BI Norwegian Business School - campus Oslo

GRA 19502

Master Thesis

Component of continuous assessment: Forprosjekt, Thesis MSc

How common risk factors affect the stock prices in Norwegian oil and gas companies

Navn: Marcus Skarnes Kristiansen, Rabia Mahmood

Start: 01.01.2018 09.00

Finish: 15.01.2018 12.00

Study programme: MSc Business with Major in Finance

Title: How common risk factors affect the stock prices in Norwegian oil and gas companies

Name of supervisor: Costas Xiouros

Summary

In this paper, the main objective is to assess how different risk factors affect stock returns of the Oslo Energy Index. Previous papers suggest that the following factors should affect stock returns: foreign exchange exposure, the term premium, the market portfolio and fluctuations in the oil and natural gas price. These factors are found to be significant, and we will therefore apply these in several multifactor models to obtain the exposure and the risk premia. This will enable us to compare the expected returns using different approaches.

Table of Contents

1.0 Introduction

The oil sector is considered as a volatile industry. As presented by Mork et. al. (1994), the Norwegian economy is affected by changes in the oil price, and due to Norway´s status as a relatively large net exporter of oil, the Norwegian economy benefits significantly from increases in oil price. During the last years, the oil sector has gone through a large number of fluctuations as a result of political events, exchange rate of the US dollar, geopolitics and other factors.

The factors describing the return on assets has been a debated topic in asset pricing, with numerous suggestions of factors and models based on theory and conducted in empirical research. The Capital Asset Pricing Model (Sharpe, 1964; Lintner, 1965; and Mossin 1966) suggests that the market return is the only factor explaining the expected return. Based on limitations to the CAPM model, multifactor models such as the Intertemporal CAPM (Merton, 1973) and Arbitrage Pricing Theory (Ross, 1976) was introduced. Empirical multifactor models such as the Fama-French 3-factor (Fama and French, 1993) and 5-factor model (Fama and French, 2015) extends the CAPM by several explanatory variables, and its empirical results has proven to be significant over time. Alternative models that are also still applied extensively was introduced in Chen et. al. (1986) which suggests a multifactor model using a two-step cross-sectional regression method with macroeconomic variables following Fama and MacBeth (1973). More up-to-date research by Sadorsky (2001) conducted a study on Canadian oil and gas companies. This study estimates the exposures to Canadian oil and gas industry stock prices for a set of risk factors between 1983 and 1999 by applying market multifactor models.

To examine the expected return on oil and gas companies in Norway, we will apply different approaches and compare these. We will apply the method introduced by Fama and MacBeth (1973) and Chen et. al. (1986) to obtain the exposures to risk factors and risk premia for the various risk factors. Further, a more recent approach by Sadorsky (2001) will be applied to obtain the exposures, whereas another method will provide us with the risk premia. It is interesting to gain knowledge of the determinants of expected return of Norwegian oil and gas companies, i.e. the amount of risk and the price of risk. The exposure of oil and gas companies returns to different risk factors can further be applicable for both the companies and institutional investors, as this information could be used for hedging of the relevant risk factors.

To our knowledge, there are no prior research on this particular topic within´ the Norwegian oil and gas sector. Hence, we have arrived at the following research question: *"How does risk factors affect stock returns of the Oslo Energy Index based on different multifactor market models?"*

2.0 Literature Review

2.1 The CAPM, ICAPM, APT and Fama-French factor approaches to explaining returns

The Capital Asset Pricing Model (CAPM) is a single factor model that describes the relationship between the expected return and risk. The foundation of this single factor model is built upon the work of Sharpe (1964), Lintner (1965) and Mossin (1966). They suggested that the only component that explains the expected return is the market return.

Major criticisms to the CAPM are related to the heavy assumptions and the requirement of the additional assumptions such as homogeneous expectations and that the CAPM is a single-period model. The critique of Roll (1977) suggests that the market portfolio is impossible to observe. Further, Merton (1973) argues that these assumptions are unrealistic to accomplish in the real-world investing, since an investor often participates in the financial market for multiple years, and not a single year like the CAPM assume. Due to these limitations, the Intertemporal Capital Asset Pricing Model (ICAPM) was introduced by Merton (1973). ICAPM is a consumption based asset pricing model that in contrast to CAPM takes the investors participation behavior in the market into account. Hence, investors require a compensation for changes in the investment opportunity set. The returns of the securities are normally distributed over multiple time periods and all future consumption will be funded by these returns.

As an alternative to the CAPM with softer assumptions, the Arbitrage Pricing Theory (APT) was introduced by Ross (1976). The APT states that the relationship between the asset and common risk factors can predict an asset's return. Ross (1976) describes that a linear combination of many independent macroeconomic variables can explain the relationship between returns of a portfolio and the return of a single asset.

Fama and French (1993) extended the CAPM due to its limitations in explaining expected returns by adding two additional factors, related to firm size and book-to-market equity, to better capture the differences in returns. Further, Carhart (1997) introduced a fourth factor to the 3-factor model, momentum, to examine the trends for stocks to continue to increase or decrease. Recently, Fama and French (2015) introduced a 5-factor model, extending their three-factor model by including profitability and investment as factors.

2.2 The Fama and MacBeth, Chen, Roll and Ross and recent empirical approaches to explaining returns

Fama and MacBeth (1973) introduced a time series two-pass cross-sectional (rolling) regression method to examine if the relation between expected return and betas are linear (Jagannathan et. al., 2010). Firstly, by running a time-series regression, estimates of the return´s exposure to the risk factors are obtained. Secondly, the obtained estimates are applied using alternative cross-sectional regressions for each period to provide the risk premia for the risk factors. Consequently, this approach can be used to test the CAPM and an extended version, i.e. with multiple factors (Cochrane, 2000, p. 245). However, this approach introduces the errors in variables problem by using the estimated betas in the second regression, which often are handled by grouping stocks into portfolios following Black et. al. (1972) (Jagannathan et. al., 2010 p. 75).

Following the APT and the factor-analytic methods of Roll and Ross (1980), Chen et. al. (1986) introduced an approach in which the two-pass cross-sectional regression of Fama and MacBeth (1973) was applied. Chen et. al. (1986) tests whether several observable macroeconomic variables, suggested by financial theory that affects stock market returns, are rewarded. Among these suggested variables are the industrial production and the term premium. It is observed that the suggested sources of risk are significantly priced. Further, it is concluded that stock market returns are exposed to systematic economic news that can be identified through rather intuitive financial theory, and priced accordingly.

Following Jorion (1990), Khoo (1994), Faff and Chan (1998), Faff and Brailsford (1999), a multifactor market model relating an oil and gas stock index to several macroeconomic risk factors is constructed in Sadorsky (2001). Among the recent empirical studies conducted within the oil and gas industry that applies multifactor models to estimate the exposure of oil and gas firms to several risk factors are Sadorsky (2001), El-Sharif et. al. (2005) and Boyer and Filion (2007). Sadorsky (2001) firstly introduce a 2-factor model containing the monthly return to oil prices and the monthly excess return on the market index. Further, Sadorsky (2001) introduces a 4-factor model to avoid an underspecified model, by including additional variables such as the CAD/USD exchange rate and the term premium. This multifactor model is later adopted by El-Sharif et. al. (2005). Sadorsky (2001) and El-Sharif et. al. (2005) both employ the same multifactor model to examine the relationship between risk factors and oil and gas returns in Canada and the UK, respectively. To examine Canadian oil and gas companies' exposure to related risk factors, Boyer and Filion (2007) adopts a similar approach to that of Sadorsky (2001), but introduces a fifth common risk factor, the natural gas price return and fundamental factors as well. Nevertheless, neither of these studies concerns pricing the risk of the exposures, only the variance decomposition of the returns. Hence, it is necessary to apply an additional step to obtain the risk premia for the factors to be able to determine the expected return.

2.3 Risk factors

Which factor that explain the return of stock prices, i.e. the determinants of stock market returns have been a debated topic in asset pricing for a long time. The literature suggests numerous factors for explaining the return of stock prices, such as the CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) and the multifactor models proposed by Fama and French (1993; 2015), and Carhart (1997). For the purpose of this paper, we will primarily focus on factors provided in studies conducted on stock returns within the same industry, which is the oil and gas industry. We follow the suggestions of Roll and Ross (1980) and Kryzanowski and To (1983) with five factors as sufficient to obtain a noteworthy explanatory power.

2.3.1 Foreign exchange exposure

Sadorsky (2001) applies a multifactor model to investigate the relationship between risk factors and Canadian oil and gas stock returns. The results indicate that the returns of the Canadian oil and gas companies are sensitive to several risk factors, including the CAD/USD exchange rate. More specifically, an increase in the CAD/USD exchange rate decreases the return to Canadian oil and gas stock prices. Further, El-Sharif et. al. (2005) provides a similar research to that of Sadorsky (2001) and examines the relationship between oil prices and equity values in the UK. Their findings indicate that oil and gas stock returns are impacted by changes in oil prices, the stock market as a whole and the GBP/USD exchange rate to a lesser extent. In the UK, an increase in the USD exchange rate is found to decrease the return. In similarity to Sadorsky (2001), Boyer and Filion (2007) assesses the common and fundamental factors in stock returns of Canadian oil and gas companies, and notably conclude that a weakening of the CAD against the USD has a negative impact on the returns.

Further, Gjerde and Saettem (1999) investigates causal relations among macroeconomic variables and stock returns in Norway by utilizing a multivariate vector autoregressive approach. It is shown that the USD exchange rate seemingly is important, due to its effect on both the Norwegian and international real activity. In a more recent study, Kopytin (2014) assesses the influence of various global and national factors on the stock market indices in Norway and Russia. Using a VAR- approach, Kopytin (2014) finds that the changes in the Norwegian index is determined by the USD exchange rate and the S&P500 stock index. Hence, previous studies reveal different impacts of oil and gas companies' exposure to the USD exchange rate both for the oil and gas industry in Canada and the UK, but also on the stock market in Norway.

2.3.2 Oil price

A great deal of studies has assessed the relationship between oil prices and returns in the oil and gas industry, as the oil prices will directly affect the cash-flows for the companies within the oil and gas industry. Chen et. al. (1986) found no significant evidence that oil price risk was rewarded in the stock market. Further, the reaction of stock returns in Canada, Japan, the UK and the US to oil price fluctuations is examined by Jones and Kaul (1996) based on a cash-flow dividend valuation model. They conclude that the reaction of the stock market in Canada and the US are explained by the impact of oil shocks on cash flows, whereas the results for Japan and the UK are inconclusive (Arouri and Nguyen, 2010).

Further, Huang et. al. (1996) applies an unrestricted vector autoregressive model and do not find evidence of a relationship between the S&P500 market index and the oil prices. Park and Ratti (2008) examines the relationship between oil price shocks and the stock markets in the US and twelve European countries, including Norway. It is concluded that the Norwegian stock market responds positively to an increased oil price, whereas the US and the remaining European countries stock returns are negatively affected (Arouri and Nguyen, 2010). Sadorsky (2001) and Boyer and Filion (2007) examines the effect of oil price changes in stock returns of Canadian oil and gas companies. The former finds evidence that an increase in the oil price factor increases the return to the oil and gas stock prices. Similarly, the latter finds that the stock returns are positively associated with increases in the prices of crude oil. Furthermore, in a study on causal relations of macroeconomic variables in Norway, Gjerde and Saettem (1999) concluded that the strong dependency of Norway to oil is reflected in the stock market, which responds rationally to changes in oil price, and that the oil price affects stock returns.

2.3.3 Term premium

The risk emerging from changes in the interest rate is a common risk factor, due to the relation to general macroeconomic conditions. Nevertheless, there is a discrepancy in the literature regarding the impact of the interest rate to returns in the oil and gas industry. The findings of Sadorsky (2001) and Boyer and Filion (2007) indicates that the term premium has a significant negative impact on the return of Canadian oil and gas companies. The term premium is computed consistently to Harvey (1989), i.e. the difference in returns of a 3-month and 1-month T-bill. Similar findings for the Norwegian stock market are presented in Gjerde and Saettem (1999), where changes in the real interest rate are found to immediately affect Norwegian stock returns. The results in El-Sharif et. al. (2005) exhibits a positive correlation between the term premium and the oil and gas returns in the UK, nevertheless the result is not significant. Further, the findings presented in Oberndorfer (2009) indicates that in the Eurozone the term premium yields positive and significant effects on the oil and gas returns.

2.3.4 The market portfolio

A market factor as a part of either a multifactor model or a vector autoregressive model is fairly common when investigating the sensitivity of the returns in this particular industry. Examining oil and gas companies in Canada and the UK, Sadorsky (2001), Boyer and Filion (2007) and El-Sharif et. al. (2005) finds evidence supporting that an increase in the market increases the return. Boyer and Filion (2007) further concludes with a noteworthy result: the market beta of Canadian oil and gas firms is smaller than 1, i.e. the systematic market risk is lower for the oil and gas firms than that of the average Canadian company. For the Norwegian stock market, Kopytin (2014) suggests that changes in share quotations are determined by changes in the S&P500 index, i.e. a proxy for the market.

2.3.5 Natural gas price

Boyer and Filion (2007) concludes that the stock return determinants for firms producing mainly oil and mainly gas are not the same. This may be due to the direct effect a change in the price of natural gas will have on the cash flows for the firms mainly producing gas. Hence, it might be beneficial to include the natural gas price risk. Including the natural gas prices as an additional factor in the multifactor models introduced by Sadorsky (2001) are among the main contributions of Boyer and Filion (2007) to the literature on the financial determinants of Canadian oil and gas company stock returns. Their findings indicate that the influence of prices of natural gas on the stock returns increase significantly between the two periods 1995-1998 and 2000-2002.

3.0 Data

In the following sections, we will specify where we will gather the data needed for the purpose of applying the multifactor models with the different risk factors. We will examine data from the beginning of 2010 until the end of 2017, where the pre-crisis period is defined from the beginning of 2010 until the end of 2013, whereas the crisis period is defined as the beginning of 2014 until the end of 2017. However, if the number of observations shows to be limited we need to readjust our period of study which will depend on the dataset we will be able to gather.

3.1 Return on the Oslo Energy Index

We currently possess daily data for the Oslo Energy Index for the period January 2013 until January 2018, collected from Oslo Børs. However, as this data is strictly limited to the official turnover in NOK, last, high and low, we find it appropriate to examine whether it is possible to obtain more detailed data if needed, in addition to a longer horizon. However, the OSLENX might contain a limited number of historical operational data because the index was recently created in June 2010 (e.g. Netfonds Bank quote the highest and lowest price since 30/6-2010). Bernt Arne Ødegaard is the contact person for students from BI that needs to obtain data for a period longer than 5 years. Hence, we will contact Ødegaard to hopefully obtain the necessary data. We also have the possibility to gain access to Oslo Børs Informasjon (OBI) through BI, which should provide us access to these data.

Due to these limitations to the data on OSLENX, it is probable that we will create a new portfolio consisting of Norwegian oil and gas companies. The companies in the portfolio will be given weights according to their market capitalization each year in the period of study. To focus specifically on oil and gas companies might be more relevant as to draw a plausible conclusion, as the literature we apply on the determinants of returns mainly concerns oil and gas companies. In such a portfolio, we will primarily focus on big companies within the oil and gas sector in which we can obtain a sufficient amount of data, such as Aker BP, Statoil, Hydro, Fred. Olsen Production, Petroleum Geo-Services and DNO ASA. Further, we are certain that obtaining data on these companies will not be an issue through Oslo Børs Informasjon, Bloomberg or Infront.

3.2 Return on the Benchmark Index

We will use OSEBX as proxy for the market return in this paper. OSEBX comprise the most traded shares on Oslo Børs and adjusts for dividend payments. In similarity to the OSLENX, we currently have daily data for OSEBX. We have been able to obtain data since the launch of the OSEBX, i.e. for the period December 1995 until January 2018, collected through Oslo Børs. This data is also limited to the official turnover in NOK, last, high and low. If it is necessary to obtain more detailed data for OSEBX, this should be possible through either Ødegaard or OBI as mentioned above.

3.3 Exchange rate for USD

We currently have the daily exchange rates between NOK and USD from December 1980 until January 2018. These data are obtained through Norges Bank.

3.4 Interest rate variable

Further, we will use the the three-month treasury bills as a proxy for the risk-free interest rate. Treasury Bills are considered as a reasonable and commonly used proxy when applying asset pricing models. Data with the monthly average of treasury bills for the period February 2003 until November 2017 are currently available for download on the Norges Bank website. Nevertheless, if it is shown that we need to obtain additional information on the term premium, data is available from the Bloomberg terminal, which is available for students at BI. Further, it is possible to compute the monthly yields as presented in equation 1:

$$r_t^M = (1 + r_t^{3M})^{\frac{1}{12}} - 1 \qquad (1)$$

where:

r_t^M is the monthly yield for the risk-free rate

r_t^{3M} is the annualized 3-month rate.

3.5 Oil prices

The monthly return on oil prices is another factor, which will be calculated by using 3-month oil futures prices on Brent Crude Oil Futures, which is denominated in US dollar. By using prices denominated in USD, Boyer & Filion

(2007) suggest that this will enable us to identify and isolate the impact of variations in the exchange rate independently of variations in the oil prices. Brent Crude (or Brent Blend) is used rather than WTI, as European oil production tends to be priced relative to this oil (Bjørnland, 2009). We will obtain historical data on prices for Brent oil futures through Investing.com. However, we will examine whether other sources such as the US Energy Information Administration or Bloomberg can provide data as well.

3.6 Natural Gas Prices

Boyer and Filion (2007) based their common factor model on Sadorsky (2001) and takes into account a factor on the natural gas prices when assessing the financial determinants of Canadian oil and gas company stock returns. As they conclude that stock return determinants are different for firms producing mainly oil and for firms producing mainly natural gas, we have decided to include the return on natural gas 3-month futures prices as a common factor in our models as well. We will obtain historical data on natural gas futures prices from Investing.com. Similar to the oil prices, we will examine other sources as well.

4.0 Methodology

This research paper will primarily focus on gaining knowledge of several common risk factors affecting the return on Norwegian oil and gas companies, similar to earlier studies conducted for oil and gas companies within Canada and the UK (Sadorsky, 2001; El-Sharif et. al., 2005; Boyer and Filion, 2007). Therefore, the methodology will be based upon several studies conducted within similar sectors, such as Jorion (1990), Khoo (1994), Faff and Chan (1998), Faff and Brailsford (1999), Henriques and Sadorsky (2001). Further, another approach to gaining knowledge of the expected return of the oil and gas companies will be based upon the methodology introduced in Fama and MacBeth (1973) and Chen et. al. (1986).

The expected returns of the stocks can be computed as shown in equation (2). Hence, it is necessary to obtain the exposures of the stock returns to the risk factors, as well as the corresponding risk premia.

$$Expected\ Return = Riskfree\ Rate + \sum_{j=1}^{j=k} \beta_j \left(Risk\ Premium_j\right) \qquad (2)$$

These are classic linear regression models and will be estimated using the Ordinary Least Squares (OLS) method. We will describe the single factor model, multifactor models and common risk factors that will be applied in the following sections.

4.1 The Sadorsky, El-Sharif and Boyer and Filion approach

We will apply a factor model that only takes the excess return of the market into account. A single-factor model is often referredas the single-index model, as it utilizes a market index to proxy for a common macroeconomic factor. (Bodie et. al., 2014). For the purpose of this paper, the return on the Benchmark Index (OSEBX) is used to proxy for the market return. Therefore, the following regression is applied:

$$R_{it} = \propto\ + \beta_m R_{mt} + \varepsilon_t \qquad (3)$$

where R_{it} and R_{mt} are the excess returns on the stock and the market index, respectively. Further, α is the constant term and ε_t are the residuals. The parameter β_m represents the market beta, i.e. the stock return´s sensitivity to the market index.

Further, we apply multifactor models based on Jorion (1990), Khoo (1994), Faff and Chan (1998), Faff and Brailsford (1999), Henriques and Sadorsky (2001), Sadorsky (2001) and Boyer and Filion (2007). Hence, we assume that the variation of stock prices of Norwegian oil and gas companies are associated with variations of risk factors as identified by these authors. The equations (4) and (5) are standard market models augmented by an oil price factor and a natural gas price factor, respectively. Equation (4) has been used in earlier asset pricing literature, in addition to several oil related studies such as Chen et. al. (1986), Al-Mudhaf and Goodwin (1993), Faff and Brailsford (1999), Hammoudeh and Li (2004) and Nandha and Faff (2008). Equation (5) is a similar model, but the oil price factor is substituted by a natural gas price factor to capture the stock returns sensitivity to price changes in natural gas. Equation (6) contains the market factor, oil price factor and the natural gas factor, whereas equation (7) is similar to those of Sadorsky (2001) and Boyer and Filion (2007). The following regressions are applied:

$$R_{it} = \propto \; + \beta_m R_{mt} + \; \beta_o R_{ot} + \; \varepsilon_t \qquad (4)$$

$$R_{it} = \propto \; + \beta_m R_{mt} + \; \beta_{NG} R_{NGt} + \; \varepsilon_t \qquad (5)$$

$$R_{it} = \propto \; + \beta_m R_{mt} + \; \beta_o R_{ot} + \; \beta_{NG} R_{NGt} + \; \varepsilon_t \qquad (6)$$

$$R_{it} = \propto \; + \beta_m R_{mt} + \; \beta_o R_{ot} + \; \beta_{NG} R_{NGt} + \; \beta_{tp} R_{tpt} + \; \beta_e R_{et} + \; \varepsilon_t \qquad (7)$$

where R_{it} is the excess return on the oil and gas stocks, R_{mt} is the excess return on the market, R_{ot} is the return on the oil price futures, R_{NGt} is the return on the gas price futures, R_{tpt} is the term premium and R_{et} is the change in the USD/NOK exchange rate.

Running these regressions will yield the exposures of the oil and gas stock return to each risk factor. Further, to be able to examine how the risk factors affect the stock returns, it is necessary to compute the risk premia for the factors. However, we have not yet found the optimal model to compute these to obtain a comparable result to the approach of Fama and MacBeth (1973) and Chen et. al. (1986).

4.2 The Fama-MacBeth and Chen et. al. approach

Further, a multifactor model based on the two-pass cross-sectional regression method used in Fama and MacBeth (1973) and Chen et. al. (1986) is applied.
In the first part, the betas are estimated using time series regression. The factor loadings or exposures for a portfolio or asset to the m risk factors are obtained by regressing the individual portfolio´s or asset´s return on the factors using the regression:

$$R_{n,t} = \propto_n + \beta_{n,F1} F_{1,t} + \; \beta_{n,F2} F_{2,t} + \cdots + \; \beta_{n,Fm} F_{m,t} + \; \epsilon_{n,t} \qquad (8)$$

where $R_{n,t}$ is the return of the portfolio or asset i (n total) at time t, $F_{m,t}$ are the risk factors and $\beta_{n,Fm}$ are the exposures (IHS EViews, 2014).

Further, the second part examines the relation between the estimated betas and returns using cross-sectional regression. Regressing the returns on the obtained betas in the first step yields coefficients for the risk premium for each risk factor. The following regression is applied:

$$R_{i,T} = \gamma_{T,0} + \gamma_{n,1}\hat{\beta}_{i,F1} + \gamma_{n,2}\hat{\beta}_{i,F2} + \cdots + \gamma_{n,m}\hat{\beta}_{i,Fm} + \epsilon_{i,T} \qquad (9)$$

where the returns R are similar to that of step 1, $\hat{\beta}$ the is the estimated factor exposures from step 1 and γ are the coefficients that is further used to calculate the risk premium for each factor. Lastly, to obtain the expected premium for a unit exposure to each factor, the average of the computed risk premium coefficients is used (IHS EViews, 2014).

4.3 Risk factors

The dependent variable in our models is the monthly excess returns on the OSLENX index, i.e. the share price in excess of the 1-month treasury bill rate. This is calculated similarly to Henriques and Sadorsky (2001), Sadorsky (2001) and Boyer and Filion (2007):

$$R_{it} = OSLENX\ monthly\ return - 1month\ treasury\ bill\ rate \qquad (10)$$

As mentioned under the data section, we reserve the right to change the dependent variable to a portfolio of large Norwegian oil and gas companies. In this case, the OSLENX monthly return in equation (10) will be substituted by the monthly return on the portfolio.

A factor in our models is the monthly excess return on the market index, i.e. the price in excess of the 1-month treasury bill rate. The Benchmark Index (OSEBX) will be used as a proxy for the market return, calculated as:

$$R_{mt} = OSEBX\ monthly\ return - 1month\ treasury\ bill\ rate$$

The monthly growth rate of the exchange rate between NOK and USD is another factor in our models. The monthly growth rate will be calculated as:

$$R_{et} = \frac{(Exchange\ rate\ \frac{NOK}{USD})_t}{(Exchange\ rate\ \frac{NOK}{USD})_{t-1}} - 1 \qquad (11)$$

In the application of asset pricing models, three-month treasury bills are commonly used as a proxy for the risk-free rate. As we are examining the monthly excess returns on the OSLENX and OSEBX, these may be in excess of the 1-month treasury bill rate. Further, the interest rate variable, i.e. term premium, following Sadorsky (2001), El-Sharif et. al. (2005) and Harvey (1989), is calculated as the return on the premium between the annual yield 3-month treasury bill and the yield on the 1-month treasury bill, as shown in equation (12).

(12)

$$R_{tpt} = R_t^{3M} - R_t^{1M}$$

We depart from using spot prices as Sadorsky (2001) suggests that spot prices are affected by short-run price fluctuations to a greater extent. We will compute the monthly return on the oil prices using the formula as shown in equation (13).

$$R_{ot} = \frac{(Futures\ price\ of\ Brent\ Crude\ oil\ barrel\ in\ USD)_t}{(Futures\ price\ of\ Brent\ Crude\ oil\ barrel\ in\ USD)_{t-1}} - 1 \quad (13)$$

Bibliography

Al-Mudhaf, A., & Goodwin, T. H. (1993). Oil shocks and oil stocks: evidence from the 1970s. *Applied Economics*, *25*(2), 181-190.

Arouri, M. E. H., & Nguyen, D. K. (2010). Oil prices, stock markets and portfolio investment: evidence from sector analysis in Europe over the last decade. *Energy Policy*, *38*(8), 4528-4539.

Bjørnland, H. C. (2009). Oil price shocks and stock market booms in an oil exporting country. *Scottish Journal of Political Economy*, *56*(2), 232-254.

Black, F. M., C. Jensen, and M. Scholes. (1972). The Capital Asset Pricing Model: Some Empirical Tests. In M. C. Jensen (Ed.), Studies in the Theory of Capital Markets (pp. 79–121). New York, NY: Praeger

Bodie, Z., Kane, A. and Marcus, A. (2010). *Essentials of Investments*. 5th ed. Boston: McGraw-Hill Irwin.

Boyer, M. M., & Filion, D. (2007). Common and fundamental factors in stock returns of Canadian oil and gas companies. *Energy Economics*, *29*(3), 428-453.

Carhart, Mark M. 1997. “On Persistence in Mutual Fund Performance.” *The Journal of Finance*, 52 (1): 57-82.

Chen, N., R. Roll and S. Ross (1986). Economic Forces and the Stock Market. *Journal of Business*, 59(3), 383-403.

Cochrane, J. H. (2000). *Asset Pricing*. Princeton university press.

Demirbas, A., Omar Al-Sasi, B., & Nizami, A. S. (2017). Recent volatility in the price of crude oil. *Energy Sources, Part B: Economics, Planning, and Policy*, *12*(5), 408-414.

El-Sharif, I., Brown, D., Burton, B., Nixon, B., & Russell, A. (2005). Evidence on the nature and extent of the relationship between oil prices and equity values in the UK. *Energy Economics*, 27(6), 819-830.

Faff, R., Chan, H., 1998. A multifactor model of gold industry stock returns: evidence from the Australian equity market. *Applied Financial Economics*, 8(1), 21-28.

Faff, R., Brailsford, T., 1999. Oil price risk and the Australian stock market. *Journal of Energy Finance & Development*, 4(1), 69-87.

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of political economy*, 81(3), 607-636.

Fama, Eugene F., and Kenneth R. French. 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1): 3-56.

Fama, Eugene F., and Kenneth R. French. 2015. A five-factor asset pricing model. *Journal of Financial Economics*, 116 1-22.

Gjerde, Ø., & Saettem, F. (1999). Causal relations among stock returns and macroeconomic variables in a small, open economy. *Journal of International Financial Markets, Institutions and Money*, 9(1), 61-74.

Hammoudeh, S., Dibooglu, S., & Aleisa, E. (2004). Relationships among US oil prices and oil industry equity indices. *International Review of Economics & Finance*, 13(4), 427-453.

Hammoudeh, S., & Li, H. (2004). The impact of the Asian crisis on the behavior of US and international petroleum prices. *Energy Economics*, *26*(1), 135-160.

Harvey, C. R. (1989). Time-varying conditional covariances in tests of asset pricing models. *Journal of Financial Economics*, *24*(2), 289-317.

Huang, R. D., Masulis, R. W., & Stoll, H. R. (1996). Energy shocks and financial markets. *Journal of Futures Markets, 16(1), 1-27.*

IHS EViews. (2014). Fama-MacBeth Two-Step Regression. Retrieved from: http://didattica.unibocconi.it/mypage/dwload.php?nomefile=fama-macbeth20141115121157.pdf

Jagannathan, R., Skoulakis, G., & Wang, Z. (2010). The analysis of the cross section of security returns. *Handbook of financial econometrics*, *2*, 73-134.

Jones, C. M., & Kaul, G. (1996). Oil and the stock markets. *The Journal of Finance*, *51*(2), 463-491.

Jorion, P., 1990. The exchange-rate exposure of US multinationals. *The Journal of Business*, 63(3), 331-345.

Khoo, A., 1994. Estimation of foreign exchange exposure: an application to mining companies in Australia. *Journal of International Money and Finance* 13(3), 342-363.

Kopytin, I. A. (2014). Influence of oil prices on stock market indexes in Russia and Norway. *Studies on Russian Economic Development*, *25*(1), 99-110.

Kryzanowski, L., & To, M. C. (1983). General factor models and the structure of security returns. *Journal of Financial and Quantitative Analysis*, *18*(1), 31-52.

Lintner, John. 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The review of economics and statistics*, 47(1), 13-37.

Merton, R. C. (1973). An intertemporal capital asset pricing model. *Econometrica: Journal of the Econometric Society*, 41(5), 867-887.

Mork, K. A., Olsen, Ø., & Mysen, H. T. (1994). Macroeconomic responses to oil price increases and decreases in seven OECD countries. *The Energy Journal*, 15(4), 19-35.

Mossin, Jan. 1966. Equilibrium in a capital asset market. *Econometrica: Journal of the Econometric Society*, 34(4), 768-783.

Nandha, M., & Faff, R. (2008). Does oil move equity prices? A global view. *Energy Economics*, *30*(3), 986-997.

Oberndorfer, U. (2009). Energy prices, volatility, and the stock market: Evidence from the Eurozone. *Energy Policy*, *37*(12), 5787-5795.

Park, J., & Ratti, R. A. (2008). Oil price shocks and stock markets in the US and 13 European countries. *Energy economics*, *30*(5), 2587-2608.

Roll, Richard. (1977). A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory. *Journal of Financial Economics*, 4(2), 129–176, doi:10.1016/0304-405X(77)90009-5.

Roll, R., & Ross, S. A. (1980). An empirical investigation of the arbitrage pricing theory. *The Journal of Finance*, *35*(5), 1073-1103.

Ross, S. A. (1973). *Return, risk and arbitrage*. Rodney L. White Center for Financial Research, The Wharton School, University of Pennyslvania

Sadorsky, P. (2001). Risk factors in stock returns of Canadian oil and gas companies. *Energy economics*, *23*(1),17-28.

Sadorsky, P., & Henriques, I. (2001). Multifactor risk and the stock returns of Canadian paper and forest products companies. *Forest Policy and Economics*, *3*(3), 199-208.
Sharpe, William F. 1964. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." *The Journal of Finance*, 19 (3), 425-442.