Exploration Risk
in Oil & Gas Shareholder Returns

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Abstract
Previous research clearly suggests that the explanation of excess asset returns is not fully captured by excess return on the market portfolio and the CAPM beta, as implied by Fama-French (1993) three-factor model. Among the large number of studies following in the footsteps of Fama and French, very few studies include industry-specific variables to explain excess asset returns. Using monthly financial data for 117 oil and gas companies from 1992 to 2006, we supplement the Fama French approach with an industry-specific fundamental factor to capture company exposure to oil and gas exploration risk. Our results indicate that exploration risk contributes significantly to the explanation of oil company excess returns over the period.

Key words: Asset pricing; Oil price; Risk factors
JEL classification: G12, L71; Q40
1. Introduction

Estimation of a firm's cost of equity remains one of the most critical and challenging issues faced by financial managers, analysts, and academics. Theory provides several broad approaches, such as the CAPM (Sharpe, 1964, Lintner, 1965; Black, 1972), the intertemporal capital asset pricing model (ICAPM: Merton, 1973), the arbitrage pricing theory model (APT: Ross, 1976) and multifactor models (Fama & French, 1993; 1996). Of these, the CAPM is clearly the preferred asset pricing model among large US firms and investors (see e.g. Bruner et al, 1998; and Graham and Harvey, 2001), in academic textbooks (e.g. Damodaran, 2001) and in applied articles (e.g. Kaplan and Peterson, 1998; Ruback, 2002).

Despite its popularity, a considerable amount of evidence documents the empirical shortcomings of the CAPM. In particular, the poor explanatory power of the market portfolio combined with the existence of asset pricing anomalies¹ have been highlighted as the perpetrators. Fama and French (1992) conclude that among the host of firm characteristics that do have explanatory power, size (measured by the market capitalization, ME) and book-to-market ratio (measured by the book equity-to-ME ratio, BE/ME) offer the best explanation of cross-sectional variance in expected returns. According to Fama and French (1993) the higher returns associated with small and high BE/ME stocks must be compensation for additional risk factors in returns related to ME and BE/ME.² In consequence, they develop a multifactor model as an alternative to the CAPM using the portfolios SMB³ and HML to mimic these two additional risk factors (see Fama and French, 1993; 1996). Nonetheless, as Fama and French themselves point out, these factors are only proxies for underlying unobservable risk factors. Their three-factor model combines the principles from Ross’ (1976) APT model and Merton’s (1973) ICAPM. While CAPM investors care only about the wealth their portfolio produces at the end of the current period, ICAPM investors are also concerned with how their future wealth might vary with future state variables.⁴ As a result, optimal portfolios are multifactor efficient. Fama and French argue that although size and book-to-market equity are not themselves state variables,

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¹ Pricing anomalies are patterns in average stock prices, usually related to firm characteristics, not explained by the CAPM.
² Assuming that assets are rationally priced.
³ SMB (Small minus big) is the return on a zero-investment portfolio long in small capitalization firms and short in large-cap companies. Correspondingly, HML (high minus low) is the return on a zero-investment portfolio long in high BE/ME firms and short in low BE/ME companies.
⁴ Examples of state variables include labour income, the prices of consumption goods and the nature of future portfolio opportunities, and expectations about labour income, consumption and investment opportunities (see e.g. Fama and French, 2004).
the higher average returns on small stocks and high book-to-market stocks reflect unidentified state variables that produce undiversifiable risks in returns that are not captured by the market return and are priced separately from market betas. Ideally, these factors should also be included in an asset pricing model.

Despite the overwhelming amount of literature on the explanatory power of common factors (macroeconomics, financial ratios and other), very few studies include industry-specific fundamental variables to help explain excess returns. This is puzzling since industry-specific information will most likely improve the explanatory power of empirical models. While companies within an industry are subject to the same industry-wide shocks, different industries react to different factors. Hence, industry specific factors may well contribute to the explanation of returns on oil stocks. To devise more accurate models it is essential to understand these determinants of stock returns.

The reserve concept is unique to non-renewable resource industries, and so is exploration activity. Oil and gas reserves are not readily available in well-functioning input markets, like the case is for traditional inputs. Rather, oil and gas companies have to invest in risky exploration activities, simply to maintain and grow their base of oil and gas reserves, and to sustain subsequent production activity over the longer term. At the same time, reserve additions are the result of a production process of its own, and both the efficiency of this process and the implied accumulation of oil and gas reserves contribute significantly to the value of an oil company (Mohn, 2008). In other words, company exposure to exploration activities represents a source of idiosyncratic risk that should also be reflected in both the cost of equity and in shareholder returns.

**Figure 1. Total shareholder returns and the oil price**

Source: ReutersEcowin (http://www.ecowin.com).
Figure 1 provides an overview of shareholder returns for oil and gas stocks compared with total market returns in the US stock market, as well as the oil price development. We see that oil company stocks were clearly outperformed by the rest of the market towards the end of the 1990s. However, a wave of corporate mergers and massive restructuring improved the cost base across the industry and provided a firm base for stock market appreciation as the oil price started rising – around the turn of the century. We will test the hypothesis that parts of this development is due to characteristic factors that are specific to the oil and gas industry.

Specifically, we evaluate and quantify the ability of the Fama-French three-factor model combined with an industry-specific fundamental factor, exploration intensity obtained from company data, in explaining oil and gas excess stock returns. Exploration of oil and gas is a highly risky business. Drilling for oil and gas is connected with a high probability of failure. On the other hand, development activity involves developing and producing reserves that have already been discovered. Hence, investors should expect higher returns on exploration stocks compared to the stocks of oil and gas companies mainly focusing on development oil and gas reserves.

Monthly data from 117 oil and gas companies over the years 1992-2006 serve as the empirical point of departure for our study. To improve the estimation precision, we construct portfolios of oil and gas firms according to their ranking of the two Fama-French factors and an industry-specific factor. A total of eight portfolios are created in the intersection between our three risk factors.

The novelty of this paper is the combination of the Fama French approach with an industry-specific factor relating to exploration risk, an industry-specific source of risk among oil and gas companies. Furthermore, we use a portfolio approach while other researchers have used individual securities. Moreover, we study a sample of international oil and gas companies listed in the US, whereas previous studies of oil and gas stocks are limited to the Canadian stock market (e.g., Sadorsky, 2001; Boyer and Filion, 2007) and/or North-American stocks (e.g., Talbot, Artiach and Faff, 2013). We provide econometric evidence that exploration risk contributes significantly to the explanation of excess returns in the oil and gas industry. At the same time, the Fama French factors relating to company size and book-to-equity remain significant in our econometric models, indicating that the industry-specific exploration risk is not captured by the three-factor model of Fama and French (1993).
The remainder of the paper is organized as follows. Section 2 provides a brief review of the empirical literature on asset pricing, whereas previous studies of industry-specific risk for the oil and gas industry is introduced in Section 3. Section 4 presents the model and estimation technique. Section 5 describes the data. The results are presented and discussed in Section 6, while Section 7 concludes.

2. Literature review

The arrival of the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) is clearly one of the most important developments in modern finance theory. Practitioners were presented with a method for estimating cost of capital and portfolio performance, and researchers were given a powerful theory for asset pricing. The model asserts that the market beta is the correct measure of riskiness, and that the risk premium per unit of riskiness is the same across all assets. In capital market equilibrium, the value-weight market portfolio, \( M \) is mean-variance-efficient\(^5\). The mean-variance-efficiency of \( M \) requires that:

(i) \( \beta \), the slope in the regression of a security’s return on the market return, is the only risk factor needed to explain expected return;
(ii) There is positive expected return for \( \beta \) risk

Fama and French (1996) assert that evidence of (ii), a positive relation between \( \beta \) and expected return, is supportive of the CAPM only if (i) also holds. This implies that \( \beta \) suffice to explain expected return.

Early empirical studies of the CAPM (Black, Jensen and Scholes, 1972; and Fama and MacBeth, 1973) provide some support for the model. However, during the 1980s and 1990s several asset pricing anomalies were discovered, challenging the CAPM. These anomalies imply that factors other than the market beta contribute to the explanation of expected returns. For instance, empirical studies have shown that factors such as company size (Banz, 1981; Fama and French 1992; Kothari, Shanken and Sloan, 1995), and various market value multiples\(^6\) (Basu, 1983; Chan, Hamao, and Lakonishok, 1991; Fama and French, 1992; 1993; 1996; and Lakonishok, Schleifer and Vishny, 1994) add significantly to the explanation of average asset return.

\(^5\) See Fama (1976), Roll (1977) and Fama and French (1996).
\(^6\) Examples include price/earnings, price/cash flow, and price/book ratios.
Fama and French (1992) conclude that among the firm characteristics that do have explanatory power, company size (i.e. market capitalization, ME) and book/market ratio (measured by ratio of book equity to market capitalization, BE/ME) offer the best explanation of the cross-sectional variance in expected returns. According to Fama and French (1993) the higher returns associated with small and high BE/ME stocks seem to compensate for the corresponding risk factors. Based on these results, Fama and French (1993) propose a three-factor model. Their model augments the CAPM with two additional factors, to account for company size and current market valuation. Fama and French (1996) provide evidence that the average absolute pricing errors of the CAPM are large; approximately three to five times those of their three-factor model. Furthermore, they find that many of the CAPM average-return anomalies are related and that they are captured by the three-factor model.

While Fama and French (1996) show that their three factor model capture many of the anomalies identified in the empirical literature, some anomalies still remain. One such anomaly is the momentum effect (Jegadeesh and Titman, 1993). Stocks that do well relative to the market over the last three to twelve months tend to continue to do well for the next few months, and stocks that do poorly continue to do poorly. Furthermore, additional anomalies may still exist, and will remain to be uncovered. As these may exist at the industry-level, it is appropriate to include industry-specific information in asset pricing models.

3. Fundamental risk factors in the oil and gas sector

The Fama-French three-factor model does not capture industry-specific factors which may be highly relevant to the explanation of asset returns (Fama and French 1997). Empirical evidence indicates that natural resource stocks are more sensible to fundamental factors and less so to general market factors (Morin, 1980). Faff and Chan (1998) find that gold prices along with market return have significant explanatory power on Australian gold stocks over the years 1979 to 1992. Similarly, Henriques and Sadorsky (2001) find that commodity prices have significant explanatory power of Canadian paper and forest firms. Moreover, Sadorsky (2001) and Aleisa, Dibooglu and Hammoudeh (2003) show that variation in crude oil futures prices have a significant impact on the stock returns of oil and gas companies. Boyer and Filion (2007) provide evidence that industry specific factors such as variation in proven reserves, variation in production volume (albeit with the opposite of expected sign on the coefficient) as well as the variation in oil and natural gas prices and the market return have explanatory
power for Canadian oil and gas stocks. In a recent study of North-American oil industry stocks, Talbot, Artiach, and Faff (2013) explore the drivers of commodity price betas, concluding that exogenous firm characteristics play a less prominent role than market conditions-type variables in the determination of oil price risk in oil industry shareholder returns.

All the above studies neglect the specific risks relating to exploration activity, and their effect on oil stock returns. However, a key differentiating factor of the production technology among oil and gas companies is the reserve concept, which represents a crucial input in the production process. Oil and gas companies have to invest in risky exploration activities, to sustain production over the longer term. Traditionally, this activity has offered great rewards for the successful companies, but the associated risks are also high (e.g., Walls and Dyer, 1996). Consequently, exploration activities and success have a potentially high relevance for company valuation and shareholder returns.

The studies of Faff and Chan (1998), Henriques and Sadorsky (2001), Sadorsky (2001) and Boyer and Filion (2006) use multifactor models. However, the variables identified by Fama and French (1993; 1996) are excluded. Typically, these studies regress stock returns or stock index returns on market return and a set of macroeconomic and industry specific fundamental factors. We contribute to the literature by including both the company size factor and book-to-market factor identified by Fama and French (1993, 1996), along with an industry-specific variable to capture company-specific exposure to exploration activities.

4. Methodology

The Fama and French (1993, 1996) model is an expansion of the Sharpe-Lintner CAPM equation, which describes the relation between expected return and beta,

$$E(R_i) = R_f + \beta_{IM}(E(R_M) - R_f), \quad i = 1, \ldots, N. \quad (1)$$

The CAPM states a relation between the expected risk premium on individual assets and their “systematic risk”. The expected return on asset $i$ is the risk-free interest rate ($R_f$) plus a risk premium, which represents the systematic risk factor of asset $i$ ($\beta_{IM}$) multiplied by the premium per unit of beta risk ($E(R_M - R_f)$). The risk premium per unit of riskiness is the same across all assets.
A typical approach to estimating the market beta is to run regressions of the expected excess return on the asset on the expected excess return on the market portfolio:

\[
E(R_i) - R_f = \alpha_i + \beta_i (R_m - R_f) + \epsilon_i
\]  

(2)

where \( \epsilon_i \) is a well-behaved error-term. A problem with regressions of excess returns for individual stocks is that estimates of beta are imprecise, creating a measurement error problem when they are used to explain average returns (Fama and French, 2004). To mitigate this problem, researchers started working with portfolios rather than individual stocks (Blume, 1970; Friend and Blume, 1970; and Black, Jensen and Scholes, 1972). The rationale is that if the CAPM explains stock returns it should also explain portfolio returns.

Many of the CAPM average-return anomalies are related and are captured by the three-factor model outlined by Fama and French (1993; 1996). The three-factor model states that the expected return on a portfolio of stocks less the risk-free rate \( E(R_m - R_f) \) is explained by the sensitivity of its return to three factors: (i) the excess return on a broad market portfolio \( R_m - R_f \); (ii) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB, small minus big); and (iii) the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks (HML, high minus low). To simplify notation, let \( r_{SMB} = R_S - R_B \) represent the return differential between a portfolio of Small company stocks \( R_S \) and a portfolio of Big company stocks \( R_B \), whereas \( r_{HML} = R_H - R_L \) is the corresponding difference in returns between two portfolios of companies with High \( R_H \) and Low \( R_L \) book-to-equity ratios, respectively. The Fama-French three factor model now states that the expected excess return on portfolio \( i \) is,

\[
E(R_i) - R_f = \beta_{IM} (E(R_m) - R_f) + \beta_{SMB} E(r_{SMB}) + \beta_{HML} E(r_{HML})
\]  

(3)

where \( E(R_m) - R_f \), \( E(r_{SMB}) \), and \( E(r_{HML}) \) are expected premiums, the slopes in the time-series regression \( \beta_{IM} \), \( \beta_{SMB} \), and \( \beta_{HML} \) represent factor sensitivities or loadings on the expected market risk premium and the two differenced portfolio returns, respectively. Assuming rational expectations, \( R_m = E(R_m) + n_m \), \( r_{SMB} = E(r_{SMB}) + n_{SMB} \), \( r_{HML} = E(r_{HML}) + n_{HML} \), where the error terms are orthogonal to the information at time \( t-1 \), and letting \( r_{Mt} = R_m - R_f \) represent the difference between market return and the return on a risk-free asset and \( r_{it} = R_i - R_f \) describe
the corresponding return spread for asset $i$, the following time series regression may now be formulated for Equation (3):

$$ r_i = \alpha_i + \beta_{it}M_t + \beta_{itSMB}SMB_t + \beta_{itHML}HML_t + \epsilon_i, $$

(4)

Using this specification, Fama and French (1993; 1996; 1998) find that their three-factor model captures much of the variation in average returns on portfolios formed on size, book-to-market equity and other price ratios that have shown to possess explanatory power.

The novelty of this paper is that we augment the Fama-French three-factor model with an industry-specific factor $r_{EMDt} = R_{Et} - R_{Dt}$ to capture the potential difference in returns between exploration-intensive oil companies ($R_{Et}$) and oil companies that are more intensive in development and production activities ($R_{Dt}$). Finally, we include a return variable to capture the potential influence of changes in the price of crude oil ($r_{Pt}$):

$$ r_i = \alpha_i + \beta_{it}M_t + \beta_{itSMB}SMB_t + \beta_{itHML}HML_t + \beta_{itEMD}EMD_t + \beta_{itP}P_t + \epsilon_i, $$

(5)

where $r_{EMDt}$ represents exploration intensity risk factor. A statistically significant coefficient on $r_{EMDt}$ provides evidence that company-specific exploration exposure contributes significantly to the explanation of excess oil stock returns. Crude oil price fluctuations have been identified as an important common risk factor and the variable is therefore included in the empirical models (e.g., Sadorsky (2001), Boyer and Filion (2007), Ramos and Vega (2007), and Mohanty and Nandha (2011)). We formulate this variable in terms of the rolling annual percentage return from an investment in crude oil, to align the time series properties of the oil price variable with the rest of the variables of our model.\(^7\)

5. Data

Financial statement data

Our data sample contains international oil and gas companies (1992-2006) drawn from John S. Herold Company’s (JS Herold) oil and gas financial database.\(^8\) The

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\(^7\) Preliminary tests indicate that all the return variables are stationary ($I(0)$), whereas the oil price has a trend ($I(1)$). The annual differencing of the oil price removes this trend, to secure stationarity in all model variables.

\(^8\) Founded in 1948, John S. Herold Inc. is an independent research firm that specialises in the analysis of companies, transactions, and trends in the global energy industry. Herold serves a global client base with analyses and key financial and operational data on the valuation, performance, and strategy of more than 400 oil and gas companies (http://www.herold.com/).
JS Herold database consists of financial and operating data from annual financial statements of 542 publicly traded energy companies worldwide. From this universe we select firms with data on book value of equity (shareholders’ equity in million US dollars), exploration and development investments (reported as costs incurred in exploration and development activities, in million US dollars). We select only companies which are listed on US stock exchanges. The final sample consists of 117 individual firms, leaving approximately 15 firms in each of our eight portfolios.

As all companies in the data sample are listed in the US stock market, we use a reference price for crude oil from the North-American market. Our choice is West Texas Intermediate (WTI), and for each of the months of our sample, we base our one-year return measure on the one-month futures contract.

Stock price returns
Market data (stock returns, market index returns and interest rates) are collected from the ReutersEcowin\(^9\) database. All market variables are measured at monthly frequencies over the period July 1993 to July 2006. The 1 month US Treasury Bill rate is used as the risk free interest rate. While Fama and French (1993) calculate \(R_M\) as the value-weight return on all stocks in their various portfolios, we use the return on the S&P 500 index as a proxy for the return on the market portfolio. \(R_f\) is measured using the one-month Treasury bill rate (beginning of month).

The specific design of SMB, HML and EMD portfolios is described in the Appendix. Note, that the 2x2x2 design produces a total of eight portfolios of oil companies with varying characteristics in three dimensions. Table 2 shows the average excess returns on our eight portfolios of value-weighted NYSE and AMEX stocks. As indicated in Table 2, portfolios characterised by a high exploration exposure tend to yield higher returns than portfolios with a low exploration exposure. For instance, the S/L/E portfolio (Small companies; Low book-to-equity ratio; high Exploration exposure) produced an average monthly return of 2.60% while that of the corresponding low-exploration exposure was 1.85%. The positive premiums on the exploration factor indicate that on average, portfolios dominated by companies with high exploration exposure have outperformed portfolios dominated by companies with low exploration exposure.

\(^9\)http://www.ecowin.com
Table 1. Descriptive statistics

Excess returns and market risk premium

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<tr>
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<th>Min</th>
<th>Max</th>
<th>SD</th>
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</thead>
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<tr>
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<td>-61.45</td>
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<td>Market premium</td>
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<td>-14.98</td>
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<td>4.10</td>
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<tr>
<td>Oil price return</td>
<td>156</td>
<td>-21.48</td>
<td>35.34</td>
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Portfolio excess returns

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<tr>
<td>S/L/E</td>
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<td>-20.49</td>
<td>32.32</td>
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<td>10.07</td>
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<td>S/L/D</td>
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<td>-25.93</td>
<td>37.65</td>
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<td>S/H/E</td>
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<td>-28.19</td>
<td>43.85</td>
<td>1.72</td>
<td>10.63</td>
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<td>S/H/D</td>
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<td>B/L/E</td>
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<td>B/H/E</td>
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<td>31.24</td>
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<td>6.45</td>
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<td>-14.20</td>
<td>17.13</td>
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<td>5.48</td>
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Risk factors

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<th>Max</th>
<th>Mean</th>
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<tr>
<td>SMB</td>
<td>156</td>
<td>-13.43</td>
<td>18.08</td>
<td>-0.10</td>
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<tr>
<td>HML</td>
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<td>EMD</td>
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<td>-9.45</td>
<td>11.18</td>
<td>0.37</td>
<td>3.50</td>
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Data source: JS Herold (http://www.herold.com).

6. Results and discussion

As time-series analysis is prone to the potentially negative effects of serial correlation and heteroskedasticity, relevant tests have been carried out to test for these source of misspecification. Serial correlation is analysed using the augmented Dickey-Fuller test (Said and Dickey, 1984), while heteroskedasticity is analysed using the Breusch-Pagan (Breusch and Pagan, 1979) and Cook-Weisberg (Cook and Weisberg, 1983) tests. The diagnostics tests (not tabulated) do not reveal the presence of neither serial correlation nor heteroskedasticity.

The model is estimated by ordinary least squares, and the results are obtained with Stata 9.0. Table 2 presents the regression results for the multifactor model presented in Equation (5) applied with the exploration intensity factor. The market
beta ranges from 0.60 to 0.72, and is statistically significant for all portfolio variants. This is similar to studies on individual Canadian oil and gas company stock returns. Sadorsky (2001) reports betas in the range of 0.70 to 0.78. However, Boyer and Filion (2007) report substantially lower market betas, in the range of 0.14 – 0.54. They find that the oil betas (coefficients on the oil price) are higher than the market beta, a result that contrasts with both Sadorsky’s (2001) and this study. The discrepancies may be related to the use of market portfolio. Sadorsky regresses the return on a Canadian oil stock index (portfolio) on the return on the Canadian market portfolio, while Boyer and Filion regresses individual Canadian oil stocks on the Canadian market portfolio. Our approach is therefore more similar to Sadorsky’s.

Table 2: Econometric results: Estimated excess return by portfolio

<table>
<thead>
<tr>
<th></th>
<th>S/L/D</th>
<th>S/L/E</th>
<th>S/H/D</th>
<th>S/H/E</th>
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<td>0.016***</td>
<td>0.012**</td>
<td>0.004</td>
<td>0.008**</td>
<td>0.006*</td>
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<td></td>
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<td>(3.592)</td>
<td>(2.080)</td>
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<td>(2.435)</td>
<td>(1.097)</td>
<td>(2.845)</td>
<td>(3.549)</td>
</tr>
<tr>
<td>$r_M$</td>
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<td>0.851***</td>
<td>0.964***</td>
<td>1.080***</td>
<td>0.673***</td>
<td>0.831***</td>
<td>0.716***</td>
<td>0.568***</td>
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<tr>
<td></td>
<td>(7.248)</td>
<td>(7.844)</td>
<td>(7.084)</td>
<td>(7.939)</td>
<td>(8.360)</td>
<td>(6.700)</td>
<td>(8.436)</td>
<td>(5.044)</td>
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<tr>
<td>$r_{SMB}$</td>
<td>1.245***</td>
<td>1.471***</td>
<td>1.474***</td>
<td>1.067***</td>
<td>-0.116</td>
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<tr>
<td></td>
<td>(10.041)</td>
<td>(14.714)</td>
<td>(11.758)</td>
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<td>(-1.565)</td>
<td>(1.083)</td>
<td>(1.527)</td>
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<td>$r_{HML}$</td>
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<td>-0.459***</td>
<td>1.116***</td>
<td>0.859***</td>
<td>-0.195*</td>
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<td>(-2.105)</td>
<td>(1.542)</td>
<td>(3.607)</td>
</tr>
<tr>
<td>$r_{EMD}$</td>
<td>-0.165</td>
<td>1.262***</td>
<td>-0.288*</td>
<td>1.303***</td>
<td>-0.118</td>
<td>0.480***</td>
<td>0.030</td>
<td>0.415***</td>
</tr>
<tr>
<td></td>
<td>(-1.028)</td>
<td>(9.785)</td>
<td>(-1.028)</td>
<td>(8.064)</td>
<td>(-1.237)</td>
<td>(3.260)</td>
<td>(0.297)</td>
<td>(3.099)</td>
</tr>
<tr>
<td>$r_P$</td>
<td>0.299***</td>
<td>0.248***</td>
<td>0.405***</td>
<td>0.387***</td>
<td>0.214***</td>
<td>0.385***</td>
<td>0.228***</td>
<td>0.126***</td>
</tr>
</tbody>
</table>

$R^2$ | 0.572 | 0.712 | 0.644 | 0.593 | 0.414 | 0.406 | 0.406 | 0.244 |

$N$ | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 |

Econometric results for Equation (5): $r_c = \alpha + \beta_{EMD} + \beta_{HML} + \beta_{SMB} + \beta_{P} + \epsilon$, estimated by Ordinary Least Squares. t-values in brackets; ** Significant at 90, *** Significant at 95 and **** Significant at 99 per cent confidence level, respectively.

Return factors related to company size ($r_{SMB}$), book-to-equity ratios ($r_{HML}$), and exploration exposure ($r_{EMD}$) contribute significantly to explaining returns on portfolios of small oil stocks. In particular, the company-size factor appears to be important, with relevant betas above 1 for small stocks but much lower and statistically insignificant for large caps. This tendency is similar to the results of Fama and French (1996) studying a cross section of NYSE, AMEX and NASD stocks over the years 1963-1993. The lowest coefficient on the company-size
factor (-0.12) is found for the super majors, who are characterized by large company size, modest book-to-equity ratios, and low exploration exposure.

The coefficients on the book-to-equity factor \( \left( r_{F_{HML}} \right) \) vary from negative estimates for companies with low book-to-equity ratios to positive estimates in the range 0.17-1.12 for companies with high book-to-equity ratios. This is somewhat higher dispersion than in Fama and French (1996), but the inclination in coefficients across portfolios is similar. With the exception of the B/H/D portfolio, all estimated book-to-equity factors carry significant loadings. The difference between large caps and small caps with regards to the significance of the book-to-equity factor may be related to different accounting methods between different types of companies. Large caps by and large apply the successful efforts method for accounting for oil and gas upstream activity (see Wright and Gallun, 2005 and FASB, 1982 for a presentation of petroleum accounting methods). Under the successful-efforts method only costs incurred from the drilling of producible wells are capitalized and included on the balance sheets, and thus incorporated into book equity. Under the competing accounting method, the full cost method, all costs incurred from exploration activity are capitalized, and ultimately incorporated into book equity. The Full-cost method is the preferred choice among small oil and gas companies. Recent research has shown that figures produced by the Full-cost method are more relevant for the pricing of oil and gas companies than the successful-effort method (Bryant, 2003). This may explain the lack of statistical significance of the book-to-equity factor among large oil and gas companies.

In line with expectations, the loadings on the portfolios with high exploration exposure are higher than those with lower exposure. For the low-exploration portfolios, the exploration exposure factor takes coefficients in the range of -0.29 to 0.03, while those of the high exploration portfolios range from 0.42 to 1.30. Thus, our results indicate that investors require a higher rate of return when investing in exploration companies compared to companies that invest relatively more in field development. This result is in contrast to Talbot, Artiach and Faff (2013), who conclude that exogenous firm characteristics have less compelling economic significance than market conditions-type variables in their recent study of the commodity price beta of oil industry stocks.

Loadings from the exploration exposure factor are low and negative for portfolios with a bias towards development and production activities. Boyer and Filion (2007) find that changes in oil and gas production carry a negative beta, i.e. an increase in production leads to a decrease in stock returns. They put forth four
explanations for this unexpected finding. Firstly, the returns related to the production of crude oil and natural gas is concave so that energy firms experience decreasing returns to scale. Second, because the cost associated with the shutdown of a well is very large, energy companies continue to produce even if the average cost is superior to the average benefit. A third explanation is that increased production is a signal that many firms are pumping out the same oil patch, leading to a so-called “tragedy of the commons”. As a result oil and gas producers, acting in their own self-interest, generate lower industry profits than if they collaborated.10 A final possibility is that more production is associated with the exercising of an option of the possibility to drill proven reserve patches. By exercising this option, firms reduce the risk of their assets and thus their required stock return. Our results point to a fifth possibility. A low level of exploration activity combined with a high production rate indicates a low rate of reserve replacement. Future cash flows flowing to an oil and gas firm, and thus its value and expected returns, depend on that firm’s ability to continuously replace depleting reserves.

Although this paper has documented that industry-specific factors may help in the explanation of excess returns, this does not automatically mean that they should be included in cost of capital calculations. As Fama and French (2004) put it: “...the cost of capital is forward looking, so if the premiums are sample specific they are irrelevant”. For instance, the momentum effect of Jegadeesh and Titman (1993) has been described as the three-factor model’s most serious problem, but the effect is short lived and is largely irrelevant for estimates of the cost of equity capital (Fama and French, 2004). The reader should bear this in mind when contemplating to use empirical models on historical stock returns to calculate the cost of equity capital.

7. Conclusion

Estimation of expected return or cost of equity for individual stocks is an integral part of many financial decisions, such as portfolio management, capital budgeting and performance evaluation. The most popular approach involves the application of the capital asset pricing model (CAPM). On the other hand, empirical evidence from the academic literature has documented the failure of the CAPM in explaining excess stock returns and strongly suggests an alternative model, the Fama-French three-factor model. The success of this model is its ability to explain

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10 For a discussion on this topic see e.g. Osmundsen, Asche, Misund and Mohn (2006) and Osmundsen, Mohn, Misund and Asche (2007).
many of the asset pricing anomalies uncovered by researchers during the 1980s and 1990s.

One shortcoming of the Fama-French model is its lack of industry-specific fundamental factors. While a few studies have documented the importance of industry-factors in explaining asset excess returns, none have combined industry-specific factors with the important Fama-French risk factors. Our contribution lies in the combination of these two approaches, in an application that sheds new light on the valuation of oil and gas company stocks. The aim is to devise a more accurate model for explaining the determinants of oil and gas stock returns.

Our study provides robust empirical evidence for both Fama-French risk factors and an industry-specific fundamental risk factor in explaining the excess return on portfolios of oil and gas stocks. Excess returns on portfolios of oil and gas stocks over the years 1992-2005 are explained by excess returns on the market portfolio, company size, and book-to-equity factors identified by Fama and French, variation in oil exploration exposure, as well as variation in the oil price. This approach captures the risky nature of exploration of oil and gas reserves and adds quality to the current state-of-the-art approach to empirical asset pricing.

In conclusion, our model improves on both the CAPM and the Fama-French three-factor model in explaining the variation in oil and gas stock returns, and provides important input to cost of capital estimation. However, a cautionary note is required. The results from this paper are the product of analysis of historical returns. For cost of equity capital estimation, forward-looking estimates are required.
Appendix: Design of SMB, HML and EMD portfolios

The Fama-French (1996) methodology consists of several steps. First, monthly stock returns are calculated. Second, the monthly returns are sorted according to the value of the explanatory factors. For instance, the data are sorted from the highest to the lowest value of market capitalization of equity. Then, the stocks are divided into relevant groups, according to their factor rank. For example, stocks can be divided into the largest 50% and lowest 50% (2 groups). This is done for the size, book-to-market equity, and in this paper, industry factors. Finally, monthly returns are calculated for portfolios formed on the intersections between the various factor groups (company size (SMB), book-to-market ratio (HML), and exploration exposure (EMD)). Fama and French (1993, 1996) advocate the use of stock portfolios in order to reduce the idiosyncratic noise that otherwise would make it difficult to detect the presence of predictable components, facilitating the isolation of firm characteristics.

The explanatory return component of company size is created as follows. At the end of June each year \(t\) (1991-2005), oil company stocks are split into two equal-sized groups according to their market capitalization of equity. Similarly, the return component for book-to-equity variation is calculated by a split of the sample into two equal-sized groups according to their score on the book-to-market ratio. In the same way, expected returns from exploration exposure are calculated by a division of the companies into one group with high exploration exposure and one group with low exploration exposure. The ratio of exploration investments to development investments is chosen to measure exploration intensity. Exploration and development capital expenditure are drawn from the supplementary oil and gas activity disclosure that oil and gas companies are required to disclose as part of their annual 10k filing with the US Securities and Exchange Commission (SEC). Portfolio characteristics according to our three factors are summarised in Table 1.

Table A1. Summary of portfolio characteristics – and notation tags

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market capitalization</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>Book-to-equity ratio</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>Exploration exposure</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>

11 See the Statement of Financial Accounting Standards, SFAS No. 69 (FASB, 1982) for more details on the oil and gas firm supplementary disclosure requirements.
We now go on to define portfolios based on the intersections of the three pairs of groups defined in table 1. This yields the following eight portfolios:

1. S/L/D  
2. S/L/E  
3. S/H/D  
4. S/H/E  
5. B/L/D  
6. B/L/E  
7. B/H/D  
8. B/H/E

Value-weighted monthly returns are calculated from July (following month) to June the following year. The monthly difference in return between small companies (S) and large companies (B) is now given by the difference (each month) between the average of the returns on the four small-stock portfolios \((S/L/E + S/L/D + S/H/E + S/H/D)\) and the average of the returns on the four big-stock portfolios \((B/L/E + B/L/D + B/H/E + B/H/D)\):

\[
r_{SMBr} = R_{Sb} - R_{Bb} = \frac{1}{4}(S/L/E + S/L/D + S/H/E + S/H/D) - \frac{1}{4}(B/L/E + B/L/D + B/H/E + B/H/D). \tag{A1}
\]

Similarly, the difference in return between companies with high \((H)\) and low \((L)\) book-to-equity ratios is calculated as the difference between the monthly average returns on the four portfolios with high book-to-equity ratios and the corresponding returns of the for portfolios with low book-to-equity ratios:

\[
r_{HMLb} = R_{Hb} - R_{Lb} = \frac{1}{4}(S/H/E + S/H/D + B/H/E + B/H/D) - \frac{1}{4}(S/L/E + S/L/D + B/L/E + B/L/D). \tag{A.2}
\]

Finally, the difference in return between companies with high \((E)\) and low \((D)\) exploration exposure is calculated as the difference between the monthly average returns on the four portfolios characterised by high exploration exposure and the corresponding return for the four portfolios with low exploration exposure:

\[
r_{EMDr} = R_{Ee} - R_{Dd} = \frac{1}{4}(S/H/E + S/L/E + B/H/E + B/L/E) - \frac{1}{4}(S/H/D + S/L/D + B/H/D + B/L/D). \tag{A.3}
\]
Literature


