find that top PE firms focus on the shareholders and act as unsentimental owners.

5.1.2 - The parenting effect

The parenting advantage theory introduced by Goold (1991), states that value is created when the corporate center, i.e. the PE firm, can provide parenting advantage to the subsidiaries that outweigh the increased costs of added organizational complexities. The parenting effect of PE ownership creates value through vertical synergies. Strategic guidance, transferable skills, management capabilities, financing expertise, and the contribution of industry-specific expertise regarding market trends, are some of these synergies (Cotter & Peck, 2001; Kruehler, Pidun, & Rubner, 2012). In addition to direct contributions from the PE firms themselves, synergies can be extracted across the companies in the portfolio. Working as an intermediary between the portfolio companies, the PE firms enable them to leverage their assets (Hannus, 2015). An example of such synergies, could be that the portfolio companies agree to supply each other during times of distress, enabling companies without contracts to sustain.

PE firms often excel in implementing common service platforms, supervision and guidance (Hannus, 2015, p. 5). A study conducted by BCG 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 companies, and knowledge of turnarounds, work as value generating factors. Additionally, PE firms are believed to generate value through constructive interaction and active management, by careful selection of the management team, and by bringing back the entrepreneurial spirit of managers (Berg & Gottschalg, 2005).

5.1.3 – The resource-based view

PE can also create value by redeploying resources. The theory of resource-based view suggests redeploying a bundle of valuable 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 that resource bundles in acquisitions comply with the four criteria for obtaining a sustainable advantage. Hence, suggesting that PE buyouts create value through redeployment and transfer of resources from the PE firm, and across the portfolio companies (Hannus, 2015, p. 6).

5.1.4 – Hypotheses on tax benefits and wealth transfers

The tax benefit hypothesis states that the typical increase in leverage constitutes an important source of wealth gains stemming from the increased tax shield (Renneboog, 2012). The wealth transfer hypothesis states that wealth is transferred from bondholders to shareholders through dividend increases, unexpected debt issuance or increased investment risk (Renneboog, 2012). These theories can be interesting due to the use of leverage in buyouts.

5.2 – Theory on PE performance against peers during oil price shocks

Our study of PE performance relative to peers focuses on the oil price shock of 2008 and 2014. Consequently, this subchapter directs the attention towards theories related to their performance, and why it might divert from comparable companies.

5.2.1 – Bank relations and cost of debt

Ivashina and Kovner (2011) find that PE firms that participates in leveraged buyouts utilize their repeated transactions with the bank and their ability to cross-sell to the portfolio companies, to obtain better loan terms. These relationships are materialized through lower cost of debt and less restrictive debt covenants, often referred to as covenant-lite loans. Compared to similar companies without PE funding, portfolio companies will have more leeway during an external shock due to lower financing cost and less restrictive debt covenants.

5.2.2 – Default risk and debt repurchase during crisis periods

Related to performance during shocks, is default. Thomas (2010) finds that the default rate of portfolio companies is half of that observed for comparable companies during the Financial Crisis of 2008. Despite not offering any definitive conclusion for this observation, he argues that it might be a combination of both loan terms and the PE firms' ability to perform open-market debt repurchases. Open-market debt repurchases enables the PE firms to take advantage of financial distress in their own portfolio companies. As debt holders are willing to sell the portfolio companies' debt at a discount to par value, PE firms can significantly improve their portfolio companies' debt situation through repurchasing and retiring of this debt.

5.2.3 – Investments during crisis periods

Bernstein, Lerner, and Mezzanotti (2017) find that portfolio companies have significantly higher investment rates during the financial crisis of 2008. They argue

that portfolio companies have superior access to financing, due to the PE firms' bank relations and that PE owners can inject follow-on investments when comparable companies are denied further financing by their lenders.

5.2.4 – PE and real options

Brown et al. (2017) find a convex relationship between returns on energy investments and the oil price. Interestingly, this convexity is found to be greater for PE compared to public investments, indicating that energy PE has a better ability to capitalize on the oil price increase. The authors also offer a possible explanation, relating to the real options inherent in PE investments. They argue that investors are offered the opportunity to invest in a portfolio of options through PE firms. Investing in traditional public energy funds can be viewed as an option on a portfolio of companies with the desired exposure. In contrast, PE investments should be viewed as a portfolio that contains many individual real options at the disposal of the general partners, due to the high level of flexibility and opportunities of operating leverage in PE.

5.3 – Research question and hypothesis

The highlighted theories have focused on addressing reasons for how PE is believed to ensure improved performance in the portfolio companies. By incentivizing management, putting constraints on cash usage, and ensuring control, PE is believed to reduce agency costs and add necessary mechanisms to ensure such improved performance. They are also believed to have a parenting advantage, by creating synergies through common service platforms, owning and controlling several companies, and having industry knowledge and turnaround expertise, that give them a great opportunity set. Followingly, by redeploying and transferring resources from the PE firm and across the portfolio companies, they are believed to have a sustainable and competitive advantage. Based on the theories of how PE ensures improved performance in their portfolio companies and due to our motivation to better understand the impact of oil price shocks, our research question is:

What is the relative performance of PE in the Nordic oil and gas sector during oil price shocks?

Moreover, some theories argue for a better crisis management of PE investors. Hence, the outperformance during oil price shocks, such as that found by Brown et al. (2017), is argued to be due to better financing and loan terms through good banking relations,

a lower default risk due to liquidity control, and the possibility of repurchasing distressed debt in their portfolio companies. Similarly, PE is argued to act as opportunists, investing during downturns and having additional funding opportunities in crises. The real-option structure of their portfolio companies ensures great flexibility across their investments, arguing that PE performance is improved through the option of redeploying resources and adapting their strategy to the changing market conditions. Based on the theories and reasoning above, our hypothesis in this thesis is the following:

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

6.0 – Methodology

In this chapter, we motivate the models used for testing drivers of PE performance and the models used for comparing performance of PE against its peers. We will refer to literature on the models, followed by the testing of the model assumptions. The statistical software programs used are Stata and SPSS.

6.1 – Methodology for the drivers of performance

Drivers of performance are studied by regressing the internal rate of return (hereafter IRR) on operational changes in the portfolio companies. The IRR is essentially the compounded annual growth rate of cash, adjusting for cash flow timing (Please refer to appendix 8 for the formula). The models used to conduct our studies, are cross-sectional multiple linear regressions and median regressions (Please refer to appendix 3 for the formulas). What follows are three sub-sections motivating our selection of variables and models; explaining the model, highlighting relevant literature; and testing the model assumptions, respectively.

6.1.1 – Motivating the selection of variables and model for drivers of PE performance

We start by motivating the performance metric used to measure performance, followed by sections motivating the model selection and the corresponding coherent independent variables. Finally, we motivate how to ensure comparability between PE and listed peers. Please refer to appendix 8 for a complete list of formulas for the investigated variables.

6.1.1.1 – Motivating the selection of the dependent variable and the econometric model

Researchers disagree on the appropriate way to measure PE performance. The most common performance metric is IRR, a result of the dependency of cash flow timing of PE investments (Diller & Kaserer, 2004, p. 5; Gompers et al., 2016). Because such a performance metric is highly relevant for the industry and aligned with our intention of contributing to the investment decision of potential limited partners, IRR is our chosen metric. Furthermore, studying an average yearly return is applicable when relating performance to performance changes (measured in percentages). For instance, studying an average yearly return against average yearly changes in sales growth, is arguably coherent and interpretable.

Notably, while IRR considers the timing of cash flows and thus also the time value of money, it has some drawbacks in that it assumes cash flows are reinvested at the same rate of return, puts more emphasis on recent cash flows, and might yield multiple answers. While other measures of absolute performance exists, such as the money multiple and the total value to paid-in-capital (H. K. Baker & Filbeck, 2013, pp. 327-328), they are inapplicable for our research, as they disregards the time value of money.

There exists relative performance measures, such as the Public Market Equivalent, a measure that mimics the cash flow structure of PE in a public market index (H. K. Baker & Filbeck, 2013, p. 330). The method seeks to find the excess IRR of a public benchmark relative to a PE firm or deal, and is inapplicable for an important reason. The method assumes that PE and the listed benchmark have similar risks and thus also expected returns. Brown et al. (2017) finds that oil and gas companies owned by private and public equity are fundamentally different in terms of risk related to oil price movements. Hence, this violates the assumption and a comparison would not be accurate.

Due to our focus on identifying PE performance indicators, IRR is arguable the most coherent measure. By firstly identifying the drivers of PE performance, and secondly measuring the relative development of these drivers through oil price shocks, we can make a coherent comparison between the investment vehicles.

6.1.1.2 – Motivating the model structure and coherent Independent variables

When determining a deal value, PE firms and transaction advisors rely on accounting information, and PE investors often incorporate comparable company multiples when valuing a deal (Gompers et al., 2016, pp. 12-15). The entry and exit values are the most influential factors in measuring performance through IRR (Phalippou & Gottschalg, 2009, p. 1760). Thus, a coherent way to measure drivers of IRR per deal, is to look at the operational improvements in the portfolio companies during the holding period. By studying annual average changes of accounting information for profitability, liquidity, sales, capital structure, and operating efficiency, we can uncover appropriate performance drivers for investment vehicle comparison. A suitable model for assessing such relations is a cross-sectional multiple linear regression, regressing IRR as a dependent variable on performance drivers and control variables.

6.1.1.3 – Motivating the selection of Independent variables

Sales growth, *EBITDA growth*, and *EBITDA margin* are found to be operating drivers for PE performance, using IRR as the performance measure (Acharya et al., 2013; Achleitner et al., 2010; Meerkatt et al., 2008). Since the research focuses on Europe and PE firms in different industries and countries, it is relevant to test if PE performance in Nordic oil and gas industry has similar performance drivers. Additionally, the oil and gas sector uses specific valuation multiples (Howard & Harp, 2009) that might impact the results, as the IRR will depend upon the exit valuation. Importantly, ceteris paribus, sales growth is arguably a driver of performance as an increase in revenues will increase value by making the company bigger. Similarly, EBITDA growth can increase value, as it is often included in valuation multiples. The EBITDA margin shows the relation between revenues and EBITDA, and thus addresses the profitability margin of the company. Indeed, making the company more profitable per unit of revenue generates more cash to the owners, increasing the deal value. Notably, since EBITDA is found to serve as a good proxy for cash flows (Opler & Titman, 1993), we choose to only study the former, to avoid the issue of multicollinearity addressed in subchapter 6.3.

The *asset turnover* measures a company's efficiency in its use of assets to generate sales. Murray et al. (2006) use this as a measure of operating performance in their study on PE buyouts. Thus, it can be relevant to test *asset turnover* as an operating driver in our research. Additionally, the theories arguing for PE putting constraints on inefficient resource usage, might indicate a more efficient use of resources in portfolio companies and consequently a higher asset turnover.

Leverage usage in PE has been a topic of discussion, especially due to the aggressive use of leverage in the buyouts of the 1980s. During this period, PE typically applied highly leveraged capital structures using junk bonds, until the junk bond market crash, that resulted in numerous portfolio companies defaulting and going bankrupt (S. N. Kaplan & Strömberg, 2009, pp. 1-2). In recent years, value creation in the PE industry has shifted away from leverage, and towards operational improvements (Meerkatt et al., 2008). However, leverage is still used, and the fact that PE obtains better debt facilities, might contribute positively to performance. In general, leverage increases the

upside potential by increasing the risk and, as long as the increased upside is greater than the increased cost, value is created.

Leverage at entry might also be relatively high, for reasons mentioned in the paragraph above. Oil and gas companies, such as in the exploration and production segment (hereafter E&P), can be very capital intensive. We therefore study the leverage at entry, as this might help explain performance. Even though leverage might be less important for performance than before, it might still be a contributing driver.

On the other hand, it is relevant to study drivers that might be unique to the relevant industry and region we investigate. Thus, *earnings before interest, taxes, depreciation, amortization, and exploration costs* (hereafter EBITDAX) is tested as a driver, since E&P companies often incur multiple periods with exploration costs before either discovering oil or stop exploring the area. EBITDAX is a common pricing metric for E&P companies (Howard & Harp, 2009), and could also be an important target for PE firms aiming to improve the exit valuation.

Liquidity can, in addition to being a measure of the immediate financial situation in a company, also be used to assess a company's investment opportunities (Rhodes & Stelter, 2009). Portfolio companies' ability to invest is important for factors such as growth and obtaining proprietary technology, and it is likely that this will be reflected in the valuation of portfolio companies and the IRR. From the perspective of an oil and gas company, oil price volatility and shocks can result in great liquidity problems and increase the risk of default. Not only is the chance of liquidity problems high due to potential losses on receivables during unfavorable market condition, customers might also go bankrupt, leading to dwindling future income. We expect that liquidation due to the liquidity issues in an unfavorable market will severely impact the return to the PE firm, hence liquidity variables should be tested.

There are two common liquidity ratios, namely the current ratio and the quick ratio. The current ratio looks at the relation between current assets and current liabilities, whereas the quick ratio is similar, but excludes the inventory. The underlying logic of these ratios is to understand the company's ability to cover short-term liabilities. Related to our insinuated relation between liquidity and the survival of companies. Brédart (2014) finds that liquidity in form of the current ratio can predict which US

companies that remain healthy throughout the period of 2000 to 2012. We choose to use the current ratio because of this empirical evidence.

6.1.1.4 – Motivating the selection of control variables

Seeking to isolate the performance impact stemming from operating changes in the portfolio company, we motivate the use of control variables to capture other factors we believe impact PE performance in Nordic oil and gas sector. Firstly, we believe there is a difference between mid-stage and later-stage investments. We make this distinction at 5 years of continuous operation. It is arguably more risk in earlier investment stages, as the company is less developed, and uncertainty is greater. Therefore, we control for the stage in a portfolio company's life-cycle.

Secondly, oil price changes might impact performance, as the role of oil and gas in the Nordic economy is substantial, making it a relevant control variable. Even though Brown et al. (2017) finds PE performance to be less oil dependent than listed peers in US oil and gas sector, we believe oil and gas have a different role in the Nordics. In difference from the US, Norway is a major oil and gas exporter, and the impact of oil price shocks on the petroleum sector has been found to be severe (Bergholt & Larsen, 2016).

Thirdly, we believe adjusting for the overall growth in the economy is relevant, as the mere expansion or contraction of the economy can affect the deal value and thus also the performance.

6.1.1.5 – Motivating comparability of performance drivers across investment vehicles

To ensure consistency and coherence in the performance testing against peers, we also need to evaluate similar relations for comparable investment vehicles. The comparing methodology of PE against other investment vehicles is a debated topic, due to the structure of PE investments. Many other investment vehicles are publicly traded and the performance is tracked daily. For instance, investors in listed companies typically measure performance using total shareholder return as a metric, studying stock price development through time relative to an initial investment. Most research on performance of listed companies and stock prices is therefore done using time-series regressions, limiting the relevance to our study (Eugene F Fama & French, 1993; Eugene F. Fama & French, 2015; Jegadeesh & Titman, 1993; Lintner, 1965; Sharpe, 1964).

However, research has linked financial statement items to stock price movements (Holthausen & Larcker, 1992; Ou & Penman, 1989). Koller, Goedhart, and Wessels (2015, p. 57) show that the key drivers for total return to shareholders originates from sales growth, profit margin improvements, earnings yield, and the changes in shareholders' expectations about company performance. The stock price changes continuously to reflect the shareholders' changing expectations, making it different from PE performance measures. To overcome this difference, we study the listed counterparts in a similar fashion as the PE deals, namely by looking at the listed companies as individual deals. By calculating the holding period yield from an entry to an exit date, we obtain a comparable cross-sectional measure for performance.

In conclusion, the first step is to use the same regression model utilizing performance and accounting data for both investment vehicles. The second step is to investigate similarities and differences in the performance drivers of the investment vehicles. This ensures robust measures and thus strengthens the validity of our conclusions.

6.1.2 – Model introduction and literature for identifying the drivers of performance

Cross-sectional multiple linear regressions will be used to identify performance drivers (Please refer to appendix 3). According to Stock and Watson (2012, pp. 270-272), transformation of a dataset is important to consider for two reasons. Firstly, economic reasoning should be used when choosing the proper transformation, in order for the data to fit with the expected economic relationship between the variables. Secondly, the log-log transformation can help make the data honor the model assumptions, as the logged variables will now act as elasticities. In our case, elasticities are useful for studying the ratio of the percentage change in a variable (IRR) to the percentage change in another (performance driver), making it ideal for our study. To illustrate, a coefficient of 5% for the sales growth, means that an increase of one sales growth unit increases IRR by 5% (not percentage points). The model assumptions are tested in the following subchapter.

Moreover, to ensure robustness, we also use median regressions, as they are not sensitive to outliers (Hao & Naiman, 2007). Since we want to identify what explains IRR, the goodness of fit is a key element for our study. The quantified measure to assess the fit is R^2 (Please refer to appendix 4), which explains how much of the variability in IRR is explained by the performance drivers and control variables.

Importantly, adding variables will never result in a decrease in the goodness of fit, as R^2 does not penalize for adding irrelevant variables. However, the adjusted counterpart, $\bar{R}^2$, both measures the marginal increase of additional variability explained from adding variables, and penalizes for marginal costs from additional estimation uncertainty (Greene, 2012, pp. 31-40). Therefore, using $\bar{R}^2$ helps us pick a model with variables that explain IRR and also identifies when adding variables does not improve our model. Please see appendix 4 for the formula.

A potential pitfall of using $\bar{R}^2$, is that it does not help assess whether a variable (statistically) significantly impacts performance. Therefore, we also check the statistical significance of the independent variables, providing a solution to such a pitfall (Stock & Watson, 2012, p. 234). The conservative assumption is that a variable does not help explain IRR, and testing of significance helps us address whether we have statistical support to reject this. Conventional levels of significance testing are 10%, 5%, and 1%. The testing has the following logic; if the estimated coefficient is different from 0 and we test the assumption above at a 10% level of significance, then, we are assessing whether it is less than 10% likely to observe such a coefficient estimate if the true parameter of the population were 0. Hence, we have statistical evidence in favor of rejecting the assumption of the parameter value being 0.

Significance testing, on the other hand, relies on an underlying assumption of the population distribution. The underlying distribution of the residuals (see appendix 6) in a linear regression model is the standard normal distribution (Greene, 2012, p. 56). For small (non-asymptotic) samples, some carefulness must be shown regarding the distribution. Followingly, the t-statistic assuming a Student t distribution and corresponding probability values (hereafter p-value) are used (Stock & Watson, 2012, pp. 75, 90). For n greater than 15, there is only infinitesimal differences between the p-values using a Student t and a standard normal distribution, and having 25 to 30 observations are considered sufficient for good approximations and reliable results (Hogg, Tanis, & Zimmerman, 2015, p. 202).

Importantly, if the asymptotic distribution is assumed to follow a normal distribution, when it in fact does not, inference of the overall population becomes inconsistent. In our case, we find it unlikely that the asymptotic distribution of IRR follows a normal.

On the other hand, it is plausible that it follows a unimodal normal, however with leptokurtic (many outliers) and possibly positively skewed (larger positive outliers) distribution. The reason for this is that there is an asymmetric relation between positive and negative performance. While the downside potential of a deal is limited to the amount invested, there is a theoretical unlimited upside potential. Some deals are likely to have a greatly positive IRR, stemming from a short holding period, for instance.

Furthermore, similar tests are done for the complete model. Fisher tests (hereafter F tests) and Wald tests are conducted. They are joint tests used if all regressor coefficients are equal to zero. On the one hand, the F test assumes linearity in the restrictions, which the Wald test does not. On the other hand, the Wald test assumes an asymptotic distribution making its small-sample behavior erratic (Greene, 2012, p. 230), which the F test does not. The F test adjusts for the inclusion of irrelevant variables, similar to the $\bar{R}^2$. For the reasons above, we look at both tests in combination.

6.1.3 – Testing model assumptions for identifying drivers of performance

Appendix 6 shows a list of the underlying model assumptions for a cross-sectional multiple linear regression and the diagnostic tests to check if the assumptions hold. Primarily, we need to assess the linearity in the regression functions, and the potential need for transforming our data. A linear regression function is suitable when establishing relations that you have reason to believe in fact is linear. In subchapter 6.1.1 we give an economic reasoning for why we choose to use log-log transformed data for our regressions. However, we also need to assess whether the population regression function is a nonlinear function of the independent variables (Stock & Watson, 2012, p. 252). In other words, we need to test whether the model function selected based on economic reasoning also honors the necessary assumptions for the model to be relevant.

In appendix 10, we test both the assumed linear non-transformed data, and the log-log-transformed data. Important assumptions for the regression model are the conditional expectation of the dependent variable and the normality assumption regarding the distribution of the residuals (Please refer to appendix 6). Please note that the residuals indeed depend on which of the independent variables are included in the regression. Therefore, we run this testing simultaneously with the driver regressions in chapter 8.

Normality tests for the residuals are performed, and is found in appendix 10. A visual inspection of the histograms, reveals that the log-log transformed data (the bottom histogram) seems more normally distributed than the linear data. To properly test for normality, we use the Shapiro-Wilk test, as it has been found to be the most accurate model for small sample sizes (Mendes & Pala, 2003). The tests reject normality for the non-transformed data. As a result, we test the log-transformed residuals, due to the reasoning stated in chapter 6.1.2. We cannot reject normality for the log-transformed residuals, and we conclude that our transformed data does not violate the normality assumption.

Furthermore, the first assumption is that the conditional error distribution has a mean of zero. By including a constant term, the assumption is honored, as verified by inspecting the descriptive statistics in appendix 10.

The second assumption requires all variables to be independently and identically distributed (hereafter IID). Independency is questioned, partly because the selection process of IRR is influenced by other factors than its dependence of performance drivers and control variables. Such a bias is known as sample selection bias, which means that the selection process is influenced by non-random sampling or missing data (Stock & Watson, 2012, p. 323). Additionally, the independent variables are mostly compiled using financial accounting information, which is affected by changes in accounting standards and different accounting methods. An example of such a difference is the choice between *successful effort* (Capitalize expenses for only successful oil discoveries) and *full cost* (Capitalize all expenses) methods in oil and gas exploration. Hence the accounting data might not be identically distributed.

The third assumption states that large outliers are unlikely, and the honoring of the assumption is verified by confirming that all fourth-order moments are finite. The fourth assumption addresses the potential issue with collinearity. No perfect multicollinearity is present, as Stata would not compute all coefficients in such an event. Despite this, there might still be presence of high collinearity, causing inflated standard errors. In appendix 11a, the correlation matrix is displayed to address this issue. The correlation matrix shows that asset turnover ratio and sales CAGR have a correlation of 88%, and a correlation of 62% between the control variables oil and

GDP. Potential consequences must be addressed when running the regressions. By studying the variance inflation factor, which measure the variance increase of a variable due to a linear association with other independent variables, we avoid any inference issues (Chatterjee & Hadi, 2012, p. 250). When running our regressions, we find no such issues with the selected models studied in chapter 8 (Please refer to appendix 11b). An inflation factor in excess of 10 is an indication that collinearity may be causing problems in estimation (Chatterjee & Hadi, 2012, p. 250), which is far from our case.

In addition to the four assumptions, the variance around the regression line must be assessed. If the variance is assumed constant across all values of the independent variables (homoscedastic variance), when it in truth varies across such values, estimations become inefficient. Using robust standard errors solves this potential issue, and we use this for all our regressions.

6.2 – Methodology for PE performance against peers during oil price shocks

When studying PE performance against peers, we use the Wilcoxon Signed-Rank test, and study the development of the identified performance drivers through 2008 and 2014. What follows are three sub-sections motivating our selection of variables and models; explaining the model, highlighting relevant literature; and testing the model assumptions, respectively

6.2.1 – Motivating model selection for PE performance against peers

Based upon our findings for drivers of performance in PE, we perform a series of tests, comparing the performance of PE with private and public reference companies during the oil price shocks. Our tests are designed to uncover potential under- and outperformance by PE portfolio companies, compared to other possible investment vehicles.

6.2.1.1 - Selection of time intervals

Measuring performance impacted by PE involvement put restrictions on how we can compile, measure, and test the data. Securing only portfolio companies whose performance is fully affected by the PE investment professionals, poses a problem in the data compilation, as this requires information about the internal situation of the portfolio company. This information is not available for our research; thus, we must impose assumptions. One of these assumptions is when a company reflects the PE firm's involvement. We assume that companies that have PE ownership in 2006 and

2012 reflect this involvement for 2007-2009 and 2013-2015. Hence, we assume that the PE firms have had sufficient time to implement their strategy and take the appropriate measures before the oil price shocks. On the other hand, we do allow for exits during the periods, as this will not affect the overall comparison. Entries during the period is not possible, because the effect of the involvement after the oil price shock will unable a comparative indexation, as the base value will rely on the year of the oil price shock. The indexation procedure will be further explained in the subsequent section.

6.2.1.2 - Data preparation and indexing

Comparisons of absolute numbers and ratios of portfolio and reference companies have little ability to shed light on the development taking place during the period of the oil price shock. For example, sales and EBITDA margins vary between private and public companies and among the sub-sectors within the oil and gas industry. Hence, we use an index system to enable comparisons through time and across portfolio and reference companies. The developments for significant drivers of performance through the period are all compared with the values of 2006 and 2012 and multiplied with 100.

Formula 1 - Indexing
The formula presents the calculation method used for indexing the development of performance.

$$Index_i = \left(\frac{Driver_i}{Driver_{entry}}\right) * 100$$

If a company experiences a 16% increase in sales in 2013, this equals an index of 116, and a current ratio increase from 1.5 to 2, equals an index of 133. Because of this indexation, we have removed the company specific absolute value and ratio, enabling us to compare different companies across industry and equity type. This indexing is performed for all companies, including publicly and privately-owned companies. By subtracting the index values of the portfolio company and the reference year by year, we have differences that we can test for statistical significance. These differences will be denoted as percentage outperformance by the portfolio companies, where negative values indicate an underperformance by the portfolio company.

Indexing introduces some challenges regarding extreme values. Using 2006 and 2012 as base years, irregular values for the drivers of performance can lead to abnormal

index values. Most problematic are base values that are close to zero, as this leads to high or low index values, that greatly impact our sample. Thus, we have introduced a requirement, that any index above 250 and below -250, are either set to these border values, or must be removed if such substitutions do not solve the problem. An example of such a situation occurs when a base year yield a value close to zero and is combined with a slightly positive and negative margin in two subsequent years. In such a situation, we might observe extreme changes in the indexed values, whereas the actual margin development is miniscule.

6.2.2 – Model introduction and literature for PE performance against peers

To choose the most suitable model, we test the distribution of our data. Because none of the three-year periods for any of the parameters pass the Shapiro-Wilk test for normality, the traditional paired sample t-test is not suitable (Please refer to appendix 20). Hence, we use the two-tailed Wilcoxon Signed-Rank test. The test utilizes the difference of the median, thus, avoiding the assumption of normal distribution. Furthermore, the two-tailed test enables us to be more conservative, compared to a one-tailed test. By comparing the indexes of both the portfolio and the reference companies, our hypothesis is that the index changes are the same, and the difference should equal zero. Hence, our hypothesis for the statistical tests are:

$$H_0: Differences\ of\ the\ indexes\ equal\ to\ 0$$
$$H_1: Differences\ of\ the\ indexes\ unequal\ to\ 0$$

Due to the relatively low number of observations, we will accept statistical significance down to the 10% level. Furthermore, we will highlight consistent development that is close to this level. On the other hand, we have used the software package G*Power to calculate the required sample size. The simulations show that our required sample size was 19 (Faul, Erdfelder, Lang, & Buchner, 2007), a level we surpass for all our tests. Please refer to appendix 20 for a complete overview of normality test results.

7.0 – Data for the drivers of PE performance

Data and information from the PE sector are notoriously scarce and considered to be a *black box*, reserved for insiders and invited investors. We partly overcome this hurdle by using information on portfolio companies held by PE firms, as they are obliged to report their financial statement in accordance with the national laws.

7.1 – Data collection for drivers of performance and performance calculation

We start by computing IRR and performance indicators. After identifying PE firms who have invested or are currently invested in Nordic portfolio companies, we identify portfolio companies that have most of their operations in Nordic oil and gas, by assessing their revenue sources. PE firms are identified using the venture capital and PE associations in the regions, the Zephyr database, and a dataset of PE deals from the Argentum Centre for Private Equity at The Norwegian School of Economics. Potential performance drivers are calculated using the financial statements of the portfolio companies, downloaded using the Proff Forvalt database, CVR, and Allabolag (Allabolag, 2017; CVR, 2017). IRR is computed by mapping the cash flow structure of each deal. Entry and exit information is collected using Zephyr, while follow-on funding and dividends are calculated using information on equity injections, dividend payment and ownership structure from the financial statements. Other information sources are examined in the case Zephyr provides insufficient information regarding deal entry and exit value.

For the listed counterpart, we utilize statistics of total annual return to shareholders found at the homepage of The Oslo Stock Exchange (Oslo Børs, 2017a). The same source is used to collect information on listing and de-listing of companies. Data availability narrows the time period studied from 2003 to 2016, inclusive. Similar to the calculation of PE drivers, financial statements are used to compute drivers of listed companies.

The data collection revealed 104 portfolio companies in the relevant industry and region, and sufficient deal information for IRR computation is obtained for 31 of these. Appendix 9 shows the complete list of information sources used to obtain the IRR for each deal. Similarly, performance and performance drivers are calculated for 66 listed companies (see appendix 13).

7.2 – Drivers, control variables, and their predicted impact on PE performance

Table 1 below displays and explains the potential drivers of PE performance studied and their predicted signs, and the control variables used in the multiple linear regression.

Table 1 - Variables and predictions

The table presents the independent variables utilized for our cross-sectional and median regression. Each of the variables are categorized, described, and defined. In addition, predictions for the impact of each variable is presented, in accordance with economic theory.

Variable	Category	Definition	Data Abbreviation	Predictions
Sales growth	Company growth	Natural logarithm of revenue growth calculated as a compounded annual growth rate from entry to exit.	ln_sales	+
EBITDA growth	Operational	Natural logarithm of EBITDA growth caluculated as a compunded annual growth from entry to exit.	ln_EBITDA	+
EBITDAX growth	Operational	Natural logarithm of EBITDAX growth calculated as a compunded annual growth from entry to exit.	ln_EBITDAX	+
EBITDA margin expansion	Operational	Natural logarithm of $\frac{EBITDA}{Sales}$ growth on an average annual basis, calculated from the difference from entry to exit.	ln_EBITDA_margin	+
Current ratio change	Liquidity	Natural logarithm of the current ratio, $\frac{Curr.Assets}{Curr.liabilities}$, growth on an average annual basis, calculated from the difference from entry to exit.	ln_cr	+
Sales to asset turnover growth	Asset turnover	Natural logarithm of the asset turnover, $\frac{Sales}{Assets}$, growth on an average annual basis, calculated from the difference from entry to exit.	ln_ato	+
Debt to equity ratio	Leverage	Natural logarithm of the net-debt-to-equity ratio growth on an average annural basis, calculated from the difference from entry to exit.	ln_der_g	+
Debt to equity ratio entry	Leverage	Natural logarithm of the net-debt-to-equity ratio plus one, at the time of entry.	ln_der	+
Macro and Control Variable				
Stage		Dummy variable set to 1 if initial investment is performed at an eqarly stage	ln_stage	
Oil Price		Natural logarithm of the annual oil price growth during the investment period.	ln_oil	
GDP		Natural logarithm of the annual GDP growth during the investment period.	ln_gdp	

For reasons motivated in subchapter 6.1 regarding the selection of independent variables, the predicted signs of all variables are positive, namely that an increase in these variables positively impacts drivers of PE performance. In the mentioned subchapter, we argued that liquidity will be measured studying the changes in the

current ratio. Leverage change will be measured by studying the changes in the ratio of the net interest-bearing-debt to equity (hereafter debt-to-equity ratio), while the leverage at entry is measured looking at the debt-to-equity ratio plus one.

We previously motivated the use of control variables, to adjust for performance originating from other factors than operating measures in the portfolio company. The *Stage* variable separates mid-stage investments and later-stage investments. A dummy variable is implemented, taking a value of one in case the deal is considered mid-stage, and a value of zero otherwise. The variable coefficient when running the regressions will therefore show the impact on performance of having a mid-stage investment in relation to a buyout.

The impact of oil price on performance is measured by studying the Brent Crude price change. Being the preferred reference price for more than two thirds of the traded oil volume globally (Kaabia, Abid, & Mkaouar, 2016, p. 646), makes it the most relevant oil price data to study. Data are downloaded from the Federal Reserve Bank of St. Louis.

We adjust for the development in the overall Nordic economy, by including the annual growth in the Gross Domestic Product (hereafter GDP) as a control variable. Data on GDP are downloaded from The World Bank's databases.

7.3 – Data description for potential performance drivers: Exploratory analysis

Below is a list with the descriptive statistics of the relevant drivers, using our log-log-transformed dataset. Descriptive statistics for the listed companies are found in appendix 14.

Table 2 - Descriptive statistics of private equity portfolio companies

The table presents the descriptive statistics for our sample of Nordic oil and gas PE deals for the period 2003-2016. All values are reported in percentages. Deals included in this table are used in the cross-sectional regressions, which results are presented in the empirical section in chapter 8.

	N	Average	Median	Min	Max	Standard Deviation
Dependent variable						
Equity IRR	31	36 %	34 %	-40 %	132 %	35 %
Independent variables						
Sales Growth	31	49 %	27 %	-8 %	186 %	52 %
EBITDA Growth	23	50 %	29 %	-18 %	258 %	72 %
EBITDAX Growth	24	43 %	22 %	-18 %	267 %	67 %
EBITDA margin expansion	31	7 %	4 %	-39 %	67 %	16 %
Current ratio change	31	-26 %	-20 %	-361 %	158 %	111 %
Sales to asset turnover growth	31	20 %	13 %	-71 %	111 %	36 %
Debt to equity ratio	25	16 %	3 %	-95 %	205 %	57 %
Debt to equity ratio entry	28	13 %	12 %	-146 %	171 %	77 %
Control variables						
GDP growth	31	5 %	5 %	1 %	7 %	2 %
Oil price change	31	13 %	13 %	-14 %	29 %	11 %

Table 2 provides the descriptive statistics of the 31 deals with sufficient information to compute IRR. The equity IRR has an average of 36%, which may seem high. However, with a standard deviation of similar magnitude, and a minimum and maximum covering a range of 173 percentage points, there is a relatively high dispersion in our dataset. Our dataset suffers from having fat tails, quantified by a kurtosis of 4.2 (see appendix 12). This emphasizes the importance of doing a robustness test, despite not rejecting normality (please refer to 6.1.3). The average holding period is 5 years, close to the average holding period found in the study by Bain & Company on the global PE industry (Bain & Company, 2017).

Furthermore, the averages of revenue-, EBITDA-, and EBITDAX growth are all substantial, but all suffer from having a greater standard deviation than a mean, emphasizing the variation in the independent variables. Some portfolio companies have

a negative EBITDA (EBITDAX) margin at entry and a positive margin at exit, resulting in a loss of 8 (7) observations, as the CAGR is not possible to compute.

The change in current ratio is negative on average, but incurs great fluctuations with a standard deviation of 111%. Coupled with a minimum of -361% and a maximum of 158%, we have some relatively extreme values in our dataset, highlighting the importance of conducting a robustness test. The dispersion and difference between the mean and median for the debt-to-equity ratio, underlines a similar need for robustness testing. The same problem is present for the debt-to-equity ratio at entry.

Finally, the control variables seem to have well-behaving distributions, judging from having similar average and median values, and having relatively small standard deviations. Recall that the numbers show the average annual percentage increase in the variables, and depend on both their values at entry and exit, as well as the holding period.

7.4. – Data limitations for the deal collection and the PE performance data

There are several limitations affecting our data collection and consequently our results when calculating performance and constructing the drivers. We highlight the severest limitations.

7.4.1 – Selection bias and deal complexity

As addressed in subchapter 6.1.3, our data suffers from sample selection bias. This issue is difficult to overcome due to the nature of the PE industry. Indeed, this will affect our results and can potentially threaten the data representability.

Additionally, deal complexity can make accounting data unrepresentative and IRR very difficult to calculate. For instance, a PE firm might engage in a buyout, then demerge parts of the company into many different companies over several years, where the PE firm's stake in some of these new companies are being completely or partly sold off, while others are kept. At the same time, the original company and its identity number might still be intact, but with only a fraction of the assets left. New acquisitions might also occur along the way.

Adding to the complexity issue, is the contractual agreements in a transaction. Contracts that condition the deal value to the future performance of the portfolio

company, such as earn-out contracts, might not be accounted for. This can make our calculation of the IRR shifted downwards.

7.4.2 – Reporting bias and scarcity of transparency

Reporting bias is the selective revealing or suppression of information (Porta, 2014, p. 275). The PE industry is known for its lack of transparency, for a variety of reasons, including less stringent reporting requirements for non-listed companies and due to discretion being vital in their screening process. Furthermore, the lack of transparency can also be a mechanism to safeguard with respect to their reputation, in the case of an unsuccessful deal. PE firms arguably have reputational incentives to carefully select what to disclose or not. Even though we have tried to overcome this limitation by using several databases and other sources, we might have missed some details. On the other hand, we have used the Zephyr database (Zephyr, 2017), that claims to be the most comprehensive database on deal information in the world.

Another limitation is related to financial statements being reported only at the end of the fiscal year. Consequently, holding periods for less than a year makes ascribing accounting information a result of PE performance incorrect. Followingly, ownership information is only obtained if the portfolio company is PE-backed over the fiscal year end. Some companies are also moved abroad or absorbed into another company, resulting in a loss of information.

An issue related to the accounting data, is apparent in the calculation of the IRR. PE firms enter and exit portfolio companies at arbitrary times during a year, and fully ascribing the accounting data development to the PE firm can be misleading. We limit this drawback by setting the entry year to the actual entry year in the case the entry is before the end of June, and set the entry year to the subsequent year otherwise. A similar approach is used for the exit year; if an exit occurs pre-July, we set the year before as the exit.

7.4.3 – Survivorship bias

The survivorship bias is defined as the performance difference between an unbiased and a biased portfolio (Rohleder, Scholz, & Wilkens, 2011, p. 443). Poor performing PE firms seize to report results or do not disclose their acquisitions or exits public. Hence, unfavorable deals are left out of the dataset. This induces what is referred to as positive survivorship bias (Harris, Jenkinson, & Stucke, 2010)

7.4.4 – Calculation limitations

EBITDA CAGR cannot be computed when the EBITDA at entry is negative and becomes positive at exit. EBITDAX CAGR suffers from the same limitation. The debt-to-equity ratio at entry also has a computational problem when using logarithmic numbers. Some portfolio companies have a negative net financial debt and a low equity, making the ratio smaller than -1, which cannot be solved using such a scale.

8.0 – Empirical results for the drivers of PE performance

In this chapter, we discuss the results obtained from running regressions on our dataset, and discuss our findings. We start by analyzing the results from the testing of the drivers of PE performance. Next, we conduct a robustness test, to obtain results that are relatively insensitive to the model assumptions, such as having outliers in the dataset. Followingly, another quality assurance test is performed by assessing whether the same drivers impact the performance of listed companies. Finally, we conclude and summarize our findings, before moving on to the chapters focusing on the performance testing against peers.

Our main focus when running the regressions is to obtain a high $\bar{R}^2$. However, adding or removing variables in a linear regression affects the estimated coefficients, the standard errors, and their p-values. The pitfall might be due to omitted variable bias and inadequate model specifications, and can potentially alter the level of significance for the included variables. If careful consideration of this is ignored, our conclusions might be inapt. To overcome this pitfall, we run numerous regressions to check the changes in variable coefficients and significance. Therefore, table 3 and appendix 15 contain 20 regressions combining different independent variables when assessing potential drivers of PE performance. Similarly, appendix 17 shows numerous regressions for the listed companies.

8.1 – Analysis of the drivers of PE performance

The test results provide evidence of sales CAGR and EBITDA margin expansion being drivers of PE performance. Additionally, despite not being significant in our best model, the current ratio revealed to be significant in some of the tests. As it shows evidence towards explaining IRR, we analyze this driver further. On the other hand, EBITDA CAGR, EBITDAX CAGR, asset turnover, and the debt-to-equity ratios do not provide sufficient evidence to infer any contribution to explaining performance.

Our best model shows an $\bar{R}^2$ of 0.30, and an R^2 of 0.44. As mentioned, the adjusted goodness-of-fit is the key element of the two. The second-best model shows an $\bar{R}^2$ of 0.24, and includes all the same variables as our best model, except for the GDP control variable. No other model has a value above 0.20, and is thus given less emphasis. Furthermore, the F and Wald tests show that we reject both hypotheses on a 1%

significance level. Of the control variables, oil is the only significant variable, at a 10% level.

8.1.1 – Discussing uncovered drivers of PE performance

This section seeks to analyze and explain the economic rationale behind our results, and discuss how this relates to existing research. The following sections will be divided in accordance with the uncovered drivers of performance, ending with a discussion of the independent variables without proven effect.

8.1.1.1 – Sales as a PE performance driver: Discussion and reasoning

Understanding the impact of sales CAGR on the IRR, should be related to two aspects of how value is extracted from a transaction. Firstly, IRR depends upon the exit value that the PE firm obtains from the negotiations. For the terminal value calculation, using multiples from comparable companies and comparable transactions are the two most common methods (Gompers et al., 2016). A common factor for both of these methods, is that sales impact the final valuation. Utilizing multiples, either from comparable companies or transactions, the company valuation depends upon metrics, such as EBITDA, EBIT and earnings. Hence, all else equal, sales growth will positively impact these valuation metrics and followingly increase the exit value and the IRR. Secondly, the divestment type and company size have an impact on the valuation. As PE firms seek to exit through either a trade sale or IPO (Wilton, 2013), sales play an important role. Stock exchanges have listing requirements, such as a minimum market value (Oslo Børs, 2017b). Meeting this criterion will depend upon the size of the company. Furthermore, the characteristics of the company relates to the illiquidity discount rewarded for private companies (Damodaran, 2005). Silber (1991) finds that the discount incurred for private companies is directly related with revenues. Thus, a portfolio company will reduce this discount by obtaining high growth. Not only does sales CAGR follow the mentioned economic rationale, it is also in line with previous research (Acharya et al., 2013) and our initial predictions.

Table 3 - Regression analysis: OLS and Median

The table presents the result from the performed OLS and median regressions with Equity IRR as the dependent variable. Only the three most successful regressions, measured in terms of the adjusted R-squared, are presented for each type. Abbreviations correspond to those introduced in table 1.

	Regression Number					
Driver variables	OLS Regression			Median Regression		
	1	2	3	1	2	3
constant	31.5%***	23.2%**	54.5%*	20.5%***	9.0%	-14.0%
ln_sales	22.1%***	13.6%	19.5%**	24%**	47.8%***	24.6%*
ln_EBITDA						
ln_EBITDAX						
ln_EBITDA_margin	59.3%***	58.7%**	40.7%*	62.8%**	58.6%*	84.3%**
ln_cr	6.3%	5.3%	6.5%	5.1%		
ln_ato					-35.6%	
ln_der_g						
ln_der						
Control variables						
ln_stage	-19.7%*	-18.3%*	-18.2%	-6.4%		
ln_oil		0.93	1.5*			
ln_gdp			-8.25			5.3
Regression Statistics						
R squared	0.30	0.37	0.44			
R squared adj	0.19	0.24	0.30	22.7 %	26.1 %	19.3 %
N	31	31	31	31	31	31
F (m, N-K)	4.72***	4.42***	5.08***			
Wald test	18.90***	22.08***	30.5***			
m, number of restrictions	4	5	6			
K, number of parameters	5	6	7	5	4	4
degrees of freedom, N-K	26	25	24	26	27	27

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

8.1.1.2 – EBITDA margin as a PE performance driver: Discussion and reasoning

Like the economic rationale of sales CAGR contributing to the IRR, EBITDA margin improvements are related to the valuation of the company. All else equal, an EBITDA margin expansion has a positive impact on the valuation using common multiples in the oil and gas industry, such as EV/EBITDA or EV/EBITDAX (Howard & Harp, 2009). The positive and highly significant value for this metric is in accordance with our initial predictions. Furthermore, this indicates that operational improvements are an important driver for PE performance, in line with Meerkatt et al. (2008), and the finding is consistent with research on European portfolio companies (Acharya et al., 2013).

Besides the economic reasoning above, there is evidence that PE professionals target operational improvements such as the EBITDA margin. A recent study by EY, found that more than half of the asked PE firms would mainly prioritize improvements related

to operational performance in the portfolio companies (EY, 2017). Due to this, it reasonable to believe that the EBITDA margin or similar operational improvements are important for the value creation by PE firms, and in line with our findings.

8.1.1.3 – Current ratio as a PE performance driver: Discussion and reasoning

In table 3, we see that an increase in the current ratio has a positive impact on the IRR, but not with the greatest magnitude of the parameters in the model. There are several possible explanations for this observation. Firstly, companies with an unfavorable financial situation, indicated by the current ratio, could have low or negative IRR, due to bankruptcy, liquidation, or trade sales upon unfavorable terms. Secondly, the current ratio might also indicate whether the company is able perform investments during the holding period (Rhodes & Stelter, 2009), that could also contribute to the realized values from the investment. Lastly, it can be argued that the financial health of a company should be reflected in the exit valuation. Whether the investment is exited through a trade sale or an IPO, the acquirers will most likely do a thorough analysis of the company. Hence, an unfavorable current ratio, indicating a less healthy financial situation could lead to a discount for the acquirer, resulting in a lower IRR. Reversely, a positive development of the ratio could lead to a better valuation.

8.1.2 – Discussing remaining variables in the testing of PE performance

In addition to the identified drivers addressed above, we expected *leverage* and *EBITDA CAGR* to yield a positive impact on performance. Notably, most of our deals are below a deal value of EUR 100 million, making leverage less important for the benefit of sales growth, consistent with the findings of Achleitner et al. (2010). The debt-to-equity ratio at entry might not help explain performance not only for the same reason, but also potentially due to debt overhang, in the sense that a higher debt level may impose greater debt overhang (Myers, 1977), leading firms to underinvest in positive NPV projects.

Adding to that, Brigl, Nowotnik, Pelisari, Rose, and Zwillenberg (2012, pp. 8-9) show that using leverage to create value is not an option anymore, due to increased acquisition premiums and lower debt levels in the aftermath of the Financial crisis. Additionally, empirical evidence from A. T. Kearney (2011); (Brigl et al., 2012); Meerkatt et al. (2008) all support the idea of leverage being less important for value creation, and that there is a clear trend towards operational value creation being key for

PE firms. Brigl et al. (2012) claim that operational improvement on both cost and revenue sides of a business is PE's chief source of value today. The time where creating value primarily through either leverage or multiple arbitrage, could be over (Brigl et al., 2012, p. 1).

We have seen that sales growth and margin expansion are key performance drivers. consequently, one would assume the EBITDA CAGR to be an operating driver, too, as the result of higher sales and increasing margins means that EBITDA increases. This might stem from having too few observations on the EBITDA CAGR, as many deals had a negative EBITDA at entry, resulting in a loss of many observations due to calculation limitations. No further analysis will be presented regarding EBITDA in this section.

Notably, *asset turnover* did not help explain performance. Some theories in chapter 5 directs the attention towards a better use of cash and cash efficiency, but not asset efficiency, per se. Conspicuously, the metric was never tested as being an operating driver in the study by Murray et al. (2006), rather it was assumed to be an performance driver. Only nugatory results on such claims are found in our research.

As for the control variables, *oil* was the only variable with sufficient evidence of impacting IRR. However, the *stage* variable has a p-value of 10.5%, and *GDP* of 16.7%. Due to the relatively low p-values, especially for the stage variable, including the variables does contribute, more than the costs of adding them, in explaining performance. Recall that the p-value tells us how likely it is that the variable does not impact IRR, hence the lower it is, the more likely it is to impact performance. In line with Bergholt and Larsen (2016), oil price fluctuations impact the oil sector of oil-exporting countries, including the portfolio companies. In relation to this, GDP also helps explain performance in our selected model. We saw that the correlation between oil and GDP is 62% (appendix 11a), which is in line with the findings of Norges Bank, namely that the oil sector accounts for a significant part of GDP (Norges Bank, 2015). Thus, the GDP variable might help explain PE performance due to the inherent effect of oil on GDP. We also see that the stage variable helps explain performance in our chosen model, as argued when motivating the use of control variables.

8.2 – Median regressions of PE performance drivers

As addressed in the methodology chapter, ensuring robustness is crucial for the quality of our test results and conclusions. Robust estimates give a more comprehensive understanding of the data. Appendix 16 shows that the robustness testing of the performance drivers supports the findings of sales CAGR and EBITDA margin expansion being drivers of PE performance, however it does not provide sufficient evidence of current ratio being a robust driver.

This stresses the importance of running such tests, as median regressions withstand issues with non-normal error terms and outliers. The current ratio has a skewed distribution; hence outliers might be present. Whereas the results obtained in the chapter above studies average impacts and is affected by this skewness, median regressions overcome this shortcoming. In subchapter 7.1.3, we addressed the standard deviation of the current ratio, emphasizing the large dispersion compared to the other variables. It is evident that the skewness and the large dispersion have resulted in a non-normal distribution. Because the driver failed the robustness test, its importance is scaled down for the benefit of sales CAGR and EBITDA margin, both withstanding the robustness test.

8.3 – Testing drivers of listed oil and gas companies

A second quality assurance test is conducted, by assessing the drivers of performance for listed companies. Similar tests as for the PE performance are conducted. Starting by checking the linearity in the expectations, a log-log model is also applicable for the listed companies (appendix 19). Recall that we are using the holding period yield as performance measure for listed companies as the counterpart to IRR for PE firms.

In table 17, we observe that our testing reveals that sales growth, EBITDA margin expansion, leverage increase, and asset turnover impact the performance of listed companies. Additionally, growth in GDP output is significant on a 1% level. With an $\bar{R}^2$ ranging from 0.43 to 0.60 on our most interesting models, one can also highlight their impressive goodness-of-fit in explaining performance. Robustness testing through median regressions are also conducted, and support our findings.

On the other hand, EBITDA CAGR, current ratio and debt-to-equity level at entry do not impact the holding period yield in our data, and the oil price growth is not a significant control variable. Stage is not applicable for this testing.

Consistent with the arguments made by Koller et al. (2015, p. 57), sales growth and margin improvements are key drivers for listed company performance. Interestingly, EBITDA margin is found to be a preferred profitability and valuation metric for oil and gas companies (Francis, Schipper, & Vincent, 2003), as opposed to the conventional profit margin; earnings over sales.

Turning to the control variables, GDP is shown to impact the performance of listed oil and gas companies. Indeed, one would expect increased economic activity, inflation, and an overall heathy economy to aid the sales of goods and services by listed companies.

Even though asset turnover and leverage were found to be a significant driver of listed company performance, they are not investigated further, as these drivers are different from the PE performance drivers. Similarly, analyzing the other variables are not considered purposeful for the scope of this study.

8.4 – Summarizing the results for testing the drivers of performance

Nearing the end of the first part of our thesis, we have identified the drivers of PE performance by regressing IRR on variables stemming from their portfolio companies. We have identified sales growth, EBITDA margin improvement, and the current ratio as drivers of PE performance. Robustness testing reveals that, while sales growth and EBITDA margin improvement are robust measures of PE performance, the current ratio is not. Furthermore, studying the drivers of listed companies reveals that sales growth and EBITDA margin improvement are shared drivers of performance between the two asset classes, also after conducting the robustness testing. While the current ratio revealed to be a driver of PE performance, it was nevertheless not a robust driver and not a driver for performance for listed companies. We choose to study this further, but put less emphasis on the indicator as a driver for performance.

Because there is no reliable measure of return for private companies that are not owned by PE firms, we assume that the drivers of performance are similar to those of portfolio companies. However, we have considered using the development of assets from the

balance sheet to measure performance. We do not recon this measure to be reliable. Gompers et al. (2016) find that the valuation heavily depends upon multiples from comparable companies and transactions. Hence, the book value of assets is not a reliable measure, as it does not take into account how the market values the company, nor is it directly related to the operational measures.

By building our own dataset, motivating quantities used to measure performance, motivating an appropriate selection of model, tests, and independent variables, we have tried to overcome the comparability hurdle faced by researchers and practitioners. Having identified similar performance drivers between PE and peers, namely sales growth and EBITDA margin expansion, we have facilitated a coherent and feasible way to answer our research question.

9.0 – Data for PE performance against peers during oil price shocks

Based on the identified drivers from the first part of our thesis, we now turn our focus to investigating the differences between the development of the performance drivers of PE and those of its peers. We start by compiling a list of the relevant portfolio companies, and similarly for the listed and private counterpart. The development of these drivers during the oil price shocks of 2008 and 2014 is the area of interest for our thesis, and the data collection evolves around the two periods.

9.1 – Data collection for the testing of PE performance against peers

Turning to our list of 104 portfolio companies identified in Nordic oil and gas, we start by finding the companies that were PE-backed during the oil price shocks. As mentioned in chapter 6.2, we set 2006 and 2012 as the base years for the two crashes, respectively. While all relevant information on the portfolio companies and listed peers is available from the data collected when identifying PE performance drivers, we need to collect similar information from the private peers. For the private peers, we accessed the CCGR database from BI Norwegian Business School. CCGR tracks Norwegian companies, paying special attention to the private industry (CCGR, 2017). A careful consideration of institutional ownership is done for the latter, as the owner might be a PE firm, and must therefore be excluded.

Before comparing PE against peers, we need to match the portfolio companies with a listed and private benchmark. To ensure good comparability when comparing the development of the performance drivers, we categorize all companies into sub-sectors according to the historical company description. Since we do not have sufficient information to do this for all the companies, we also categorize according to their NACE code, which is an abbreviation for the statistical classification of economic activities in the European community (Eurostat, 2017). This leaves us with seven sub-sectors: Equipment, exploration, technology, consulting, management services, drilling, and other. Thus, each portfolio company is compared against a portfolio of similar public and private companies.

9.2 – Data limitations for performance testing against peers

The issues stemming from the identification of the drivers will affect the results for the testing of performance against peers. On the one hand, having ensured that drivers of

performance are applicable across investment vehicles, and by running robustness tests in the form of median regressions, we have improved the quality of our results. On the other hand, implicit assumptions are made, such as assuming that the drivers are time-invariant and that our sample is representable for the population.

9.2.1 – Limitations using accounting data for performance testing against peers

The testing of relative performance also uses accounting data, and similar limitations as for the performance driver testing are present here. Firstly, ascribing the yearly driver development to PE firms, that may have entered or exited the companies at any point during a year, is problematic, and we try to limit this issue in the similar approach as we do for the performance driver testing.

Additionally, information on private companies from Sweden and Finland is not as easily accessible as for Norway and Denmark. Another limitation is that the companies studied might have different backlogs, that ensures revenue for different periods of time, even during an oil price shock.

9.2.2 – Bias finding comparable private peers and public peers

We would like to identify peers, where the only difference between the investment vehicles is whether they are PE-backed. This is unquestionably difficult. Indeed, comparability always encompasses ambiguity, in that truly comparable firms are hard to find. For instance, a company producing a special type of well intervention system for drilling companies might in fact have no true comparable peer. Despite adjusting for industry, sub-industry, size, and geographical location, chances are that the companies might not be perfectly comparable, simply because they are not identical. Also, because listed companies have more reporting requirements, portfolio companies have a greater flexibility in that they do not have to disclose the same amount of information. As for the size; listed companies are much bigger than the portfolio companies, and economies of scale might separate the asset classes. Therefore, finding peers in the way proposed, is arguably difficult, and is considered a potential limitation in our research.

Another limitation, is to find relevant private peers outside Norway. The data from CCGR contains information on Norwegian private companies, and a similar list for the other countries is not available through any source known to the authors. Since most of our portfolio companies are Norwegian, the problem is considered miniscule. Once

again, we have an issue with sample selection bias in that not all portfolio companies are identified through our databases.

10 – Empirical Analysis

When comparing the performance of portfolio companies, understanding the causality of the observed differences is pivotal. The development of indicators, such as growth, margins, and liquidity, can be a result of both company specific and external factors. When comparing portfolio companies with those of public and private owners from the same geographical area and during the same time intervals, it is reasonable to assume that differences due to external factors are marginal and possibly removed. Hence, our research is suitable for investigation of company specific factors. Whether relative performance of portfolio companies is a result of the company itself or the involvement of PE firms is also an important distinction. We will use the distinction between screening and monitoring, that has already been explained in chapter 5 – Theory.

10.1 – Analysis of relative sales development through the oil price shocks

In the following subsections, we will perform a comparison and discussion related to the sales development during the oil price shocks.

10.1.1 – Comparison of sales development during oil price shock of 2008

Comparing portfolio and public companies in table 4a, we see that both experience sales growth until 2008, before both groups of companies experience a decrease in 2009. On the other hand, comparing the indexed values, we observe that the portfolio companies experience a significantly greater relative growth. In 2007, the difference equates 32.4 percentage points in favor of the portfolio companies, that increase to 70.9 percentage points in 2009; an outperformance that is statistically significant in all three years.

We observe a similar outperformance by the portfolio companies compared to the private companies in table 4b, as for public companies. Even though the private companies experience an indexed sales increase in 2008, this is lower than that of the portfolio companies. Whereas the portfolio companies experience an indexed growth in 2009, the private companies experience a decrease. The difference is consistently high throughout the period, ranging from 52.4 percentage point in 2008 to 96 percentage points in 2009; a PE outperformance that is statistically significant for all three years.

Table 4 – Relative performance test: Oil price shock of 2008

The tables present the average and median sales values for the period 2006-2009 and the indexed values for the period 2007-2009. Table 4a presents the values for portfolio companies and public equity and the corresponding comparison of the indexed values. Table 4b presents similar values for portfolio companies and private companies.

Table 4a: Performance measures 2006-2009 - PE Portfolio companies compared with publicly owned reference companies

	Portfolio Companies				Reference Companies				Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Sales	2006	2007	2008	2009	2006	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	291322	347105	393951	380955	22574767	26953743	33539108	24996584	156.2	178.1	179.3	105.8	137.3	130.1	50.4	40.8	49.2
Median	11348	65479	101033	80548	1885760	2165485	2877507	2644442	150.9	187.7	205.3	98.8	129.0	125.1	32.4***	53.7**	70.9**
Std. Dev.	481633.7	555087.2	637006.4	628670.8	87599074	106243333	133107864	94445437	74.5	77.3	77.9	10.5	18.6	21.5	77.4	79.5	87.5
P-value															0.01	0.02	0.02
EBITDA margin	2006	2007	2008	2009	2006	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	15.0%	9.5%	9.5%	3.0%	29.1%	30.6%	28.6%	25.3%	68.7	62.3	40.5	107.2	107.9	86.7	-38.5	-45.6	-46.3
Median	15.0%	8.3%	9.3%	7.6%	26.3%	31.4%	26.4%	17.6%	89.2	72.2	79.4	107.7	108.7	93.3	-28.5**	-39.3**	-2.7
Std. Dev.	6.0%	10.7%	15.0%	26.6%	20.4%	20.6%	23.8%	23.0%	58.9	72.9	119.8	8.9	5.9	23.9	52.3	68.7	126.1
P-value															0.04	0.03	0.37
Current Ratio	2006	2007	2008	2009	2006	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	2.4	1.6	1.6	1.4	1.8	1.6	1.4	1.7	94.5	94.7	89.1	96.9	85.1	84.3	-2.4	9.6	4.9
Median	1.7	1.3	1.4	1.2	1.4	1.2	1.2	1.6	80.1	85.0	73.9	104.1	90.7	84.1	-14.9	5.1	-13.0
Std. Dev.	2.1	1.1	1.0	1.0	1.3	0.9	0.7	0.8	67.2	64.0	62.8	10.1	11.8	15.8	66.3	63.7	62.9
P-value															0.51	0.66	0.94

Table 4b: Performance measures 2006-2009 - PE Portfolio companies compared with privatly owned reference companies

	Portfolio Companies				Reference Companies				Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Sales	2006	2007	2008	2009	2006	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	291322	347105	393951	380955	896472	885805	1035730	931871	156.2	178.1	179.3	104.2	118.8	121.6	52.1	59.3	57.7
Median	11348	65479	101033	80548	64785	68632	86888	68980	150.9	187.7	205.3	102.5	122.5	120.7	52.4***	96.0***	80.2***
Std. Dev.	481633.7	555087.2	637006.4	628670.8	5021298	4574243	5677163	4181059	74.5	77.3	77.9				77.4	82.2	81.6
P-value															0.01	0.00	0.01
EBITDA margin	2006	2007	2008	2009	2006	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	15.0%	9.5%	9.5%	3.0%	20.5%	104.0%	2.4%	-10.9%	68.7	62.3	40.5	75.6	73.0	68.4	-6.9	-10.6	-27.9
Median	15.0%	8.3%	9.3%	7.6%	12.4%	8.9%	8.3%	9.4%	89.2	72.2	79.4	87.2	80.7	75.7	2.0	-7.6	14.9
Std. Dev.	6.0%	10.7%	15.0%	26.6%	21.9%	30.4%	32.0%	37.2%	58.9	72.9	119.8				71.4	81.8	127.6
P-value															0.93	1.00	0.79
Current Ratio	2006	2007	2008	2009	2006	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	2.4	1.6	1.6	1.4	3.4	2.5	2.2	3.0	94.5	94.7	89.1	96.5	103.0	106.8	-2.0	-8.3	-17.7
Median	1.7	1.3	1.4	1.2	1.6	1.6	1.2	1.3	80.1	85.0	73.9	100.5	97.7	105.4	-13.8	-8.3	-33.4
Std. Dev.	2.1	1.1	1.0	1.0	7.7	3.9	4.0	7.7	67.2	64.0	62.8				67.7	80.0	62.0
P-value															0.55	0.62	0.10

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

Table 5 - Relative performance test: Oil price shock of 2014

The tables presents the average and median driver values for the period 2012-2015 and the indexed values for the period 2013-2015. Table 5a presents the values for portfolio companies and public equity and the corresponding comparison of the indexed values. Table 5b presents similar values for portfolio companies and private companies.

Table 5a: Performance measures 2012-2015 - PE Portfolio companies compared with publicly owned referencecompanies

	Portfolio Companies				Reference Companies				Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Sales	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	850157	1012591	917598	790940	33813500	31199415	30835288	25070520	126.6	134.3	126.4	108.1	117.7	117.0	18.6	16.7	9.4
Median	275838	387519	425872	317609	2852000	3059807	3389539	3051243	117.1	130.2	103.5	110.1	118.9	117.9	10.8**	13.7	-14.4
Std. Dev.	1892320	2352233.381	1653230	1425365	138255647	121706977	118877027	92106222	50.2	49.2	73.0				49.7	53.6	73.7
P-value															0.03	0.14	0.92
EBITDA margin	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	20.4 %	19.3 %	12.3 %	7.7 %	24.6 %	33.3 %	32.1 %	28.1 %	96.3	66.1	50.3	94.8	86.7	77.3	-3.0	-29.5	-35.2
Median	12.2 %	12.5 %	6.4 %	5.3 %	40.1 %	39.1 %	34.3 %	33.9 %	92.0	75.6	38.4	105.8	90.9	76.5	-13.3	-25.7*	-46*
Std. Dev.	21.0 %	20.8 %	20.8 %	22.7 %	65.1 %	31.0 %	29.1 %	28.0 %	47.2	62.1	94.2				44.6	65.0	94.2
P-value															0.21	0.10	0.10
Current Ratio	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	1.6	1.6	1.5	1.5	1.6	1.7	1.4	1.5	109.8	104.8	108.8	124.4	95.8	88.3	4.7	14.5	34.3
Median	1.2	1.3	1.2	1.3	1.2	1.4	1.3	1.3	99.4	100.7	91.8	129.6	88.7	73.9	-4.7	11.1	20.5***
Std. Dev.	1.0	0.9	1.0	0.7	1.2	1.0	0.8	1.3	44.3	49.8	55.0				45.6	50.6	55.4
P-value															0.961	0.149	0.007

Table 5b: Performance measures 2012-2015 - PE Portfolio companies compared with privatly owned referencecompanies

	Portfolio Companies				Reference Companies				Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Sales	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	850157	1012591	917598	790940	466514	529749	551424	508030	123.8	133.8	121.3	105.2	111.5	91.7	18.6	22.3	29.6
Median	275838	387519	425872	317609	54682	54593	50680	31492	117.1	130.2	103.5	102.6	102.0	86.4	11.2**	18.5**	21.1**
Std. Dev.	1892320	2352233.381	1653230	1425365	1096289	1273607	1261516	1236671	40.6	47.7	56.8				40.6	48.2	61.1
P-value															0.02	0.04	0.02
EBITDA margin	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	20.4 %	19.3 %	12.3 %	7.7 %	25.1 %	19.2 %	21.2 %	15.0 %	96.3	66.1	50.3	88.5	96.5	72.1	7.8	-30.4	-21.8
Median	12.2 %	12.5 %	6.4 %	5.3 %	14.9 %	12.5 %	14.2 %	6.7 %	92.0	75.6	38.4	87.5	95.3	73.8	6.5	-22.2*	-28.9
Std. Dev.	21.0 %	20.8 %	20.8 %	22.7 %	31.2 %	57.2 %	38.5 %	32.1 %	47.2	62.1	94.2				46.6	62.4	96.6
P-value															0.55	0.07	0.12
Current Ratio	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	1.6	1.6	1.5	1.5	3.1	2.9	3.2	2.4	109.8	104.8	108.8	101.8	110.1	98.9	8.0	-5.3	9.8
Median	1.2	1.3	1.2	1.3	1.4	1.3	1.4	1.2	99.4	100.7	91.8	98.8	103.3	95.7	0.6	-19.4	-3.8
Std. Dev.	1.0	0.9	1.0	0.7	6.2	8.0	11.0	4.9	44.3	49.8	55.0				43.9	50.7	55.8
P-value															0.69	0.13	0.71

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

10.1.2 – Comparison of sales development during oil price shock of 2014

Looking at table 5a, we observe the same pattern of sales outperformance by the portfolio companies over public companies in 2013 and 2014, as for the oil price shock of 2008. This outperformance measures 10.8 and 13.7 percentage points in 2013 and 2014, but only the outperformance in 2013 is statistically significant. In 2015, we observe a reversion, with an outperformance by the public companies, but this is not statistically significant.

In table 5b, we observe that the portfolio companies also outperform the private companies throughout the testing period, the same result as for all sales comparisons with public and private companies in this section. In difference from the oil price shock of 2008, the portfolio companies experience a decrease for the indexed sales in the year after the shock, but the decrease is not greater than that of the private companies. As a result, all three years of the testing period show statistically significant outperformance by the portfolio companies.

10.1.3 – Sales development through the oil price shocks: Discussion and reasoning

Comparing across firm type and oil price shocks in table 4 and 5, we find that the most consistent pattern is that of the portfolio companies sales outperformance. During all the testing periods, at least one year show statistically significant outperformance. Interestingly, portfolio companies tend to strongly outperform their peers both during and the year after the oil price shock. On average, the portfolio companies outperform their peers with 40 percentage points in the year after each shock. The outperformance is most distinct when compared to the private companies in table 4 and 5, for which the outperformance is consistent for all years and during both shocks. The fact that portfolio companies outperform public companies in terms of sales is in line with similar research that does not focus on the oil and gas sector, such as Wilson et al (2001).

There are several possible explanations for the sales outperformance. Closely related to the screening aspect is the firm size. As explained by David Wilton, the CIO of the World Banks's International Finance Corporation, there are two important size related explanations for why portfolio companies experience high growth (Wilton, 2013). Firstly, PE firms that successfully invest in smaller companies initiate the growth from

a lower base value than similar, but, larger public and private companies. Secondly, he argues that PE firms will always prefer to exit through a trade sales or IPO, thus, they must target high growth companies which has the possibility to reach an acceptable size that enables to attract buyers or reach the minimum stock exchange listing requirements. Comparing the size of each company type, we observe that the portfolio companies are considerably smaller than both private and public companies in 2006. On average, the private companies are about three times larger, whereas the public companies are 77.5 times larger. In 2012 on the other hand, the portfolio companies are almost 80% larger than the private companies on average, but they are still considerably smaller than the public companies, that are 40 times larger on average. Hence, a screening process that focuses on smaller companies with high growth opportunities could lead to size differences and might contribute to the observed sales outperformance. Such a theory also find backing from Chemmanur et al. (2008), who finds that VC funds invest in companies that on average are more efficient than comparable companies. They also find that this efficiency difference is increased mostly due to sales growth subsequent to the investment. Hence, this could indicate that these firms have better growth opportunities than the comparable companies. On the other hand, such a theory cannot explain the outperformance by portfolio companies compared to private companies during the oil price shock of 2014.

Another explanation is related to the time and resources allocated to the portfolio companies by their PE owners. In the Nordics, funds like Hitecvision and EV (Formerly known as Energy Ventures) are solely invested in the oil and gas sector. As exit opportunities and new investments are scarce in the beginning of the oil price shocks, it is reasonable to assume that such funds would allocate more time and resources to their existing portfolio companies. The resources and time released from exit negotiations and investment searching would likely be used to increase monitoring. Bernstein et al. (2016) find that lower monitoring cost that leads to increased monitoring by PE firms, results in increased performance. Thus, it is likely, that increased monitoring during oil price shocks would result in increased performance for the portfolio companies. Combined with the finding of Chemmanur et al. (2008), namely that most of the performance gains from monitoring by VC funds are

materialized in terms of sales improvements, this theory might explain some of the observed sales outperformance by the portfolio companies.

Overall, the portfolio companies outperform both public and private companies before and during the oil price shocks in 2008 and 2014. Both screening and monitoring abilities are credible explanations. On the other hand, we find it likely that monitoring abilities are pivotal, because the outperformance persists also when the portfolio companies are larger than private companies, such as during the oil price shock of 2014.

10.2 – Analysis of EBITDA margin development through the oil price shocks

In the following subsections, we will perform a comparison and discussion related to the EBITDA margin development during the oil price shocks.

10.2.1 – Comparison of EBITDA margin development during oil price shock of 2008

In table 4a, we see that publicly owned companies have greater margins than the portfolio companies throughout the whole testing period. The difference increases, and the publicly owned companies have almost twice as high margins in 2006 and almost three times as high in 2008, with 26.3% against 15% and 26.4% against 9.3%. Not only are the margins greater, the indexed changes show statistically significant outperformance by the public companies in 2007 and 2008, with 28.5 and 39.3 percentage points respectively. On the other hand, this difference decreases in 2009, and is no longer statistically significant.

Examining table 4b, we find that portfolio and private companies experience a similar negative development for the EBITDA margin during 2007 and 2008. After the oil price shock in 2008, the portfolio companies experience a recovery, visualized as an index increase of 7.2 percentage points from 2008 to 2009. This differs from the private companies, that experience a continuing decline in their indexed EBITDA margins in 2009. On the other hand, none of the differences are statistically significant.

10.2.2 – Comparison of EBITDA margin development during oil price shock of 2014

Similar to the oil price shock of 2008, we find in table 5a that public companies outperform the portfolio companies during the oil price shock of 2014. Even though both portfolio and public companies have experienced decreases in the indexed EBITDA margin through the testing period, the magnitudes of the decreases are greater

for the portfolio companies, with a difference increasing from 13.3 to 46 percentage points from 2013 to 2015. These differences are statistically significant in 2014 and 2015.

Comparing with the private companies in table 5b, we find a slight outperformance in terms of the EBITDA margin in 2013. Except from this year, the portfolio companies underperform compared to the private companies in 2014 and 2015, but for which only the former is statistically significant.

10.2.3 – EBITDA margin development through the oil price shocks: Discussion and reasoning

Gompers et al. (2015) find that PE firms rank margins as the fourth most important selection criteria for portfolio companies. Comparing the EBITDA margins, we do on the other hand see that portfolio and private companies have quite similar margins in both 2006 and 2012, with 15% against 12.4% and 12.2% against 14.9%. Looking at the public companies, we find that portfolio companies have considerably lower margins two years before the oil price shocks. Thus, the fact that PE firms are screening for superior margins is not apparent in our data. It could be that PE firms screen for companies with greater potential for margin improvements, but we are not able to interpret this from our data, thus we will not pursue potential explanations stemming from PE screening capabilities.

Examining the indexed changes for EBITDA margin across the testing periods, we observe that the public companies outperform the portfolio companies. This pattern is consistent during both periods, but with some differences. In the year after the oil price shocks, the developments depart. Whereas the difference narrows after the oil price shock of 2008, the difference widens after the shock of 2014. The recovery of the EBITDA margin observed in 2009, is in line with research performed by McKinsey & Company (2016), which conclude that portfolio companies recover their EBITDA margins significantly faster than public peers. Interestingly, such a development is not observable during the oil price shock of 2014. Furthermore, this development is not similar when we compare with private companies. Portfolio and private companies are not performing significantly different during the oil price shock of 2008, but the private companies significantly outperform the portfolio companies during 2014. These

variations make it interesting to study the decomposition of the EBITDA margin, as it might help us uncover the reason for the inconsistency.

In appendix 21 and 22, we see that portfolio companies have considerably higher indexed sales increases during all periods. These differences are statistically significant during three out of four comparisons. On the other hand, the EBITDA development is only significantly higher for the public companies, but only in the years after the oil price shocks, namely in 2009 and 2015. This shows that portfolio companies' underperformance in terms of EBITDA margins predominantly originates from their own sales growth outperformance. Hence, we would like to revisit our already mentioned hypothesis, that portfolio companies focus on sales growth during the oil price shocks. Such a hypothesis does not support our identification of EBITDA margin improvements as an important driver for PE firms' performance. There could be several reasons for such a discrepancy.

Firstly, the margin improvement is measured as the margin difference between the time of entry and exit. As a result, margins might be improved in the period before exit, and lower margins during the holding period would not affect the valuation. Assuming that the period during and consecutive to the oil price shock is not a favorable exit period; a margin improvement might be postponed to years outside of our testing periods and closer to the exit.

Secondly, the observed results might stem from the governance approach utilized by the PE firms. According to a report from the management consulting firm, A.T. Kearney, it is possible to divide PE firms into two categories, dependent upon their governance model (A.T. Kearney, 2013). Supervising funds tend to trust existing management, and support the firm with strategic advice and capital. This contrasts with operating funds, who tend to take control, deploying own consultancy divisions to the portfolio company and take control of the portfolio company when needed. Their research show that operating firms tend to focus on EBITDA growth. Hence, if the PE firms behind our portfolio companies are predominantly supervisors, it might be that EBITDA growth is not as highly prioritized compared to other groups of PE firms.

Finally, the cost cutting required to maintain the EBITDA margin during the oil price shock, might be more attractive for public companies. Due to investor scrutiny, public

companies that lose profitability might be penalized in terms of lower valuations and a decrease in the stock price. If the management is economically incentivized to focus on a high stock price, cost cutting and postponing projects could be more interesting than actively seeking new growth opportunities. In contrast to the management of public companies, management of portfolio companies might be more incentivized to obtain growth. PE firm that are determined to support their portfolio companies through the oil price shock must incentivize the management of the portfolio company to obtain a minimum size to qualify for either a trade sale or IPO upon exit (Wilton, 2013). This might explain why public companies have higher indexed EBITDA growth in both 2009 and 2015, both statistically significant.

10.3 – Analysis of relative current ratio development through oil price shocks

In the following subsections, we will perform a comparison and discussion related to the current ratio development during the oil price shocks.

10.3.1 – Comparison of current ratio development during oil price shock of 2008

Comparing the current ratio with public companies in table 4a, we observe that the portfolio companies experience a greater decrease throughout the oil price shock of 2008. The indexed changes also confirm a similar development, but the difference is not statistically significant in any of the years.

Inspecting the current ratio in table 4b, we observe an opposite pattern, where the portfolio companies experience an increase in 2008, before a decrease in 2009; the exact opposite of the private companies. These differences are not statistically significant, but the private outperformance in 2009 is close to the 10% threshold.

10.3.2 – Comparison of current ratio development during oil price shock of 2014

In table 5a, we observe that the differences in the current ratio in 2013 and 2014 follow the same pattern as for 2007 and 2008, where the portfolio companies experience a lower decrease in the indexed changes, turning the difference from 4.7 percentage points in favor of the public companies to a difference of 11.1 percentage points in favor of the portfolio companies. In difference from the oil price shock of 2008, the portfolio companies continue this relative outperformance also in the last year of the

testing period, resulting in a statistically significant difference of 20.5 percentage points in 2015.

Comparing the current ratio of portfolio and private companies in table 5b, we find the same pattern as for the oil price shock of 2008. During the year of the shock, 2014, the private companies strengthen the current ratio, compared to the portfolio companies and this continue in 2015, but at statistically insignificant levels.

10.3.3 – Current ratio development through the oil price shocks: Discussion and reasoning

When comparing the current ratio, there are some things that must be considered. Having a greater current ratio does not indicate greater performance by itself, as each individual company must balance current assets and liabilities in such a way that secure efficient use of assets. The current ratio does on the other hand provide an indicator of the liquidity of the companies. Hence, comparing the development of the current ratio through oil price shocks provides us with a proxy of how the companies can serve their liabilities. A low ratio, that is close to or less than one, indicate that the company might need additional funding to meet commitments, as debt holders might file for bankruptcy. Furthermore, the ratio is also used by financial institutions as a debt covenant (ECB, 2014). Considering the oil price shocks, the current ratio could indicate the health of the companies and how close the companies are to a potential bankruptcy or increased cost of debt. For a PE firm, it is likely that selling or liquidating portfolio companies during such a market situation might lead to lower return or a loss.

Because the current ratio is established on a yearly basis, we do not find it useful to consider this from a screening perspective, but merely from a monitoring perspective. Most interesting are the differences observed at the year of and after the oil price shocks. These are the years where liquidity would be most important, as portfolio companies are more likely to experience loss on receivables.

Interestingly, we see that private companies consistently have a better development for the current ratio in 2008, 2009, 2014 and 2015. This indicate that these companies have better liquidity during the oil price shocks, which should be viewed as positive. Despite the consistency, the differences are only statistically significant in 2009. Comparing

with the public companies, there is little consistency across the two shocks, but the difference in 2015 is statistically significant, in favor of the portfolio companies.

Examining the decomposition in appendix 22, we find that the private companies' significantly higher current ratio in 2015 is due the portfolio companies considerably higher level of current liabilities, which is also statistically significant. The opposite is true, when comparing with the public companies, which has significantly higher levels of current liabilities, compared to the portfolio companies.

These findings are interesting, as they indicate that private companies consistently seem to be firmer in their control of current assets and liabilities. Because a low current ratio could indicate an increased likelihood of bankruptcy and breach of debt covenants, there are several possible explanations. One possibility could be that portfolio companies are less likely to experience bankruptcy than comparable private companies. Another could be that portfolio companies have different debt covenants than private companies, making it less likely or costly to experience a covenant breach.

Thomas (2010) finds that portfolio companies defaulted at less than one half the rate of comparable private companies during the Financial Crisis of 2008. This indicates that portfolio companies should be less concerned with default and as a result tolerate a lower current ratio. More interesting on the other hand, is to understand why we observe such a difference in default. The author finds that there are several possible reasons, including covenant-lite loans and the possibility for PE firms to perform open-market debt repurchase of the portfolio companies' debt. Covenant-lite loans, which offers better terms and less debt limitations to lenders, are usually offered to PE firms that utilize high levels of leverage. These loans make covenant breaches less likely, and the cost of debt is lower, enabling portfolio companies to have lower current ratios. If the portfolio company have bonds that are traded in the market, the PE firms can perform open-market debt buybacks, even at a great discount to par, enabling the portfolio companies to escape a potential bankruptcy. Thus, our observations could be explained by PE firms' ability to secure better loans for their portfolio companies and taking opportunity of the market conditions to retire portfolio companies' debt at a discount.

11 – Qualitative study of PE performance during oil price shocks

This chapter will provide an overview of our findings from a series of interviews performed with investment professionals from Nordic PE firms and the financial industry. The purpose of the chapter is to shed light on their norms, strategies, and market views, both considering our empirical findings and in general. Finally, the chapter aims to combine the previous chapters of this thesis, by displaying a complete overview of the relations between theory, empirical findings, and the investment professionals' perspective.

11.1 – Data: Interview objects

The Nordic oil and gas sector has been the focus of this thesis. Among the portfolio companies that comprise our datasets, there are several owners. Some of these PE firms are sector investors, focusing solely on oil and gas, whereas others are generalist investors. In addition to interviewing investment professionals from the PE firms, we have interviewed investment bankers. Investment banks play an important role, as they contribute during M&A activity, debt issuance and IPOs. Thus, these professionals have insight into the entry, financing and exit of portfolio companies. Assessing the same situations, such as entry, exit and financing, from different perspectives, enables us to get a more nuanced picture of how the processes are performed, and enables a more thorough analysis.

Among the interview objects are sector investors, such as HitecVision and Statoil Technology Invest. In addition, we have interviewed professionals from generalist funds, such as Hercules Capital, Foinco, and former PE professional Lars Thoresen. Not all interview objects are disclosed, due to confidentiality.

11.2 – Main findings from interviews

11.2.1 – Findings regarding attitudes towards oil price shocks

How PE firms view the opportunities during oil price shocks is important, as it indicates what approach the firms will take in these time periods.

Despite the lower fundamental valuations of companies, all our interview objects believe that buying private companies at such low prices is unlikely, due to resilience from the owners to realize their investments at these levels. Hence, all funds experienced a lower deal activity during the oil price shocks. An explanation, offered

by one of the interview objects, is that people are mainly problem-focused, resulting in target companies and PE professionals focusing on solving the issues at hand, rather than actively seeking new opportunities in the M&A area. On the other hand, another investment professional emphasizes that there exist opportunities to acquire companies in the public market. Due to a more agile pricing mechanism, public companies are priced according to the market conditions and become more attractive for PE firms.

Interestingly, all objects perceived oil prices to be cyclical, emphasizing that the PE firms are prepared for price declines. Even though new opportunities arise during the period, the funds mainly focus on existing milestones and goals, but after considerable rescaling of the portfolio companies. One of the investment professionals also stressed that maintaining the long-term view during this period is critical, as a sale during a downturn would be highly unfavorable.

11.2.2 – Strategies for value creation and tactics during an oil price shock

As explained by one of the professionals, there are four strategies that lead to value creation towards the exit negotiations. Firstly, the fund can focus on increasing sales and build a larger company. All else equal, the valuation would increase in line with the denominator of the pricing multiple, leading to a linear relation between the sales increase and the final valuation. Secondly, the company can optimize operations and cut costs, leading to improved margins. Thus, the improvement will lead to a higher valuation as a percentage increase from the previous margins. Thirdly, the fund can help reestablish the companies' operation, such as acquiring proprietary technology or moving towards a new segment in the market. As a result, the companies can be valuated using a higher multiple. This is often referred to as margin expansion. Lastly, financial engineering encompasses a series of financial techniques, that enables the company to increase its value or returns, often through adjustment of financing, cash flow optimization or take advantage of the tax shield. These four strategies are, according to one investment manager, always considered for each portfolio company.

Interestingly, some of the funds take a reverse investment approach. They first locate potential buyers, in terms of oil and gas companies, and then mold the portfolio companies from the start to fit perfectly with their needs. Thus, the portfolio companies can become a perfect addition to the prospected oil and gas companies, maximizing the synergies, that also allows the PE firm to demand a higher price for the portfolio

company. Moreover, if the opportunity of gaining a favorable market position or the need of a prospected company is deemed to be valuable enough, one of the funds also considers entrepreneurial approaches, such as creating a new company and develop it themselves.

In line with agency theory, all interview objects put emphasis on the importance of aligning managements' interest with that of the PE firm and in accordance with the existing strategy. One investment manager explains this as an exponential relation. If the PE firm loses the investment, the agreement insures that the entrepreneurs will have a similar loss or worse, whereas positive return to the PE firm will result in a greater relative return to the entrepreneurs.

One of the interview objects highlights the PE firm's ability to be objective and perform value chain optimization as key aspects behind the firm's success. He argues that most companies assess cost cutting and sales growth from a relative perspective, where improvements lose priority when certain goals are met. PE firms can contribute with their knowledge of the industry cost levels and have a view of the total sector. Hence, they know where cost improvements can be made and how the company can reposition itself to obtain growth. This is backed by another investment professional, that told us that his PE firm is not afraid of cutting or selling the portfolio companies' most recognized products, if they find the focus on such products to be a hinder for innovation and future growth.

Regarding financial engineering, most of the investment professionals underlined that there are great differences between the PE firms today, and those that operated during the 1980s and 1990s. They all told us that financial engineering today is more related to gaining favorable financing for the portfolio companies. One of the interview objects said that today's target companies are more sophisticated than those of the past. Small changes in financing and restructuring of assets, such as selling assets to third parties and rent it back (called sale-and-leaseback agreements), are not profitable on its own.

Turning the focus towards tactics and management during oil price shocks, there is little difference between the funds, according to an investment manager from a leading oil and gas PE firm. He believes cost cutting and scaling of operations to demand is essential for all portfolio companies. Furthermore, there is also the management

perspective. When asked whether the fund intervene in the operations of the company or keep a supervising role during these periods, all the interview objects lean towards a supervising approach, but all stresses that cash flow control is especially tight during these periods. Due to the uncertainty of future income, cost control is essential, as "cash burning" during such periods is more likely and could lead to bankruptcy from liquidity issues. On the other hand, if a portfolio company shows potential for growth or have important projects during the oil price shock, one investment manager said that the fund is always ready to invest, and that potential liquidity issues will be solved by the PE firm. He also said that the PE firm would not accept that portfolio companies that could generate returns to investors went bankrupt due to short-term liquidity issues. Hence, bankruptcies among profitable portfolio companies is very unlikely during the oil price shocks.

11.2.3 – Findings related to sales growth

Despite cost cutting and downscaling of operations during the oil price shocks, portfolio companies tend to outperform comparable private and public companies. All the interviewed investment managers emphasize the ability and willingness to invest during downturns as an important aspect of the portfolio companies. Portfolio companies can obtain financing for important and profitable projects during the oil price shocks, without being prone to credit restrictions imposed by the banks. The investment managers find this as a point of difference from private and public peers.

Ensuring that the portfolio companies establish themselves in the market early in the investment process is important. One of the sector investors emphasizes that their focus after entry is to ensure that the company obtain high growth and improve their market position, even during oil price shocks. Hence, the company is most focused on the revenue aspects of the portfolio company.

Another interesting aspect, is how much time and resources that are allocated to the portfolio companies. According to the interview objects, the portfolio companies were allocated more of the funds' resources during the oil price shocks. Thus, it is likely that this could affect the performance during the period. One of the investment professionals also emphasized the need for tighter control of the portfolio companies during downturns. He indicated that the extra time and resources was mostly allocated towards monitoring of the portfolio companies' management. Because the

managements' ability to perform well during downturns might not be as good as during normal periods, the PE firm takes extra precaution, as "cash burning" and non-optimal operational decisions are more likely to occur. Hence, the PE firm takes more control to ensure that long term sales growth targets are not losing priority among the management.

11.2.4 – Findings related to the EBITDA margin

Interestingly, all interviewed investment professionals highlight that cost cutting is important during the oil price shock. On the other hand, this cost cutting is not aimed at maintaining margins, but rather is part of balancing the cash flow, to make the company maintain a healthy operation during the period. According to one of the interview objects, his PE firm is willing to run a portfolio company with a zero margin during such periods, as long the portfolio company can continue the existing operations without further funding. In addition, the interview objects underline that the focus is to continue with the long-term development plan after costs and operations reflect the market conditions after the oil price shock. One of the sector investors stressed the importance of margins, but only after the appropriate market position of the portfolio company is reached.

The consideration between margins and sales growth was also exemplified by one of the investment managers, that refers to one of his fund's investments. Despite entering the portfolio company shortly before the oil price shock of 2014, the fund helped the oil and gas company expand into four new location during the shock, both in Norway and abroad. This was done in addition to cost cutting and strict cash flow control for the existing operations. Hence, it serves as an example of how PE firms will focus on margin improvements that ensures continued and healthy operations for the existing company, but does not stop investing in growth opportunities, despite the short-term cost and the overall margin decrease.

11.2.5 – Findings related to the current ratio

Even though the current ratio is commonly used indicator for liquidity, our interviews do not uncover this as an important target. Balancing the cash flow and securing a healthy operation, without the need of further capital injections, was repeated several times during our interviews. Improving the cash flow can impact the current ratio, as the balancing between current assets and liabilities are tightened, and lead to a ratio

closer to one. It can also lead to low values, due to negotiated trade credit with suppliers, that enables later repayments compared to before the oil price shock.

Another aspect is how much risk the portfolio company is willing to accept in terms of liquidity. Loans with covenants restrict most companies from taking too much liquidity risk, as a breach leads to an increase in the cost of debt. Our interviews uncover that both investment professionals and investment bankers are familiar with better loan terms for PE firms and their portfolio companies. Due to long lasting bank relations, a perceived professionalism and high cash reserves, PE firms can obtain more loan at favorable terms. In a case with less covenants, portfolio companies should be able to have lower current ratios, without risking a covenant breach.

11.2.6 – Qualitative study: Discussion and Reasoning

In table 6, we observe that our findings from the study of performance drivers, namely sales growth, EBITDA margin expansion and the current ratio expansion party coincide with our qualitative findings. Discussing the PE firms' priority during the oil price shocks and in general, we find several explanations for the observed over- and underperformance during the two periods.

The focus on increasing the market share and impacting the valuation metrics were mentioned by several of the interview objects. Expanding the company was one of the four value creating strategies that was mentioned. In difference from comparable companies, the PE professionals emphasized their ability to inject growth capital during the oil price shocks, as one of the main drivers of their success. This finding is in-line with previous studies (Bernstein et al., 2017). Furthermore, they also take a more active role during the periods of oil price shock, primarily through monitoring of the management and giving advice. Hence, it is likely that sales growth is a general priority that is also heavily considered during the oil price shocks.

Interestingly, the PE firms prioritize the EBITDA margin in general, despite the underperformance during the oil price shocks. EBITDA was mentioned as a key metric during the valuation process and, according to the investment bankers, it is given more emphasis close to the exit period. On the other hand, maintaining margins was not prioritized during the oil price shocks. Cost cuts were mainly performed to scale the companies' operations to the new demand for products and services, and enable

continued operation without the need of additional financing from the PE firm. Hence, maintaining the EBITDA margin was not a target during these periods.

We did not find any direct relation between the current ratio and our qualitative findings. On the other hand, we did uncover that PE firms can give the portfolio companies cheaper financing at better loan terms than comparable companies. Hence, it can be argued that the portfolio companies can accept a lower current ratio, as the risk of breaching the covenant is lower. Furthermore, PE firms' focus on balancing of cash flows could also lead to a lower current ratio, as better agreements with suppliers should lead to a decrease in the accounts payable turnover.

Table 6 - Summary of findings and theories

The table presents the expectations that are based upon the highlighted theories from relevant literature and reasoning presented in the thesis. Findings from the studies are presented and highlight the most important findings related to each of the uncovered drivers of performance.

Topic	Related Theory	Expectation	Empirical Findings	Qualitative Findings
Performance drivers				
Sales Growth	(Acharya et al. 2013) (Achleitner et al. 2011) (Achleitner et al. 2010) (Meerkatt et al. 2008)	Expected to be positive (+)	One of the strongest and most important drivers of performance (+).	Important in the valuation process, and a pivotal part of the value creation process. The most emphasized among the PE professionals.
EBITDA Growth	(Achleitner et al. 2010)	Expected to be postive (+)	Not found to be significant.	
EBITDAX Growth		Expected to be postive (+)	Not found to be significant.	
EBITDA Margin Expansion	(Acharya et al. 2013) (Achleitner et al. 2011) (Achleitner et al. 2010)	Expected to be postive (+)	One of the strongest and most important drivers of performance (+).	Important in the valuation process. Mostly emphasized after appropriate sales growth has been achieved and before exits.
Current Ratio Expansion	(Brédart 2014)	Expected to be postive (+)	Show a significant and positive relation with IRR. Is not positive using median regressions (+).	Not a common target, but balancing of cash flows and financing opportunities might lead to the finding.
Asset turnover growth	(Murray et al 2006)	Expected to be postive (+)	Not found to be significant.	
Debt to Equity	(Achleitner et al. 2011) (Achleitner et al. 2010) (Meerkatt et al. 2008)	Expected to be postive (+)	Not found to be significant.	
Debt to Equity Entry		Expected to be postive (+)	Not found to be significant.	
PE Performance During Oil Price Shocks				
Sales performance	(Brown et al. 2017)*	Overall outperformance	PE outperformance	The most prioritized metric among the interview objects. Oil price shocks are anticipated, and long-term growth is not sacrificed during these periods. PE firmsrather delay the exit, than to not fulfill the potential of the portfolio company. Hence, growth capital is allocated even during oil price shocks.
EBITDA Margin Expansion	(Brown et al. 2017)*	Overall outperformance	Public outperformance	Margins are not the main priority during oil price shocks. Cost cutting is performed, but with the purpose of balancing cash flows an ensure continued operations.
Current Ratio Expansion	(Brown et al. 2017)*	Overall outperformance	Private outperformance	The current ratio is not a metric especially targeted by the PE firms. Findings can be explained by better debt facilities for portfolio companies, covenant-lite loans, and cash flow balancing.

*Brown et al. (2017) finds an overall ouperformance by PE during decreasing oil prices, and have no predictions regarding the metrics

12 – Conclusion

In this paper, we seek to investigate the relative performance of private equity as an investment vehicle in the Nordic oil and gas industry. The paper is intended for sizable investors seeking exposure to oil and gas, having the opportunity to choose between the investment vehicles private equity, public equity, and direct investments in private companies. By first identifying the drivers of private equity performance studying operating changes in portfolio companies, we facilitate a feasible and coherent approach to compare the drivers of performance of the investment vehicles during oil price shocks. By studying the development of the identified performance drivers through the oil price shocks of 2008 and 2014, we uncover findings that help us answering our research question. Finally, through interviews with private equity professionals and investment bankers, we contribute with reasoning to our findings, with a foundation in the strategies and tactics they use during oil price shocks.

Our results indicate that, during oil price shocks, private equity companies have a strong focus on sales growth relative to comparable investment vehicles, whereas the listed companies focus more on margin improvements, compared to private equity. The strategies and tactics revealed by private equity professionals give similar indications regarding a focus on growth. By utilizing their screening abilities, private equity companies invest in smaller companies with high growth-potential, where they can add investment and industry expertise and apply their monitoring abilities. Consequently, they seek to create a bridge between large industrial companies and small growth companies, tailoring the portfolio company to fit perfectly with the desired attributes in the industry. They focus on the long-term prospects of their portfolio companies and, as they perceive oil and gas as cyclical, the private equity professionals explicate the focus of wearing the downturn and applying strategies to capitalize on the coming upswings in the region, achieving the initial goals they set forth. According to our findings, these tactics and strategies enable the portfolio companies to outperform comparable public and private peers in terms of sales growth. On average, portfolio companies outgrow their peers by almost 40 percentage points the year after the oil price shocks.

We believe our findings predominantly originate from an increased monitoring effort towards portfolio companies, a willingness to provide growth capital, and an ability

to provide favorable loans to portfolio companies, during the oil price shocks. Each of these three abilities address and give reasoning for the observed differences between the investment vehicles, regarding sales growth, EBITDA margin expansion and current ratio expansion.

There is little existing research focusing on oil and gas in the region. Therefore, our thesis contributes to existing literature on private equity performance relative to comparable investment vehicles in three ways. Firstly, we overcome the hurdle of directly measuring performance by undertaking an identification of comparable underlying drivers. Secondly, we combine theories, our empirical findings, and interviews with leading private equity companies in the region. Thirdly, our study sheds light on an important research area for both the economy and potential investors, with little to no existing research on the matter.

13 – Limitations and further research

There are several limitations in our thesis. By explaining the performance of private equity studying the operating changes in their portfolio companies, we do not adjust for differences across private equity companies. Thus, an implicit assumption made, is that a private equity company investing in oil and gas in the Nordics, regardless of origin, experience, and history, will perform equally well. Additionally, adjusting for size differences across deals is not conducted, thus smaller companies might be given a disproportionate weight in explaining private equity performance.

Adding to this, we do not distinguish between different rounds of financing, as all deals are treated equally. We also assume that the drivers obtained from our first part is constant through time. Followingly, when assessing drivers of public equity, we motivate that the holding period yield is comparable to the internal rate of return. No research either for or against this assumption is known to the best of our knowledge, and might not be comparable. Furthermore, even though we motivate how liquidity access is affecting the performance, we do not adjust for the available liquidity of the fund, rather the change in the portfolio company's liquidity position.

As only a few drivers of performance were found to be similar between the investment vehicles, we have not assessed all the drivers of performance across the asset classes, and findings can be improved by finding a way to compare more performance indicators. We propose adjusting for available liquidity for private equity firms, assess opportunities to compare more performance drivers, adjust for the experience of private equity companies.

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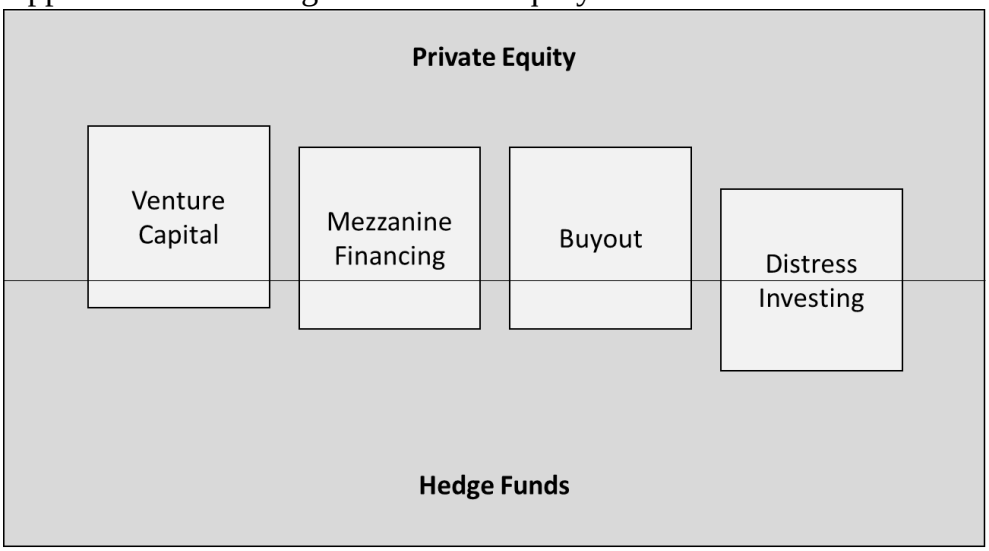
Appendix

Appendix 1 – The stages of Private Equity



Venture Capital

- Funds, not individuals
- Early stage financing

Mezzanine Financing

- Debt funding with participation through warrants
- Usually used for leveraged buyouts

Buyout

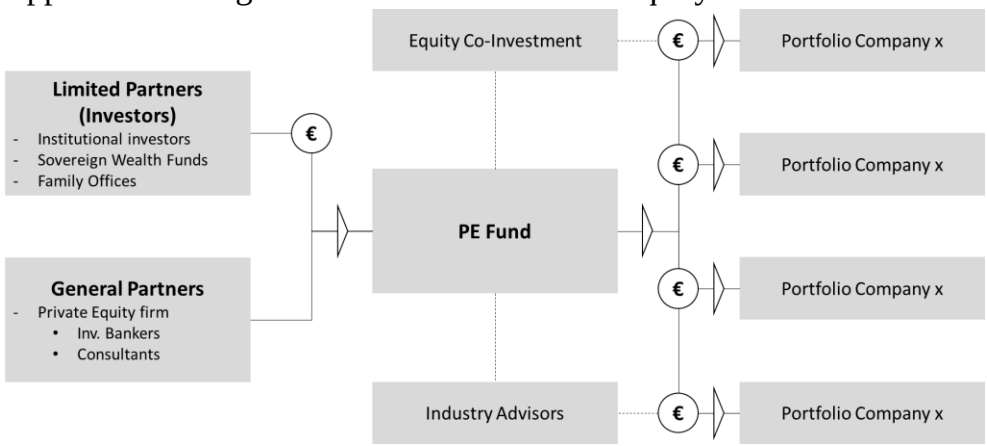
- Buy existing companies
- Often take majority shareholder position in companies

Distress Investing

- Invest in companies under distress
- Often called Special Situations Investing
- Often involve buyouts

Source: Metrick and Yasuda (2010)

Appendix 2 – Organization Chart of Private Equity



Appendix 3 – Statistical model for performance drivers

Cross-sectional multiple linear regression model

$$IRR_i = \beta_0 + \beta_1 Driver_{1,i} + \beta_2 Driver_{2,i} + \cdots + \beta_{j,i} Driver_{j,i} + u_i, \qquad u_i \sim \mathcal{N}(0,1)$$

Where:

- i denotes the specific observation
- u denotes the residual term

Median regression

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

Where the beta values are obtained by minimizing the following equation:

$$\sum \left| y_i - \beta_0 - \beta_1 Driver_{1i} - \beta_2 Driver_{2i} - \cdots - \beta_j Driver_{ji} \right|$$

Please refer to Hao and Naiman (2007) for estimation of standard errors, p-values, and pseudo-R^2

Appendix 4 – Formula and explanation of model

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 5 – Statistical tests for performance drivers

t-statistic and p-values

$$t = \frac{\bar{Y} - \mu_{Y,0}}{\sqrt{\frac{s_y^2}{n}}}, where\ \bar{Y} = \sum_{i=1}^{n} \frac{Y_i}{n}, \qquad s_y^2 = \frac{1}{n-1}\sum_{i=1}^{n}(Y_i - \bar{Y})^2$$

$$p = 2\Phi\left(-\left|\left(\frac{\bar{Y}^{act} - \mu_{Y,0}}{SE(\bar{Y})}\right|\right)\right.$$

Where:

- t is approximately distributed N(0,1) for large n.
- Φ is the standard normal cumulative distribution function

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

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.

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

Appendix 6 – Model assumptions and adequacy tests

Underlying assumptions and diagnostic tests with the relevant regression models

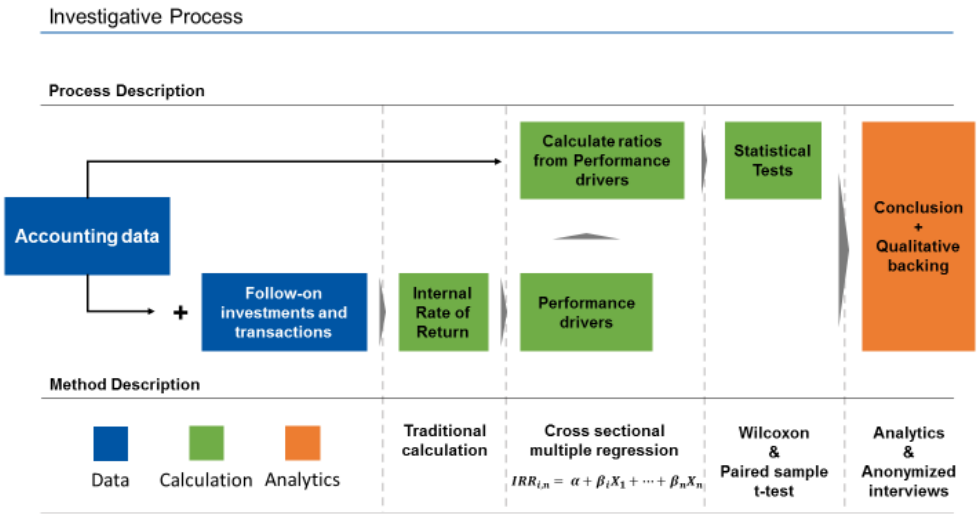
1) The conditional error distribution has a mean of zero
    a. $E[u_i|X_{1i}, X_{2i}, \dots, X_{ki}] = 0$
    b. Violation of results in omitted variable bias, occurring if and only if at least one included regressor is correlated with the omitted variable, and the omitted variable is a determinant of the dependent variable, 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 occurs when a regressor can be written as a perfect linear function of another. The mathematical problem arises because the issue creates a division by zero in the formulas for the coefficient.
    b. A regressor coefficient shows the relative effect on Y by changing a regressor, thus studying the marginal increase when increasing a regressors that at the same time is assumed constant, makes little sense.
    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.
    - Shapiro-Wilk 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 7 – Complete investigative process



Appendix 8 – Formula decomposition for drivers

Driver decomposition	
Variable	**Formula**
IRR	$\ln(1 + IRR_{simple\ return})$, where $IRR_{simple\ return}$ is the rate of return, r, that solves the following polynomial equation: $$0 = -cash\ outflow_{deal\ entry} + \frac{dividend_{yr\ 1} - follow\ ons_{yr\ 1}}{(1+r)^1} + \frac{dividend_{yr\ 2} - follow\ ons_{yr\ 2}}{(1+r)^2} + \cdots \frac{dividend_{hp} - follow\ ons_{hp}}{(1+r)^{hp}} + \frac{cash\ inflow_{deal\ exit}}{(1+r)^{hp}}$$ Where, $hp = holding\ period, the\ number\ of\ years\ from\ entry$
Revenue growth	$\frac{\ln(sales_{exit}) - \ln(sales_{entry})}{holding\ period}$
EBITDA growth	$\frac{\ln(EBITDA_{exit}) - \ln(EBITDA_{entry})}{holding\ period}$
EBITDAX growth	$\frac{\ln(EBITDAX_{exit}) - \ln(EBITDAX_{entry})}{holding\ period}$
EBITDA margin expansion	$\frac{\ln\left(\frac{EBITDA_{exit}}{Sales_{exit}}\right) - \ln(\frac{EBITDA_{entry}}{Sales_{entry}})}{holding\ period}$
Current ratio change	$\frac{\ln\left(\frac{Current\ assets_{exit}}{Current\ liabilities_{exit}}\right) - \ln(\frac{Current\ assets_{entry}}{Current\ liabilites_{entry}})}{holding\ period}$
Sales to asset turnover	$\frac{\ln\left(\frac{Sales_{exit}}{Total\ assets_{exit}}\right) - \ln(\frac{Sales_{entry}}{Total\ assets_{entry}})}{holding\ period}$
Debt-to-equity ratio	$\frac{\ln\left(\frac{Net\ interest\ bearing\ debt_{exit}}{Equity_{exit}}\right) - \ln(\frac{Net\ interest\ bearing\ debt_{entry}}{Equity_{entry}})}{holding\ period}$
Debt-to-equity ratio entry	$\ln(1 + \left(\frac{net\ interest\ bearing\ debt_{entry}}{equity_{entry}}\right)$
Macro and control variable	
Stage	Dummy variable set to 1 if initial investment is performed at an early stage
Oil price	$\frac{\ln(Brent\ Crude\ price_{exit}) - \ln(Brent\ Crude\ price_{entry})}{holding\ period}$
GDP	$\frac{\ln(GDP_{exit}) - \ln(GDP_{entry})}{holding\ period}$

Appendix 9a – Company Research Overview

	Data Source				Data Usage			
Company	FS	Press Release	Zephyr	Other	IRR	Performance	Removed	Insufficient
2K Tools	x							x
2TD	x						x	
4 Subsea	x							x
Aarbakke	x					x		
Acona	x					x		
ADB Systemer	x	x						x
Add Energy	x					x		
Advantec	x		x	x	x	x		
Agility Group	x					x		
AGR Petroleum Services	x			x	x	x		
Aibel	x		x		x	x		
Align	x					x		
APL	x	x	x	x		x	x	
Appliedsensor	x							x
Apply	x					x		
Aptomar	x					x		
Aquamarine Subsea	x							x
Bandak	x					x		
Beerenberg	x		x	x	x	x		
Bennex	x					x		
Bjørge	x							x
Bladt Industries	x			x		x		
Blueway	x							x
Bridge Energy	x	x	x	x	x			
Competentia	x							x
CorrOcean	x							x
Cubility	x					x		
Deepwell	x							x
Denerco Oil	x				x			
Eastern Drilling	x	x		x	x			
Electromagnetic Geoservices	x	x	x	x	x	x		
Enhanced Drilling	x							x
Epcon Offshore	x	x		x	x			
Esvagt	x							x
Explora Petroleum	x	x		x			x	
Exprosoft	x					x		
FourPhase	x							x
Future Production	x					x		
Gassecure	x	x	x	x			x	
GS-Hydro	x					x		
Halfware	x							x
Hitec Products Drilling	x							x
Hydra Well Intervention	x							x
Hydratech Industries	x					x		
ImniWare	x							x
Interflowcontrol	x					x		
Interwell	x							x
Isurvey Group	x					x		
Lithicon	x	x	x	x	x			
Marine Aluminum	x					x		
Marine Cybernetics	x				x	x		
Master Marine	x					x		
Metron	x	x			x			
Momek Group	x					x		
Mongstad Administrasjon	x							x
Naxys	x							x

Appendix 9b – Company Research Overview

	Data Source				Data Usage			
Company	FS	Press Release	Zephyr	Other	IRR	Performance	Removed	Insufficient
Noble Denton	x					x		
Noreco	x	x	x	x	x			
Norse Cutting and Abondonement	x		x	x	x	x		
Ocean Riser Systems	x	x	x			x	x	
Octio	x					x		
Odim	x	x			x			
Oilcamp	x							x
Omniware	x				x	x		
Petroleum Geo-Services	x					x		
Petroleum Technology Company	x					x		
Petropark	x							x
PG	x							x
Plugging Specialists International	x		x	x	x			
PSW	x							x
Rapp Marine	x					x		
Reef Subsea	x	x	x	x			x	
Reelwell	x							x
Reservoir Exploration Technology	x	x			x			
Resman	x		x	x	x	x		
Revus Energy	x		x	x	x			
Roxar	x		x	x	x			
Safran	x							x
SAR	x					x		
Scan Geophysical	x	x	x		x			
Seabox	x		x	x				x
Seagull	x							x
Sekal	x							x
Sense EDM	x						x	
Sense Intellifield	x				x			
SH Group	x					x		
Spring Energy	x							x
SPT Group	x			x	x	x		
Stimline	x			x				x
Stream	x							x
SubC Partner	x							x
Tampnet	x				x	x		
Technor	x	x	x	x		x		
TracID	x				x	x		
Troms Offshore	x			x	x			
Vector	x		x	x	x	x		
Verdande Technology	x		x	x		x	x	
Viking Intervention Technology	x						x	
Vlaco Group	x							x
Voxelvision	x		x	x	x			
V-Tech	x	x	x	x		x	x	
Welltec	x			x	x			
Ziebel	x					x		
Zi-Lift	x							x

Appendix 10 – Functional form and normality tests for PE drivers

Tests of Normality

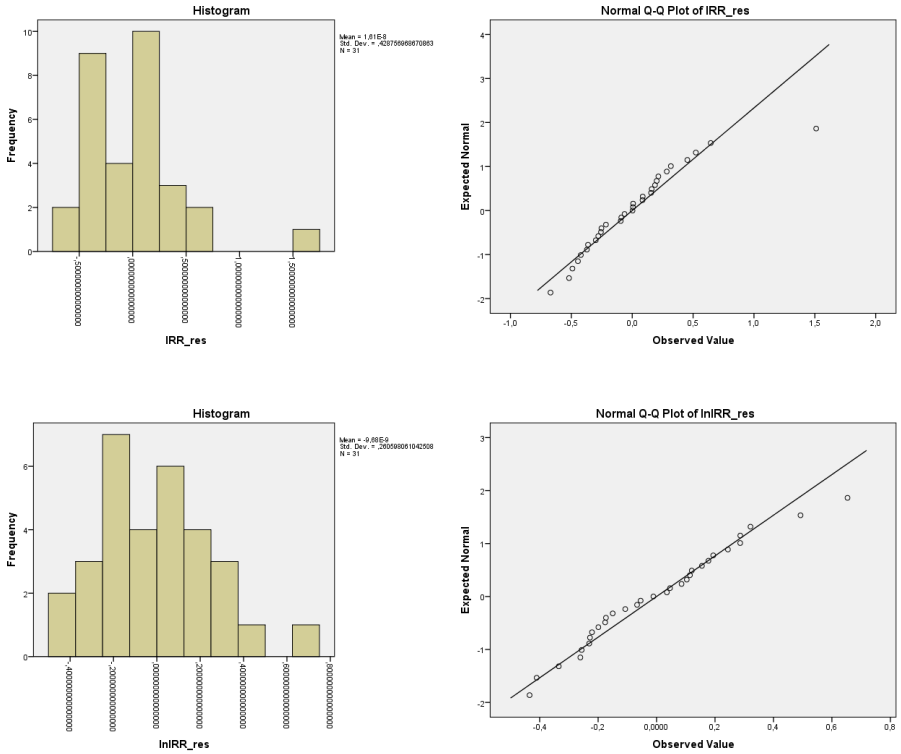
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
IRR_res	,115	31	,200*	,907	31	,011
lnIRR_res	,105	31	,200*	,972	31	,567

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Descriptives

			Statistic	Std. Error
IRR_res	Mean		,0000000161	,0770070249
	95% Confidence Interval for Mean	Lower Bound	-,157269310	
		Upper Bound	,1572693419	
	5% Trimmed Mean		-,032556243	
	Median		,0028740000	
	Variance		,184	
	Std. Deviation		,4287569687	
	Minimum		-,671162400	
	Maximum		1,510376000	
	Range		2,181538400	
	Interquartile Range		,5003609000	
	Skewness		1,410	,421
	Kurtosis		3,884	,821
lnIRR_res	Mean		-,000000010	,0468047935
	95% Confidence Interval for Mean	Lower Bound	-,095588150	
		Upper Bound	,0955881308	
	5% Trimmed Mean		-,009460142	
	Median		-,010958000	
	Variance		,068	
	Std. Deviation		,2605980610	
	Minimum		-,434617700	
	Maximum		,6533529000	
	Range		1,087970600	
	Interquartile Range		,3984108000	
	Skewness		,469	,421
	Kurtosis		-,060	,821



Appendix 11a – Test result from multicollinearity assessment

Correlation Matrix										
Metric	ln_IRR	ln_sales	ln_EBITDA_margin	ln_cr	ln_ato	ln_der_g	ln_der	ln_stage	ln_oil	ln_gdp
ln_IRR	100 %									
ln_sales	19 %	100 %								
ln_EBITDA_margin	26 %	8 %	100 %							
ln_cr	20 %	-20 %	24 %	100 %						
ln_ato	12 %	88 %	4 %	-26 %	100 %					
ln_der_g	-22 %	-43 %	14 %	-8 %	-47 %	100 %				
ln_der	8 %	-13 %	-47 %	18 %	5 %	-29 %	100 %			
ln_stage	-29 %	24 %	19 %	-10 %	16 %	-10 %	-36 %	100 %		
ln_oil	43 %	39 %	7 %	15 %	29 %	2 %	-12 %	6 %	100 %	
ln_gdp	5 %	41 %	-14 %	17 %	21 %	-13 %	-29 %	10 %	62 %	100 %

Appendix 11b – Test result from multicollinearity assessment

Variance Inflation Factor		
Metric	**Factor**	
ln_sales	1.06	0.944569
ln_EBITDA_margin	1.15	0.872277
ln_cr	1.08	0.927881
stage	1.11	0.902243
Mean VIF	1.1	

Appendix 12 – Additional information for IRR

Equity IRR	
Descriptives	
Number of deals	31
Average	36 %
Median	34 %
Minimum	-40 %
Maximum	132 %
Standard deviation	35 %
Skewness	0.5
Kurtosis	4.2
Return per unit risk	1.03 %
Average holding period	4.97
Number of PE firms	17

Appendix 13 – Listed Company Research Overview

Ticker	Company	Ticker	Company
AGR	Ability Group	IMSK	I.M. Skaugen
AKER	Aker	IOX	Interoil Exploration&Production
AKFP	Aker Floating Production	KIT	Kitron
AKVER	Aker Kværner	KOG	Kongsberg Gruppen
AKSO	Aker Solutions	KVAER	Kværner
ALX	Altinex	MSEIS	Magseis
AURLPG	Aurora LPG Holding	MCG	MultiClient Geophysical
ALNG	Awilco LNG	NORTH	North Energy
AWO	Awilco Offshore	NOI	Northern Oil
BXPL	Badger Explorer	NOR	Norwegian Energy Company
BERGEN	Bergen Group	OCR	Ocean Rig
GAS	Bergesen Worldwide Gas	OCY	Ocean Yield
BJORGE	Bjørge	OPU	Oceanteam
BON	Bonheur	ODF	Odfjell ser. A
BRIDGE	Bridge Energy	PEN	Panoro Energy
CNR	CanArgo Energy Corporation	JACK	Petrojack
COR	CorrOcean	PGS	Petroleum Geo-Services
DEEP	DeepOcean	REACH	Reach Subsea
DETNOR	Det Norske Oljeselskap	REM	REM Offshore
DNO	DNO	RXT	Reservoir Exploration Technolog
DOF	DOF	ROX	Roxar
EIOF	Eidesvik Offshore	SAGA	Saga Tankers
EMGS	ElectroMagnetic GeoServices	SEVDR	Sevan Drilling
FAR	Farstad Shipping	SEVAN	Sevan Marine
FOE	Fred Olsen Energy	SIN	Sinvest
FOP	Fred.Olsen Production	SME	Smedvig ser. A
FRO	Frontline	SOFF	Solstad Offshore
GRO	Ganger Rolf	SPU	Spectrum
GGS	Global Geo Services	STL	Statoil
GOL	Golar LNG	TEC	Technor
GGG	Grenland Group	TGS	TGS-NOPEC Geophysical Company
HAVI	Havila Shipping	TTS	TTS Marine
HEX	Hexagon Composites	WAVE	Wavefield Inseis

Appendix 14 – Descriptive statistics: listed companies

	N	Average	Median	Min	Max	Standard Deviation
Dependent variable						
Holding period yield	66	-4 %	-2 %	-69 %	113 %	29 %
Independent variables						
Revenue Growth	66	-3 %	3 %	-345 %	82 %	50 %
EBITDA Growth	53	9 %	8 %	-59 %	114 %	29 %
EBITDA margin expansion	61	6 %	0 %	-27 %	232 %	31 %
Current ratio change	66	0 %	0 %	-63 %	129 %	26 %
Sales to asset turnover growth	66	4 %	5 %	-55 %	118 %	26 %
Debt to equity ratio	31	-6 %	2 %	-179 %	52 %	39 %
Debt to equity ratio entry	66	40 %	37 %	0 %	153 %	40 %
Control variables						
GDP growth	66	3 %	4 %	-3 %	8 %	2 %
Oil price change	66	2 %	4 %	-28 %	23 %	12 %

Appendix 15 – Multiple linear regressions for drivers

	Regression Number																			
Driver variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
constant	29.1%**	25.11%**	23.0%**	25.5%**	31.5%***	23.2%**	54.5%*	40.7%	27.5%**	45.2%**	32.3%***	28.1%***	33.4%***	34.2%***	40.1%***	36%***	39.7%***	34.1%***	41.5%***	38.8%*
ln_sales	2.3%	10.9%	19.0%**	18.6%**	22.1%***	13.6%	19.5%**	24.9%**	37.0%***	13.0%	22.0%***	20.3%**	23.5%***							
ln_EBITDA	14.3%																			
ln_EBITDAX		11.5%																		
ln_EBITDA_margin			57.0%**	45%*	59.3%***	58.7%**	40.7%*	54.9%**	0.67***	67.6%***	66.6%*			52.5%**	64.7%**					
ln_cr				7.1%**	6.3%	5.3%	6.5%	6.8%				8.7%**	8.5%**	7.4%*	6.9%	9.4%**	6.8%	11%**	6.0%	9.3%**
ln_ato									-26.9%							10.9%	7.4%	21.2%		
ln_der_g										-12.6%							-3.4%		-6.9%	
ln_der											0.4%							-5.5%		-4.4%
Control variables																				
ln_stage					-19.7%*	-18.3%*	-18.2%	-19.9%*	-20.0%*	-30.8%**	-23.1%***		-15.3%		-15.2%					
ln_oil						0.93	1.5*													
ln_gdp							-8.25	-2.06												
Regression Statistics																				
R squared	0.09	0.11	0.17	0.22	0.30	0.37	0.44	0.30	0.29	0.29	0.26	0.18	0.23	0.15	0.19	0.10	0.05	0.09	0.05	0.05
R squared adj	0.00	0.02	0.12	0.14	0.19	0.24	0.30	0.16	0.18	0.15	0.13	0.12	0.14	0.09	0.10	0.04	-0.08	-0.02	-0.04	-0.02
N	23	24	31	31	31	31	31	31	31	25	28	31	31	31	31	31	25	28	25	28
F (m, N-K)	1.02	7.87**	4.99**	5.9***	4.72***	4.42***	5.08***	4.49***	7.61***	6.3***	6.09***	8.29***	5.59***	7.04***	2.67*	3.46**	0.95	3.29**	1.14	4.4**
Wald test	2.05	15.74***	9.98*	17.71***	18.90***	22.08***	30.5***	22.5***	30.44***	25.2***	24.4***	16.6***	16.8***	14.1***	8.0**	6.9**	2.84	9.86**	2.29	8.8**
m, number of restrictions	2	2	2	3	4	5	6	5	4	4	4	2	3	2	3	2	3	3	2	2
K, number of parameters	3	3	3	4	5	6	7	6	5	5	5	3	4	3	4	3	4	4	3	3
degrees of freedom, N-K	20	21	28	27	26	25	24	25	26	20	23	28	27	28	27	28	21	24	22	25

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Appendix 16 – Median regressions for PE performance drivers

	Regression Number								
Driver variables	1	2	3	4	5	6	7	8	9
constant	23.9%**	20.5%***	23.7%*	18.6%	9.0%	21.3%*	22.5%**	8.1%	-14.0%
ln_sales	26.2%**	24%**	4.7%	12.5%	47.8%***	13.1%	12.0%	15.7%	24.6%*
ln_EBITDA			15.7%						
ln_EBITDAX				13.3%					
ln_EBITDA_margin	85.2%**	62.8%**			58.6%*	42.6%	49.3%	58.4%	84.3%**
ln_cr		5.1%	2.6%	1.2%					
ln_ato					-35.6%				
ln_der_g						6.3%			
ln_der							2.4%		
Control variables									
ln_stage	-17.5%	-6.4%							
ln_oil								0.6	
ln_gdp									5.3
Regression Statistics									
N	31	31	23	24	31	25	28	31	31

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

Appendix 17 – Regressions for listed companies

	Regression Number														
Driver variables	1	2	3	**4**	**5**	**6**	**7**	8	9	10	**11**	**12**	**13**	**14**	15
constant	-3.0%	-2.4%	-5.9%*	-6%*	-6.5%*	-4.5%	-6.7%	-6.9%**	-28.1%***	-31.5%***	-17.2%*	-28.3%***	-5.6%	-4.9%	-17.6%**
ln_sales	20.0%**	35.7%**	50.6%*	51.2%*	27.8%	92.6%***	51.6%*	44.5%*	42.1%**	43.5%**	34.0%*	41.4%**	92.7%***	6.6%	17.8%**
ln_EBITDA		32.4%									17.0%				1.0%
ln_EBITDA_margin			26.5%***	29.7%*	16.6%	32%***	26.8%***	22.6%***	20.3%***	21%***		16.8%*	30.6%***		
ln_cr				-5.6%								5.9%			
ln_ato					30.3%									46.2%	59.9%***
ln_der_g						-14.7%**							-13.1%*		
ln_der							1.6%							-1.2%	
Control variables															
ln_oil								0.65**		-0.30	0.18		0.29		
ln_gdp									6.8***	7.9***	4.6*	6.9***			4.5**
Regression statistics															
R squared	0.12	0.38	0.20	0.20	0.23	0.39	0.20	0.28	0.46	0.47	0.49	0.46	0.40	0.24	0.63
R squared adj	0.11	0.36	0.17	0.16	0.19	0.32	0.16	0.24	0.43	0.43	0.45	0.42	0.30	0.21	0.60
N	66	53	61	61	61	29	61	61	61	61	53	61	29	66	53
F (m, N-K)	5.29**	8.4***	13.86***	9.08***	8.14***	15.71***	9.11***	9.15***	18.44***	16.04***	7.01***	13.73***	12.48***	4.21***	29.18***
Wald test	5.29**	16.81***	27.72***	27.24***	24.42***	47.12***	27.32***	27.44***	55.31***	64.14***	28.05***	54.91***	49.93***	12.63***	116.73***
m, number of restrictions	1	2	2	3	3	3	3	3	3	4	4	4	4	3	4
K, number of parameters	2	3	3	4	4	4	4	4	4	5	5	5	5	4	5
Degrees of freedom, N-K	64	50	58	57	57	25	57	57	57	56	48	56	24	62	48

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

Appendix 18 - Median regressions for listed companies

	Regression Number								
Driver variables	1	2	3	4	5	6	7	8	9
constant	-3.4%	-27.6%***	1.8%	-31.5%***	-11.7%**	-1.4%			
ln_sales	45.3%***	18.2%	83.2%***	24.4%**	28.5%**	43.2%**			
ln_EBITDA					3.6%				
ln_EBITDA_margin	22.8%*	15.6%*	30%***	17.7%**		21.9%			
ln_cr									
ln_ato					65.9%***				
ln_der_g			-19.5%*						
ln_der						-3.3%			
Control variables									
ln_oil				-0.39					
ln_gdp		6.98***	-1.23	8.36***	2.76*				
Regression Statistics									
N	61	61	29	61	53	61			

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Appendix 19 – Function form and normality test for public companies

Appendix 19.1 - Test results and descriptive statistics

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
res_sales_ebitda_cr_gdp	,081	61	,200*	,980	61	,429

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
res_sales_ebitda_ato_gdp	,104	53	,200*	,973	53	,265

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

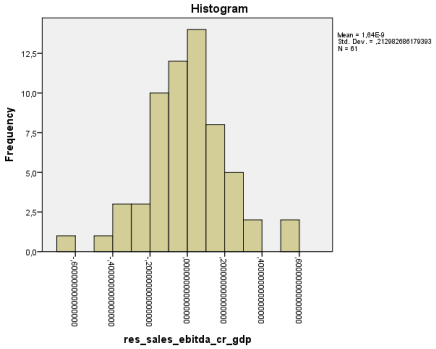
Descriptives

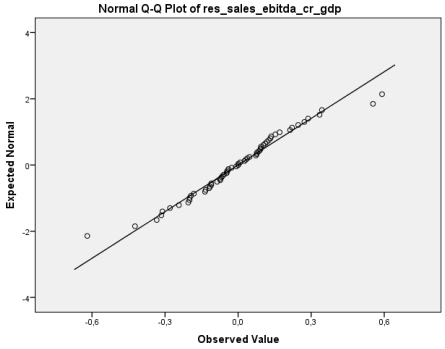
			Statistic	Std. Error
res_sales_ebitda_cr_gdp	Mean		,0000000016	,0272696386
	95% Confidence Interval for Mean	Lower Bound	-,054547397	
		Upper Bound	,0545474004	
	5% Trimmed Mean		-,002057576	
	Median		,0005895000	
	Variance		,045	
	Std. Deviation		,2129826862	
	Minimum		-,619526000	
	Maximum		,5910822000	
	Range		1,210608200	
	Interquartile Range		,2316549500	
	Skewness		,104	,306
	Kurtosis		1,283	,604

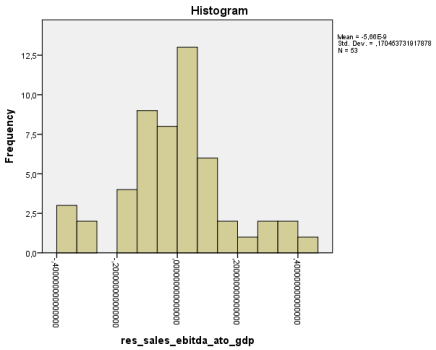
Descriptives

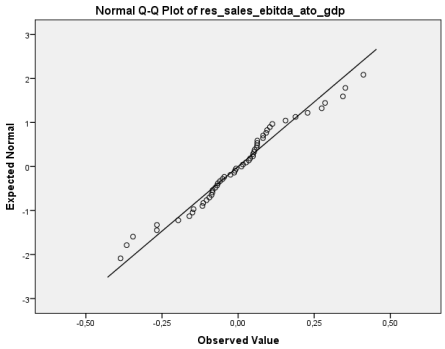
			Statistic	Std. Error
res_sales_ebitda_ato_gdp	Mean		-,000000006	,0234136207
	95% Confidence Interval for Mean	Lower Bound	-,046982873	
		Upper Bound	,0469828616	
	5% Trimmed Mean		-,000231739	
	Median		,0109470000	
	Variance		,029	
	Std. Deviation		,1704537319	
	Minimum		-,386226100	
	Maximum		,4116358000	
	Range		,7978619000	
	Interquartile Range		,1728040000	
	Skewness		,061	,327
	Kurtosis		,506	,644

Appendix 19.2 – Histogram and QQ-plots









Appendix 20 – Function form and normality tests

Appendix 20.1 - Test results and descriptive statistics - Sales

Data summary

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PE_P_Sales_2007	22	75,9%	7	24,1%	29	100,0%
PE_P_Sales_2008	22	75,9%	7	24,1%	29	100,0%
PE_P_Sales_2009	22	75,9%	7	24,1%	29	100,0%
PE_PU_Sales_2007	22	75,9%	7	24,1%	29	100,0%
PE_PU_Sales_2008	22	75,9%	7	24,1%	29	100,0%
PE_PU_Sales_2009	22	75,9%	7	24,1%	29	100,0%

Test results

Tests of Normality

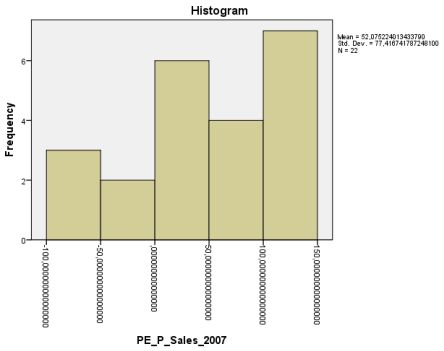
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PE_P_Sales_2007	,137	22	,200*	,922	22	,084
PE_P_Sales_2008	,240	22	,002	,848	22	,003
PE_P_Sales_2009	,264	22	,000	,857	22	,004
PE_PU_Sales_2007	,157	22	,165	,911	22	,050
PE_PU_Sales_2008	,166	22	,115	,876	22	,010
PE_PU_Sales_2009	,261	22	,000	,879	22	,011

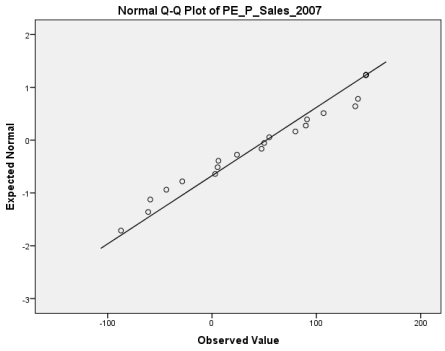
*. This is a lower bound of the true significance.

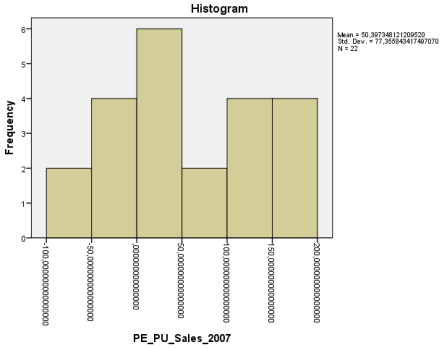
a. Lilliefors Significance Correction

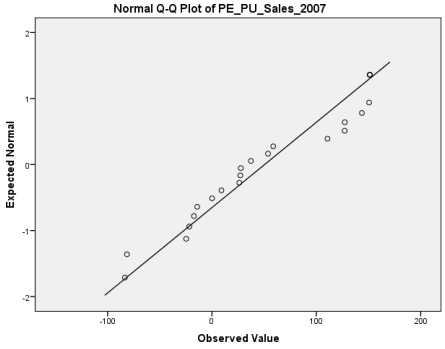
Appendix 20.2 – Histogram and QQ-plots: Sales shock 2008

Graphical description for indexed sales during 2007

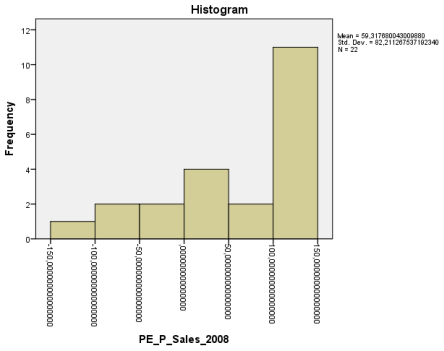


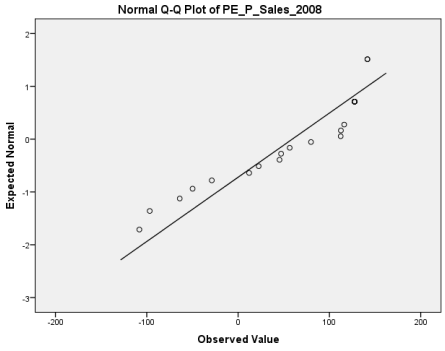


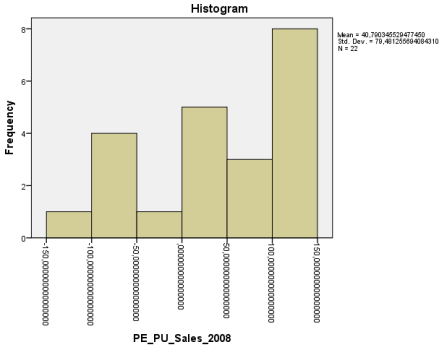


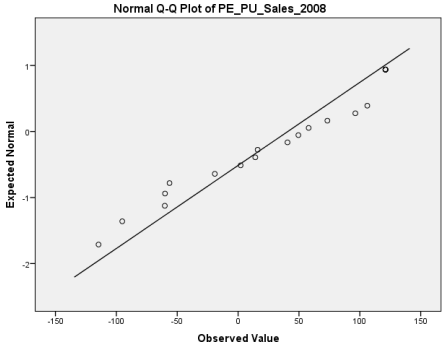


Graphical description for indexed sales during 2008

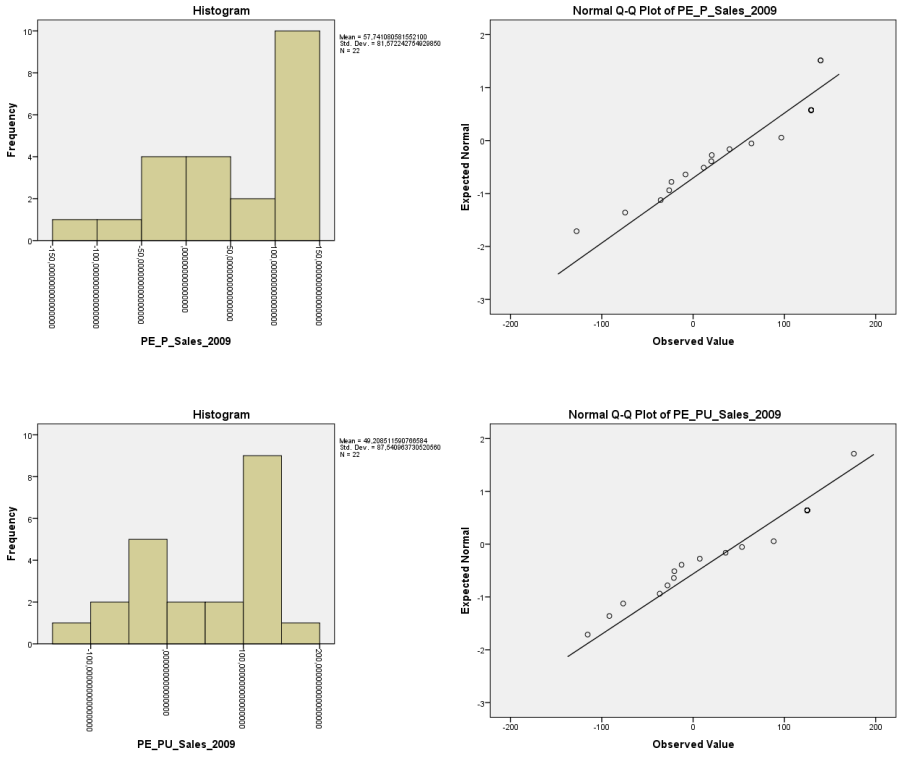








Graphical description for indexed sales during 2009



Appendix 20.3 - Test results and descriptive statistics – EBITDA margin shock 2008

Distribution test – Indexed EBITDA margin during oil price shock of 2008

Data summary

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PE_P_EBITDA_2007	16	55,2%	13	44,8%	29	100,0%
PE_P_EBITDA_2008	16	55,2%	13	44,8%	29	100,0%
PE_P_EBITDA_2009	16	55,2%	13	44,8%	29	100,0%
PE_PU_EBITDA_2007	16	55,2%	13	44,8%	29	100,0%
PE_PU_EBITDA_2008	16	55,2%	13	44,8%	29	100,0%
PE_PU_EBITDA_2009	16	55,2%	13	44,8%	29	100,0%

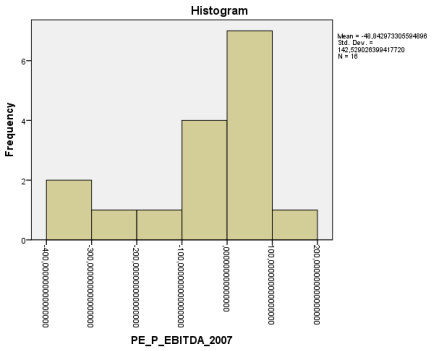
Test results

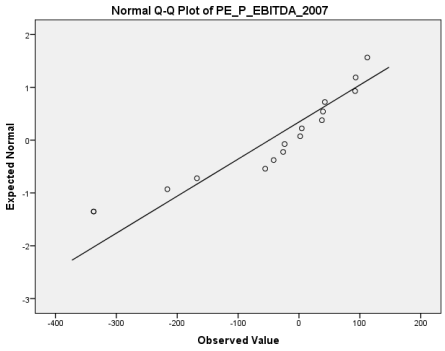
Tests of Normality

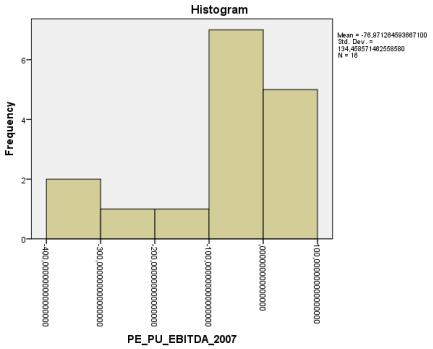
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PE_P_EBITDA_2007	,231	16	,022	,858	16	,018
PE_P_EBITDA_2008	,262	16	,005	,828	16	,007
PE_P_EBITDA_2009	,268	16	,003	,793	16	,002
PE_PU_EBITDA_2007	,246	16	,010	,847	16	,012
PE_PU_EBITDA_2008	,258	16	,006	,841	16	,010
PE_PU_EBITDA_2009	,228	16	,026	,847	16	,013

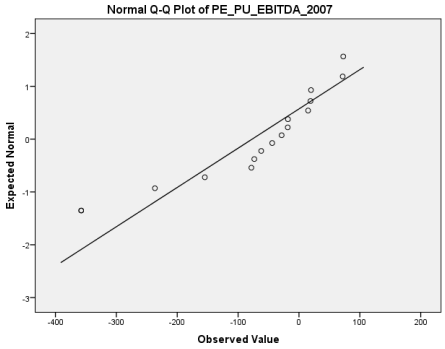
a. Lilliefors Significance Correction

Appendix 20.4 – Histogram and QQ-plots: EBITDA margin shock 2008
Graphical description for indexed EBITDA margin during 2007

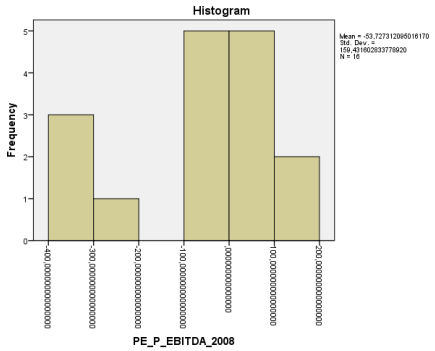


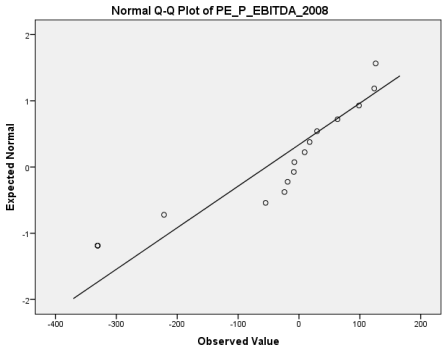


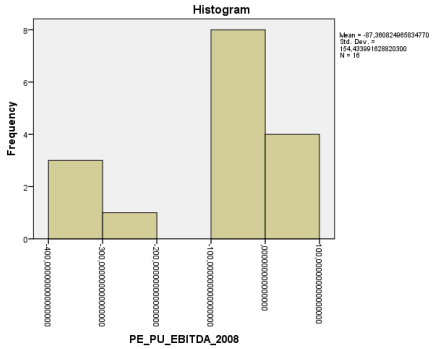


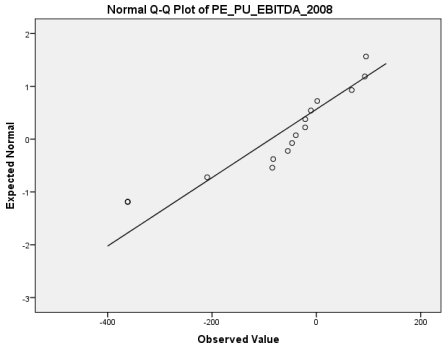


Graphical description for indexed EBITDA margin during 2008

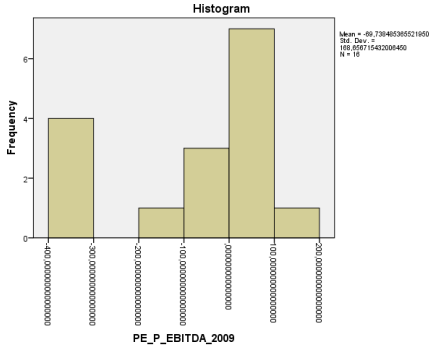


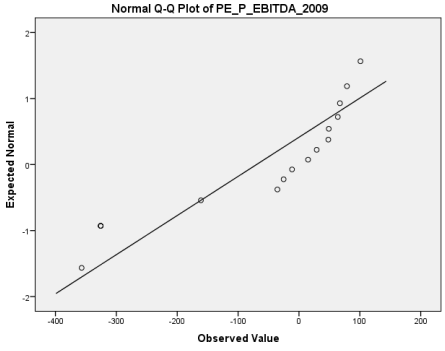


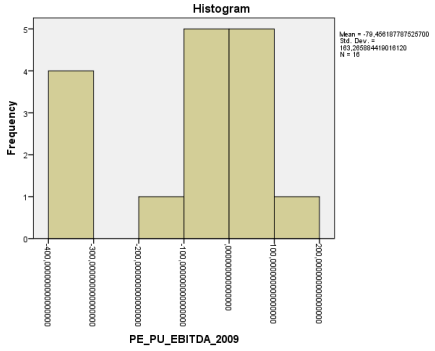


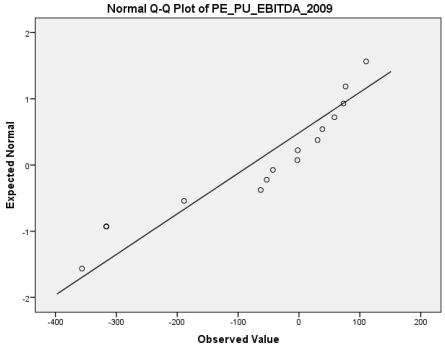


Graphical description for indexed EBITDA margin during 2009









Appendix 20.5 - Test results and descriptive statistics – Current Ratio shock 2008

Distribution test – Indexed current ratio during oil price shock of 2008

Data summary

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PE_P_CR_2007	22	75,9%	7	24,1%	29	100,0%
PE_P_CR_2008	22	75,9%	7	24,1%	29	100,0%
PE_P_CR_2009	22	75,9%	7	24,1%	29	100,0%
PE_PU_CR_2007	22	75,9%	7	24,1%	29	100,0%
PE_PU_CR_2008	22	75,9%	7	24,1%	29	100,0%
PE_PU_CR_2009	22	75,9%	7	24,1%	29	100,0%

Test results

Tests of Normality

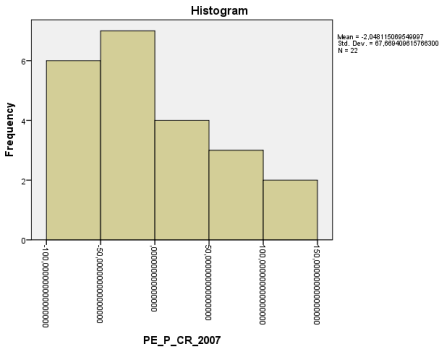
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PE_P_CR_2007	,150	22	,200*	,900	22	,030
PE_P_CR_2008	,092	22	,200*	,983	22	,952
PE_P_CR_2009	,144	22	,200*	,951	22	,334
PE_PU_CR_2007	,115	22	,200*	,925	22	,096
PE_PU_CR_2008	,084	22	,200*	,977	22	,856
PE_PU_CR_2009	,181	22	,058	,950	22	,310

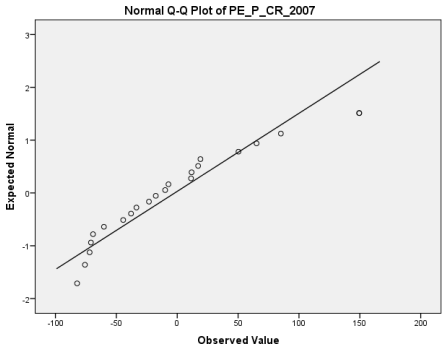
*. This is a lower bound of the true significance.

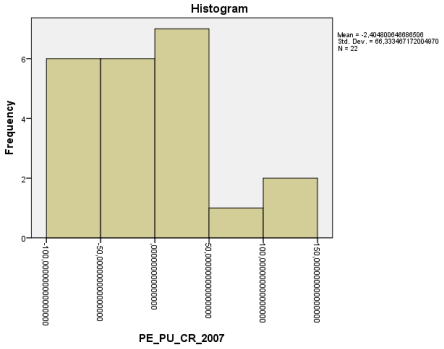
a. Lilliefors Significance Correction

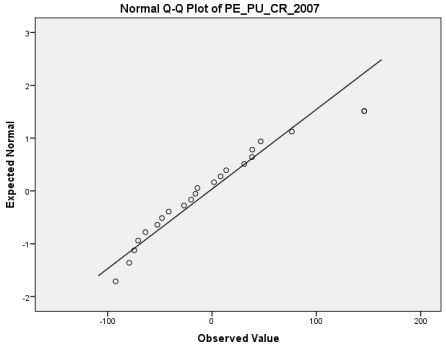
Appendix 20.6 – Histogram and QQ-plots: Current Ratio shock 2008

Graphical description for indexed current ratio during 2007

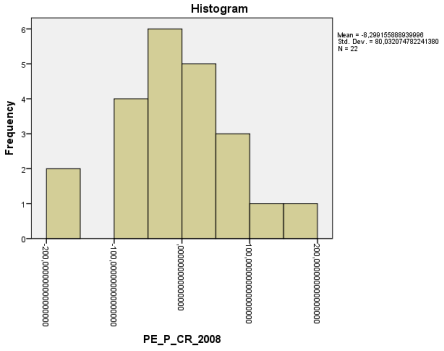


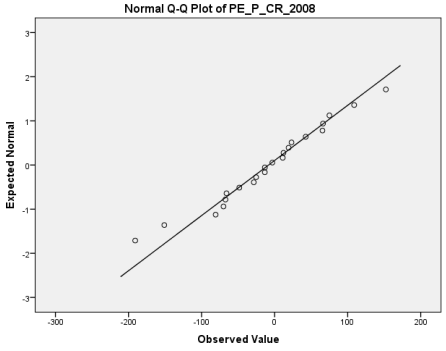


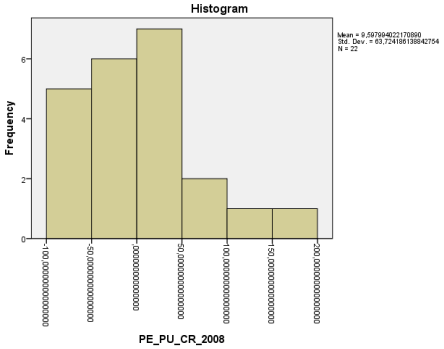


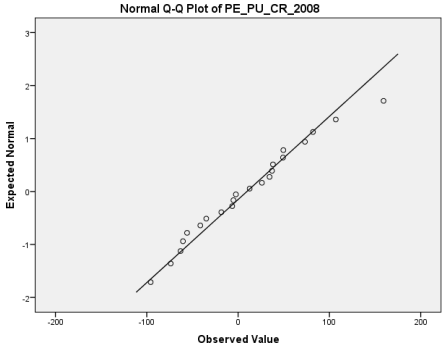


Graphical description for indexed current ratio during 2008

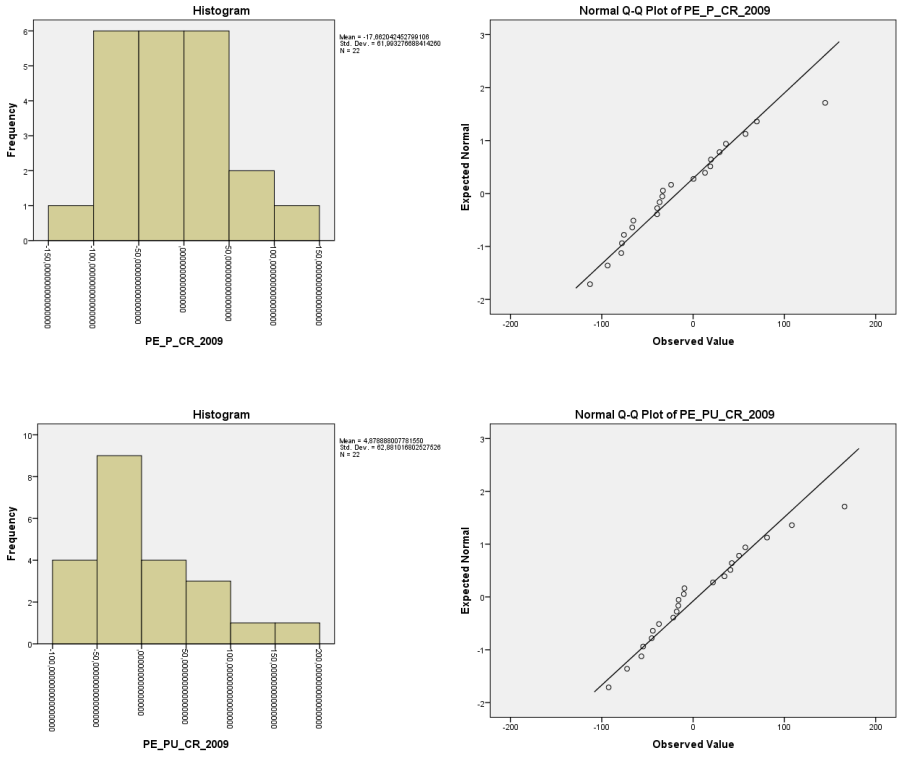








Graphical description for indexed current ratio during 2009



Appendix 20.7 - Test results and descriptive statistics – Sales shock 2014

Distribution test – Indexed sales during oil price shock of 2014

Data summary

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PE_P_Sales_2013	29	100,0%	0	0,0%	29	100,0%
PE_P_Sales_2014	29	100,0%	0	0,0%	29	100,0%
PE_P_Sales_2015	29	100,0%	0	0,0%	29	100,0%
PE_PU_Sales_2013	29	100,0%	0	0,0%	29	100,0%
PE_PU_Sales_2014	29	100,0%	0	0,0%	29	100,0%
PE_PU_Sales_2015	29	100,0%	0	0,0%	29	100,0%

Test results

Tests of Normality

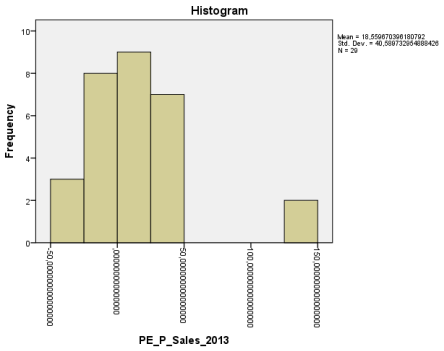
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PE_P_Sales_2013	,200	29	,004	,799	29	,000
PE_P_Sales_2014	,123	29	,200*	,952	29	,205
PE_P_Sales_2015	,127	29	,200*	,949	29	,178
PE_PU_Sales_2013	,283	29	,000	,676	29	,000
PE_PU_Sales_2014	,115	29	,200*	,981	29	,852
PE_PU_Sales_2015	,179	29	,019	,833	29	,000

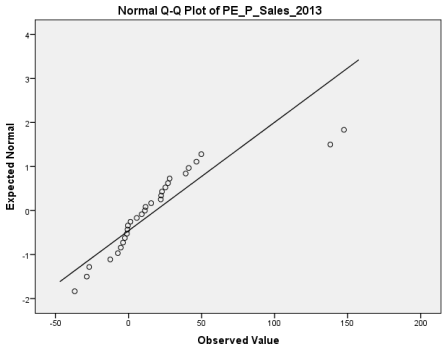
*. This is a lower bound of the true significance.

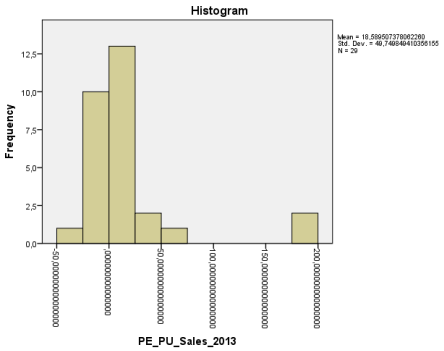
a. Lilliefors Significance Correction

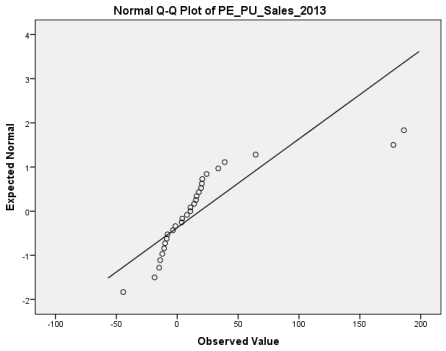
Appendix 20.8 – Histogram and QQ-plots: Sales shock 2014

Graphical description for indexed sales during 2013

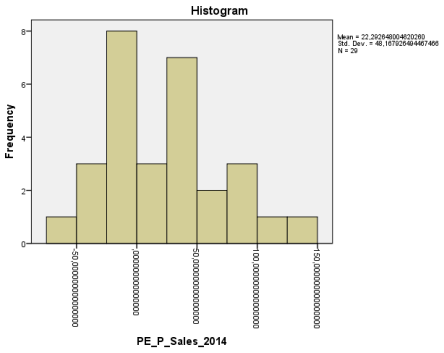


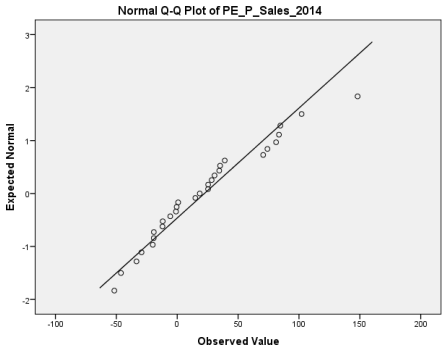


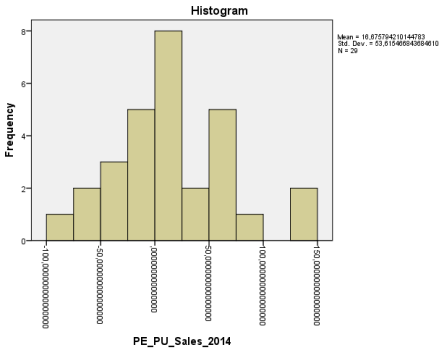


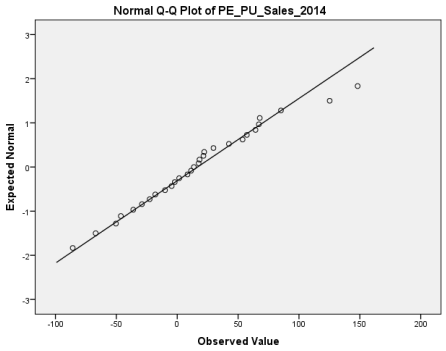


Graphical description for indexed sales during 2014

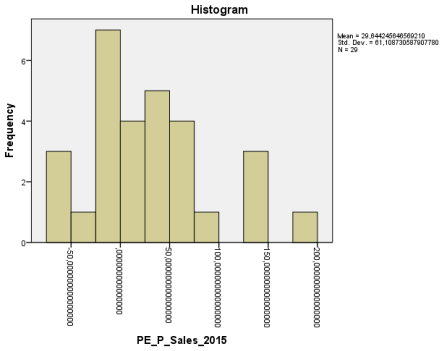


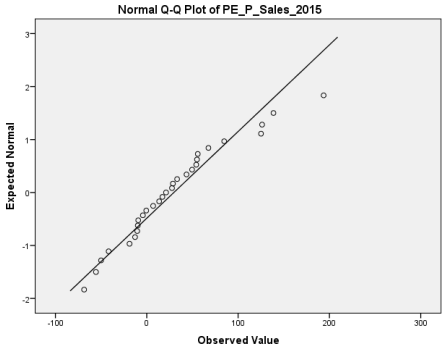


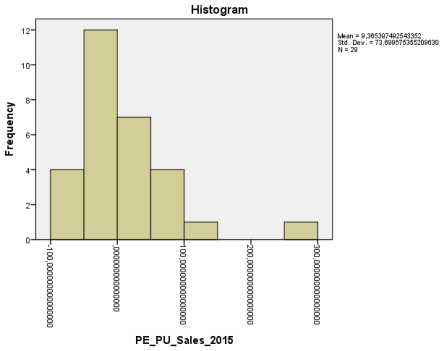


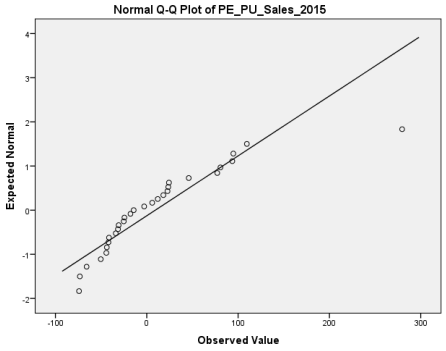


Graphical description for indexed sales during 2015









Appendix 20.9 - Test results and descriptive statistics – EBITDA margin shock 2014

Distribution test – Indexed EBITDA margin during oil price shock of 2014

Data summary

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PE_P_EBITDA_2013	17	58,6%	12	41,4%	29	100,0%
PE_P_EBITDA_2014	17	58,6%	12	41,4%	29	100,0%
PE_P_EBITDA_2015	17	58,6%	12	41,4%	29	100,0%
PE_PU_EBITDA_2013	17	58,6%	12	41,4%	29	100,0%
PE_PU_EBITDA_2014	17	58,6%	12	41,4%	29	100,0%
PE_PU_EBITDA_2015	17	58,6%	12	41,4%	29	100,0%

Test results

Tests of Normality

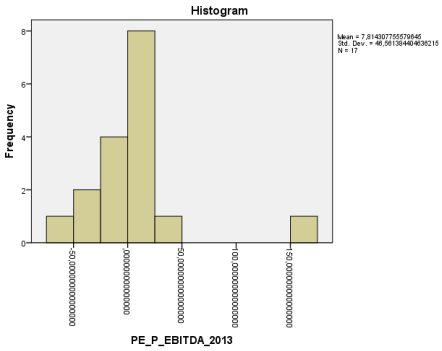
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PE_P_EBITDA_2013	,254	17	,005	,757	17	,001
PE_P_EBITDA_2014	,135	17	,200*	,972	17	,855
PE_P_EBITDA_2015	,192	17	,095	,926	17	,188
PE_PU_EBITDA_2013	,224	17	,024	,765	17	,001
PE_PU_EBITDA_2014	,160	17	,200*	,942	17	,338
PE_PU_EBITDA_2015	,238	17	,011	,903	17	,076

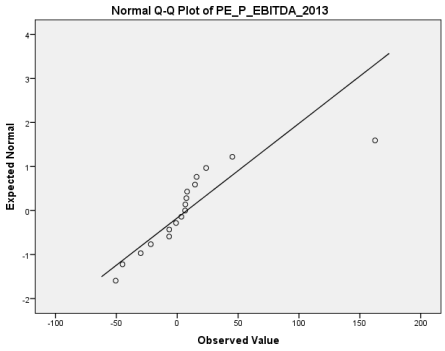
*. This is a lower bound of the true significance.

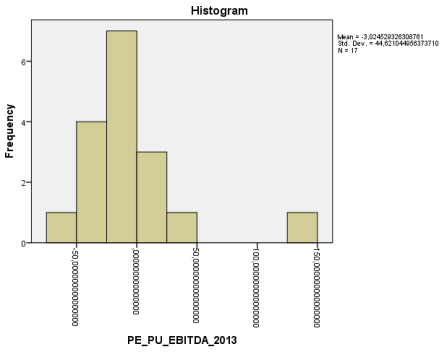
a. Lilliefors Significance Correction

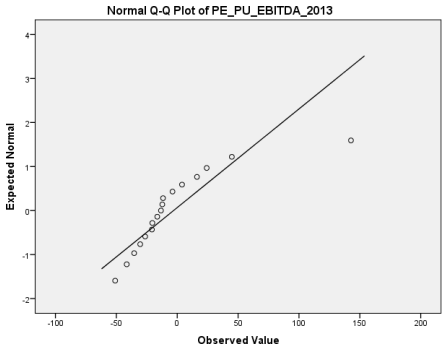
Appendix 20.10 – Histogram and QQ-plots: EBITDA margin shock 2014

Graphical description for indexed EBITDA margin during 2013

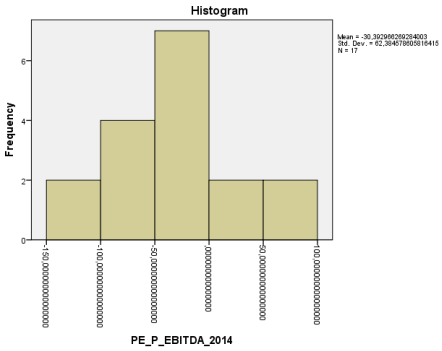


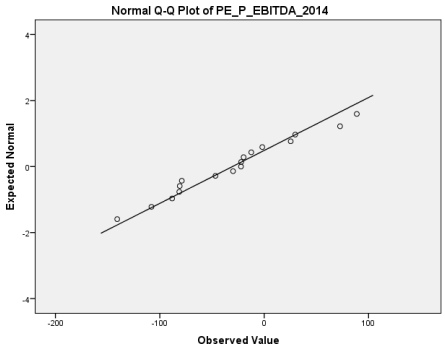


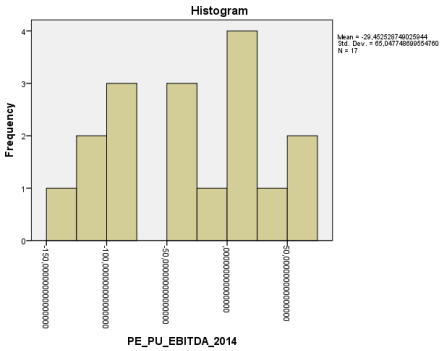


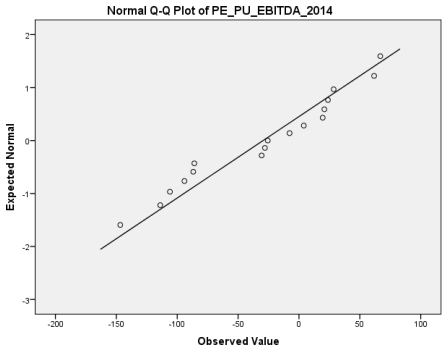


Graphical description for indexed EBITDA margin during 2014

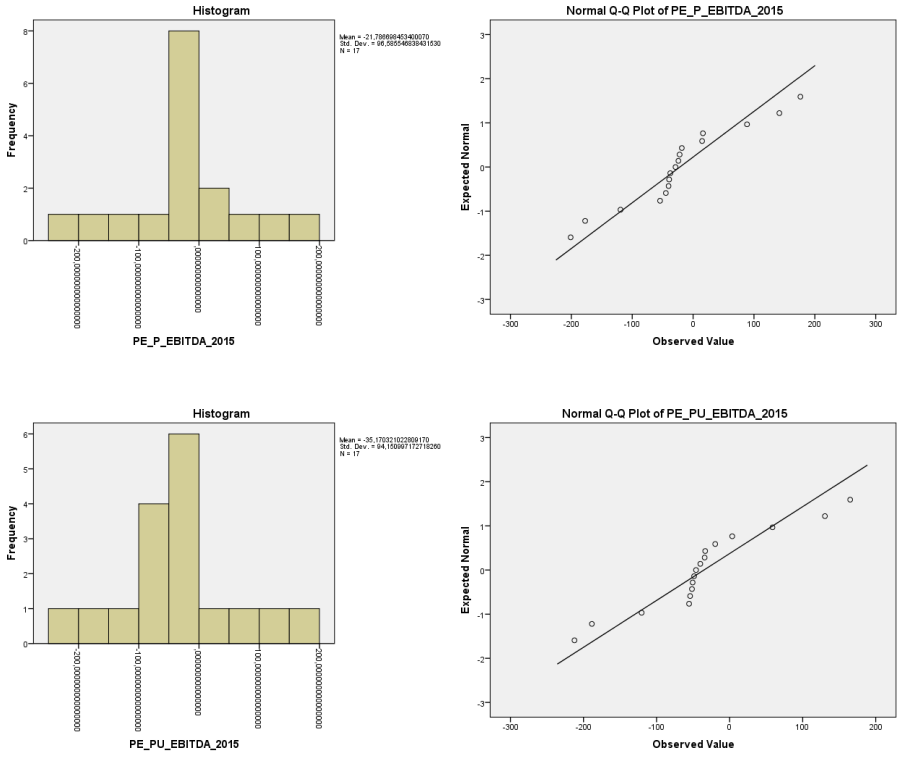








Graphical description for indexed EBITDA margin during 2015



Appendix 20.11 - Test results and descriptive statistics – Current Ratio shock 2014

Distribution test – Indexed current ratio during oil price shock of 2014

Data summary

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PE_P_CR_2013	22	75,9%	7	24,1%	29	100,0%
PE_P_CR_2014	22	75,9%	7	24,1%	29	100,0%
PE_P_CR_2015	22	75,9%	7	24,1%	29	100,0%
PE_PU_CR_2013	22	75,9%	7	24,1%	29	100,0%
PE_PU_CR_2014	22	75,9%	7	24,1%	29	100,0%
PE_PU_CR_2015	22	75,9%	7	24,1%	29	100,0%

Test results

Tests of Normality

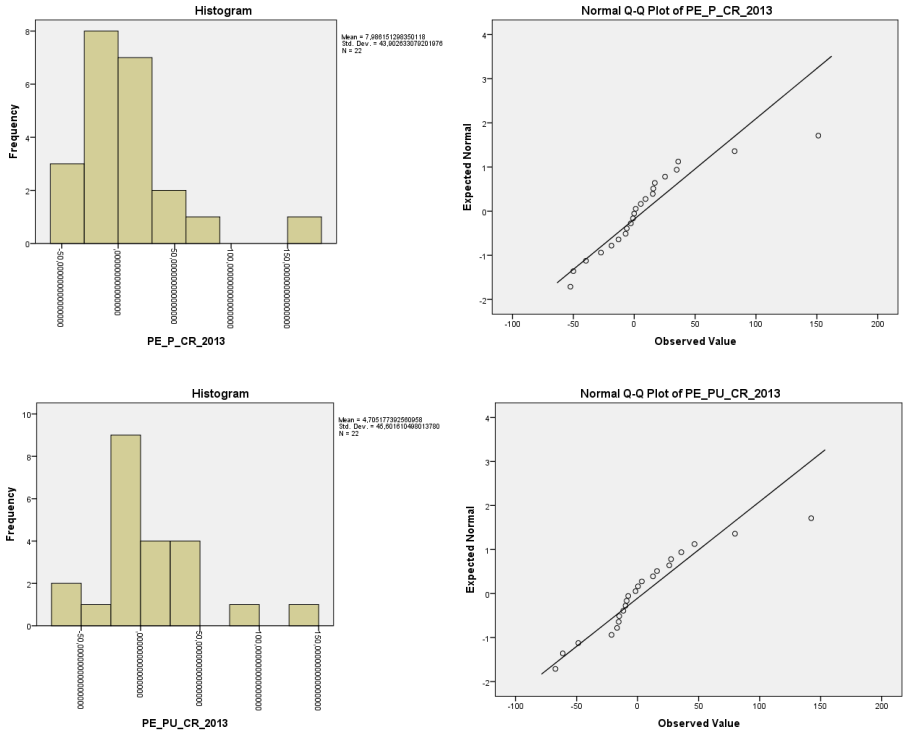
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PE_P_CR_2013	,192	22	,034	,852	22	,004
PE_P_CR_2014	,210	22	,013	,860	22	,005
PE_P_CR_2015	,173	22	,084	,917	22	,067
PE_PU_CR_2013	,148	22	,200*	,900	22	,030
PE_PU_CR_2014	,191	22	,036	,858	22	,005
PE_PU_CR_2015	,177	22	,071	,922	22	,085

*. This is a lower bound of the true significance.

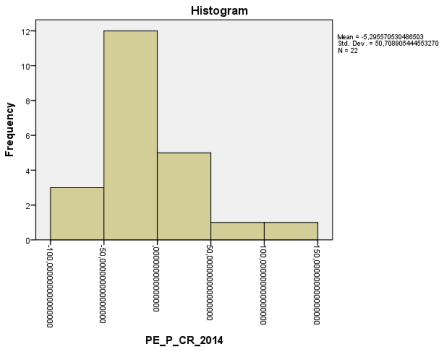
a. Lilliefors Significance Correction

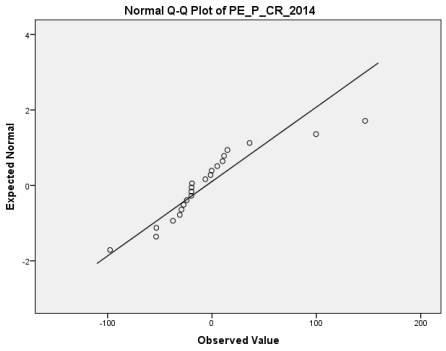
Appendix 20.12 – Histogram and QQ-plots: Current Ratio shock 2014

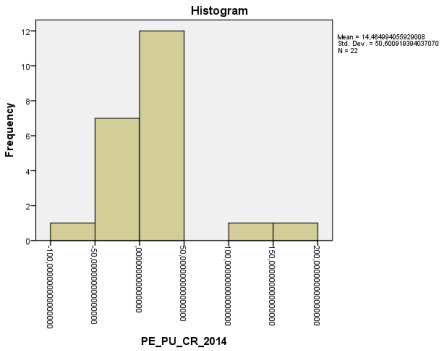
Graphical description for indexed current ratio during 2013

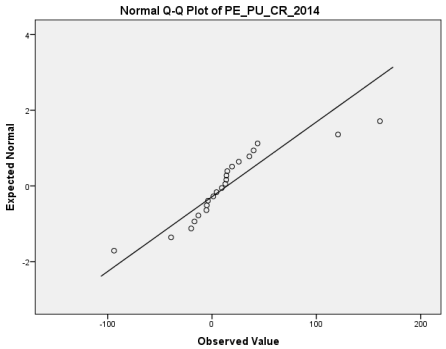


Graphical description for indexed current ratio during 2014

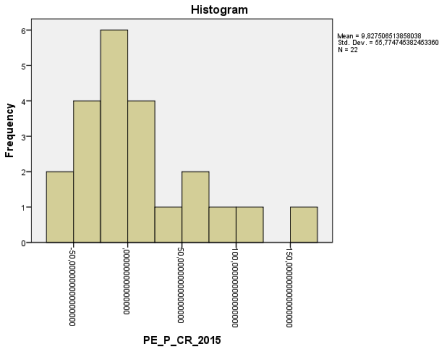


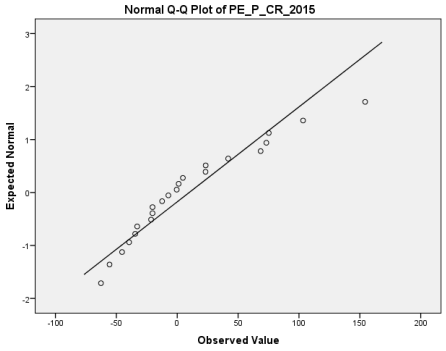


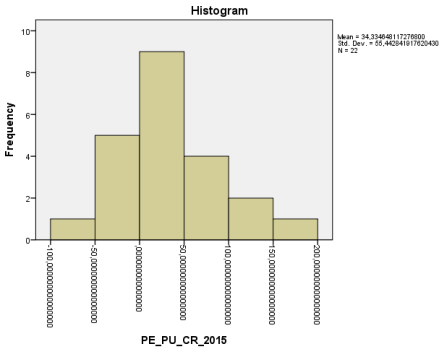


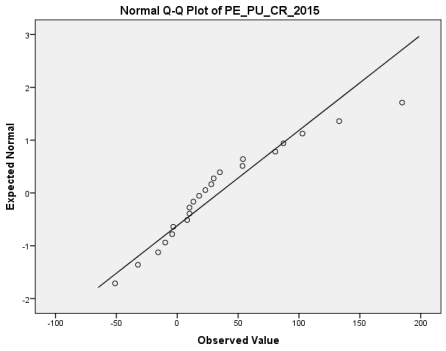


Graphical description for indexed current ratio during 2015









Appendix 21 – Ratio decomposition for 2007-2009

Table 1: Ratio decomposition 2006-2009 - PE Portfolio companies compared with privatly owned reference companies

	Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Decomposition of EBITDA Margin									
EBITDA	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	36.8	48.2	9.0	74.3	100.2	82.8	-44.6	-64.9	-75.1
Median	112.0	75.9	64.1	72.6	97.7	74.4	24.3	-14.2	-3.4
Std. Dev.	159.3	173.3	180.8				170.8	188.5	206.1
P-value							0.96	0.64	0.35
Sales	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	128.7	159.5	168.7	99.3	117.0	115.5	21.5	36.7	47.9
Median	117.6	168.7	150.8	101.4	120.4	116.7	7.3	47.5*	24.5**
Std. Dev.	65.5	77.6	83.6				66.1	78.5	80.4
P-value							0.15	0.06	0.03
Decomposition of Current Ratio									
Current Assets	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	143.1	169.4	139.2	115.0	135.1	151.5	28.1	34.3	-12.3
Median	143.4	175.6	111.4	113.4	142.0	159.0	30.1	49.3*	-40.3
Std. Dev.	68.7	74.7	84.5				71.2	83.1	96.2
P-value							0.12	0.07	0.59
Current Liabilities	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	150.5	174.0	162.7	117.8	135.0	136.0	32.7	39.0	26.7
Median	126.6	183.4	152.1	108.9	135.2	138.9	17.7	38.9*	27.7
Std. Dev.	76.7	79.0	76.5				87.2	97.1	92.8
P-value							0.15	0.07	0.25

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

Table 2: Ratio decomposition 2006-2009 - PE Portfolio companies compared with privatly owned reference companies

	Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Decomposition of EBITDA Margin									
EBITDA	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	36.8	48.2	9.0	110.3	131.2	105.8	-80.9	-96.5	-98.2
Median	112.0	75.9	64.1	104.5	120.4	95.5	-29.1	-68.0	-50.1*
Std. Dev.	159.3	173.3	180.8				157.3	168.4	183.4
P-value							0.18	0.13	0.08
Sales	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	128.7	159.5	168.7	104.3	131.5	130.5	15.9	21.8	32.4
Median	117.6	168.7	150.8	98.8	129.0	125.1	9.1	29.4	7.3
Std. Dev.	65.5	77.6	83.6				60.9	79.2	90.2
P-value							0.18	0.18	0.13
Decomposition of Current Ratio									
Current Assets	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	143.1	169.4	139.2	126.4	145.8	117.2	16.7	23.6	22.0
Median	143.4	175.6	111.4	138.1	142.2	109.2	17.6	27.6	-13.7
Std. Dev.	68.7	74.7	84.5				69.2	79.3	87.5
P-value							0.37	0.18	0.37
Current Liabilities	2007	2008	2009	2007	2008	2009	2007	2008	2009
Average	150.5	174.0	162.7	148.6	205.2	140.5	1.9	-31.2	22.3
Median	126.6	183.4	152.1	132.6	203.9	139.3	-10.3	-34.7	5.5
Std. Dev.	76.7	79.0	76.5	36.0	38.6	18.4	88.2	96.9	83.2
P-value							0.88	0.20	0.28

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

Appendix 22 – Ratio decomposition for 2013-2015

Table 2: Ratio decomposition 2012-2015 - PE Portfolio companies compared with publicly owned reference companies

	Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Decomposition of EBITDA Margin									
EBITDA	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	115.3	103.4	57.0	109.4	116.4	102.3	5.9	-13.0	-45.3
Median	103.5	98.4	51.8	117.3	121.1	106.4	-9.9	-22.7	-53**
Std. Dev.	63.4	98.8	90.9				61.7	108.8	90.6
P-value							0.72	0.60	0.03
Sales	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	128.6	139.9	125.6	108.2	116.0	115.8	20.3	23.9	9.9
Median	118.1	132.5	123.8	110.1	118.9	121.5	10.8**	13.7*	2.4
Std. Dev.	45.1	44.7	53.3				44.8	47.9	51.2
P-value							0.02	0.07	0.75
Decomposition of Current Ratio									
Current Assets	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	147.5	153.8	165.9	112.8	129.3	127.7	36.6	27.1	42.0
Median	121.4	110.9	103.1	108.2	130.1	120.8	13.2	-13.6	-13.1
Std. Dev.	149.7	188.9	229.5	11.7	12.1	30.3	155.4	194.6	240.4
P-value							0.64	0.31	0.59
Current Liabilities	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	118.2	115.9	121.8	111.3	124.9	162.0	9.2	-3.3	-32.4
Median	116.3	103.2	95.7	114.0	123.6	173.7	-1.6	-21.0	-35.5*
Std. Dev.	49.1	67.8	75.6	8.2	10.5	36.6	50.5	67.7	82.8
P-value							0.78	0.35	0.04

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Table 2: Ratio decomposition 2012-2015 - PE Portfolio companies compared with privatly owned reference companies

	Indexed Change of Portfolio Companies			Indexed Change of Reference Companies			Indexed Difference of Changes		
Decomposition of EBITDA Margin									
EBITDA	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	115.3	103.4	57.0	88.6	100.6	56.4	26.7	2.8	0.7
Median	103.5	98.4	51.8	74.3	77.0	45.9	22.8	-6.3	5.9
Std. Dev.	63.4	98.8	90.9				73.3	100.6	100.1
P-value							0.13	0.90	0.90
Sales	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	128.6	139.9	125.6	104.3	111.8	95.7	24.3	28.1	29.9
Median	118.1	132.5	123.8	100.9	104.4	94.7	13.3***	25.4**	33.2*
Std. Dev.	45.1	44.7	53.3				46.4	43.4	57.4
P-value							0.01	0.02	0.08
Decomposition of Current Ratio									
Current Assets	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	147.5	153.8	165.9	115.9	112.7	104.3	34.3	43.7	66.3
Median	121.4	110.9	103.1	109.3	115.3	113.6	12.1	0.7	10.2
Std. Dev.	149.7	188.9	229.5				152.5	193.3	231.8
P-value							0.73	0.88	0.45
Current Liabilities	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average	118.2	115.9	121.8	107.6	93.0	79.5	15.1	29.4	51.4
Median	116.3	103.2	95.7	90.0	89.0	68.4	14.7	13.2	28.2**
Std. Dev.	49.1	67.8	75.6				52.5	64.0	78.2
P-value							0.43	0.18	0.03

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level