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Research Paper

Takeover likelihood in the oil and gas industry: firm-specific, macroeconomic or industry-specific causes?

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ABSTRACT

We show how industry-specific factors can be important determinants of takeover probability in the oil and gas industry. Several of the significant explanatory variables are industry related, such as the common factor oil price, or the more firm-specific factor of oil and gas reserves. We find that oil price is negatively linked to takeover likelihood, implying that oil and gas companies change their investment policy in a low oil price environment. They lower their exploration investments and increase acquisitions of other companies. In addition, we find that the takeover likelihood is associated with other nonindustry metrics such as firm-specific return on equity, undervaluation (book-to-market ratio), expected stock market volatility (Chicago Board Options Exchange volatility index) and general stock market returns.

Keywords: takeover likelihood; industry-specific factors; firm-specific factors; oil and gas industry.

1 INTRODUCTION

In this study, we investigate drivers of merger activity in the oil and gas sector. More specifically, we seek to ascertain how key determinants influence the takeover

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likelihood of oil and gas companies. While the literature suggests that financial ratios have only a limited usefulness in predicting takeover targets (Palepu 1986), other factors, both exogenous and firm specific, have been shown to improve model accuracy (Schleifer and Vishny 2003; Fridolfsson and Stennek 2005). Further, a growing literature suggests that industry association and industry-level factors may also play an important part in modeling takeover likelihoods (Mitchell and Mulherin 1996; Andrade *et al* 2001; Andrade and Stafford 2004; Harford 2005; Pasiouras and Tanna 2010). We use the oil and gas sector as a case study to examine the impact of macroeconomic, industry- and firm-specific factors on the takeover likelihood of an oil and gas company. Because of its size and importance to the global economy, it is plausible that the industry's merger activity can be influenced by all three categories of determinants.

Although the literature suggests that there are multiple reasons for merger activity, very little is known about how to identify takeover targets in the oil and gas industry. The industry is very capital intensive with long lead times, making sufficient funding of projects essential. If such financing fails owing to macroeconomic, industry-specific or firm-specific events, this may lead a failing firm into bankruptcy or corporate restructuring. A research question emerges: are mergers in the oil and gas industry affected by macroeconomic, firm-specific or industry-specific events or combinations of these? Insight into the importance of these determinants may help oil company management make appropriate adaptations to rapid changes to industry and macroeconomic business conditions. We identify key determinants empirically using a takeover likelihood model. If one or more variables capturing the drivers of merger activity are significant, then we can conclude that they play a part in explaining acquisitions.

We use a nineteen-year data set consisting of oil and gas companies drawn from the John S. Herold database (see https://ihsmarkit.com). The data set consists of 157 firms that were acquired over the period, plus 257 control firms that have not been part of a takeover.

We create variables capturing macroeconomic, industry- and firm-specific factors. The general business cycle is captured by the market return and the Chicago Board Options Exchange (CBOE) volatility index (VIX); industry-specific factors are captured by the oil price; and the general firm-specific factors that are controlled for are profitability, growth, cashflow and leverage. Industry-related firm-specific factors, such as amounts of oil and gas reserves and growth in reserves, are also included.

Our results indicate that all three categories are important in explaining the takeover likelihood. We find that takeover likelihood increases with decreasing profitability, with degree of undervaluation (a high book-to-market ratio), general market downturn (measured as stock market decreases and increased expected stock market volatility) and industry downturn (measured by a falling oil price). The takeover likelihood also

decreases with firm size, which is consistent with other studies. In all, the results show that macroeconomic, industry- and firm-specific events affect the takeover likelihood in the oil and gas sector.

Ng and Donker (2013) demonstrate that acquirers of oil and gas companies are motivated to purchase reserves, while targets are motivated to sell their stocks based on commodity market timing. We build on their study, and provide insight into the importance of reserves and commodity price changes on the likelihood of takeovers. An important insight gained from our study is that there seems to be a negative relation between oil prices and takeover activity. A fall in oil prices leads to an increase in takeovers, implying that oil and gas companies change their investment policy in a low oil price environment: they lower their exploration investments and increase acquisitions of other companies.

The remainder of this paper is organized as follows. First, in Section 2 we provide a review of the relevant literature on takeover likelihood estimation. In Section 3, we describe the methodology. This is followed in Section 4 by a description of the data set. Section 5 contains the results and the discussion of the results. Section 6 presents our conclusions.

2 PREVIOUS LITERATURE

The literature on the application of financial statement information for forecasting certain aspects of business is vast. In particular, one strand of the literature, which examines the use of financial ratios for firm failure, has been quite prolific. During the 1960s and 1980s, several studies developed statistical methods for the prediction of business failure using financial ratios as predictors. These studies showed that credit risk could be quite accurately predicted using financial metrics such as interest coverage, financial leverage and profitability (Beaver 1967, 1968; Altman 1968, 1984; Ohlson 1980; Zmijewski 1984). A substantial literature has evolved from these pioneering studies. More recent studies on business failure prediction have focussed on applying artificial intelligence and machine learning methods, such as neural networks (Odom and Sharda 1990), genetic algorithms (Back *et al* 1996; Anandarajan *et al* 2001), support vector machines (Shin *et al* 2005; Min and Lee 2005; Sun and Li 2012) and decision trees (Gepp *et al* 2010; Misund 2016). In addition to the attention they receive from the academic community, credit risk models are used extensively by banks and rating agencies to determine firms' credit risks and credit ratings.

Following the success of credit risk models, several academic studies have examined another aspect of the predictive use of financial information: takeover likelihood estimation. Similar to the credit risk research, this line of research examined the ability of financial ratios to predict whether a firm is likely to be acquired by another. The ability to identify takeover targets can form the basis for potentially successful

investment strategies. However, this strand of research has found mixed results. Early studies reported a remarkable ability to predict acquisition targets (Simkowitz and Monroe 1971; Stevens 1973; Castagna and Matolcsy 1976; Belkoui 1978; Dietrich and Sorensen 1984). However, Palepu (1986) argued that the results from these early studies were biased by methodological flaws. After correcting these flaws, Palepu demonstrated that it is very difficult to accurately predict acquisition targets. Barnes (1998) argued that it is not possible to identify takeover targets solely using published accounting data as inputs. Recently, Brar *et al* (2008) have included factors such as market sentiment to improve model success.

Other factors might be more important than financial ratios in predicting mergers. In fact, the literature suggests that mergers often come in waves, driven by both exogenous macroeconomic cycles (Schleifer and Vishny 2003) and endogenous factors that may lead to cyclical patterns in merger activity (Fridolfsson and Stennek 2005). Size is a relevant factor to consider, since smaller companies may be easier targets for takeovers than larger firms (Offenberg 2009). Kastrinaki and Stoneman (2012), on the other hand, find that medium-sized firms are more likely to be acquired than small firms.

Moreover, industry association and industry-level factors may also play a part (Mitchell and Mulherin 1996; Andrade *et al* 2001; Andrade and Stafford 2004; Harford 2005). Loveland and Okoeguale (2016), studying the banking industry, find that industry-wide activity, such as risk taking, can affect merger activity. Moreover, Ovtchinnikov (2013) finds that merger waves often follow industry deregulation, and Pasiouras and Tanna (2010) find that industry-specific variables improve classification accuracy.

In conclusion, the literature suggests that common macroeconomic events (such as stock market development), firm-specific factors (such as size, profitability and leverage, measures of under- or overvaluation) and industry-specific factors can all explain merger activity. We include measures for all these factors in our empirical model for estimating the takeover likelihood of oil and gas firms.

3 METHODOLOGY

We apply a multivariate logit probability model to specify the relationship between a firm's characteristics and its takeover probability. The logit model (see (3.1) and (3.2)) estimates the probability of the dependent variable being equal to 1 ($Y = 1$), in other words, the event of an oil and gas company being acquired. The vector $\boldsymbol{X}$ represents the independent variables capturing firm-specific characteristics and factors external to the firm:

$$\Pr(Y = 1 \mid X_1, X_2, \ldots, X_k) = F(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k). \quad (3.1)$$

The econometric model for the takeover probability is specified as

$$\Pr(Y = 1 \mid X_1, X_2, \ldots, X_k) = \frac{1}{1 + \exp(-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k))}, \tag{3.2}$$

where $\beta_1, \ldots, \beta_k$ are the parameters to be estimated.

We now turn to the choice of firm characteristics we believe can potentially affect the takeover probability of oil and gas firms. The choice is partly based on the factors identified in previous studies (see Dietrich and Sorensen 1984; Palepu 1986; Powell 1997; Espahbodi and Espahbodi 2003; Ng and Donker 2013). We include variables linked to management efficiency, historical growth, debt, cashflow and tangible assets. However, since we study a specific industry, we also include several industry-related firm-specific characteristics we expect to influence takeover probability. These are the size of reserves and growth in reserves. Nonfirm industry-specific factors are captured by the oil price. Below we briefly explain the rationale for our choice of explanatory variables.

3.1 Firm-specific factors

3.1.1 Management efficiency

If management is perceived to have failed to maximize shareholder value, investors may seek to replace the management team by more efficient managers (Palepu 1986). Return on equity (ROE) is used as a proxy for management performance. We expect this variable to be negatively correlated to acquisition probability: a lower accounting ROE will result in a higher probability that the firm becomes a target for a takeover. ROE is averaged over the three years prior to the takeover year.

Asset turnover can serve as another proxy for management inefficiency (Dietrich and Sorensen 1984). The asset turnover ratio measures the company's ability to generate sales from assets. As a low turnover ratio can indicate inefficient use of resources, we expect a negative relationship between turnover rate and acquisition probability, by the logic that investors see opportunities to improve the company's financial performance by changing the management team. The asset turnover ratio is averaged over the last three years before the takeover year.

3.1.2 Historical growth

We apply two measures of growth: historical growth in sales, and historical growth in oil and gas reserves. As a measure of historical growth, we use the average growth in the three years before the company was acquired. We expect that a higher level of historical growth of a company will be linked to a lower acquisition probability.

3.1.3 Leverage

There are several reasons why the relationship between leverage and acquisition probability can be negative. First, we expect leverage to be negatively correlated with the probability of takeover, as acquisition of companies with a high leverage ratio can be more costly to finance (Espahbodi and Espahbodi 2003). Second, firms with more growth options have lower leverage (Smith and Watts 1992). If growth is negatively correlated to acquisition probability, then this is another argument for a negative relationship between leverage and acquisition probability. Third, debt can also have a role in motivating organizational efficiency, as leverage can reduce the agency costs associated with free cashflow since interest payments and down payments of loans reduce free cashflow. We construct the debt–equity ratio as the amount of long-term debt divided by the market value of equity.

3.1.4 Book-to-market ratio

A high book-to-market ratio means that the book value of the firm's equity is higher than the market value of the equity. This may be a result of an undervaluation of the firm's equity, or of the firm being engaged in projects with negative net present value. The book value of equity being above its market value also implies that the market value of the firm is below the book value of the assets. This represents a profit opportunity for potential acquirers that want to break up the company and sell the individual parts. Another reason to acquire a firm with a high book-to-market ratio may be to change the company's investment policy to focus on profitable projects that will add value to investors. In our study, we use the book-to-market ratio as a proxy for the undervaluation of a firm's equity. A high book-to-market ratio can indicate that a firm is undervalued and will be an attractive target for a takeover. We therefore expect that this ratio is positively correlated to takeover probability. This variable is constructed by dividing the book value of equity by the market value of equity.

3.1.5 Cashflow

Another proxy for investment opportunities is the ratio of free cashflow to total assets. A positive free cashflow indicates that the firm is generating more cash from existing projects than it is investing in new projects. This variable can therefore be a proxy for investment opportunities. High free cashflow suggests low investment opportunities, and low or negative free cashflow is a proxy for high investment opportunities. We expect that the more free cashflow a potential target firm has, the more likely it is that it will be acquired, so that the acquiring firm can take advantage of the cashflow to make new investments. High levels of free cashflow can also increase agency costs. Jensen (1986) developed an "agency costs of free cashflow" theory of takeovers, proposing that managers have incentives to grow firms in size, even if they have to engage

in negative net present value projects to do so. Therefore, according to this theory, managers will spend excess funds on projects that reduce shareholder value rather than distributing cash to shareholders in the form of dividends. We therefore expect a positive relationship between cashflow and takeover probability. This variable is calculated as net cashflow from operating activities (after working capital changes) divided by total assets. We divide free cashflow by the total assets to remove the effect of firm size from the cashflow variable.

3.1.6 Size of reserves

To secure future production of oil and gas, petroleum reserves must be acquired by oil and gas companies. As an alternative to engaging in risky exploration activities,[1] firms can obtain oil and gas reserves by acquiring companies that have already made these risky investments and have succeeded in finding reserves. Therefore, the size of reserves might be positively correlated to acquisition probability, because a company with a large amount of reserves might be an attractive takeover target. As shown in Table 1, the size of reserves is highly correlated with the market value of oil and gas companies. In previous studies (see, for example, Dietrich and Sorensen 1984), market value is found to be negatively correlated to acquisition probability. Therefore, the relation between the size of reserves and takeover probability is uncertain.

3.1.7 Tangible assets

Ambrose and Megginson (1992) find that the ratio of tangible fixed assets to total assets increases the probability of takeover. Several explanations for this observation have been proposed in the literature (see Ambrose and Megginson (1992) for a review). The acquirer of a firm that has a large proportion of fixed assets can use the target's own assets as security for financing the takeover. Ambrose and Megginson also suggest that firms operating in industries where economies of scale are present can be acquired to allow the acquiring firm to increase their production capacity. Therefore, we expect a positive relationship between tangible assets and acquisition probability. The three-year average of tangible assets before the year the company was acquired is used in the econometric analysis.

3.2 Macro factors

3.2.1 Market return

We include the return on the Standard & Poor's 500 (S&P 500) index to measure how general stock market returns influence the acquisition probability in the oil and gas sector. It may be that investors seek to increase growth in times of negative

[1] Misund *et al* (2017) examine how investors value exploration risk.

market returns by acquiring oil and gas companies. We therefore expect a negative relationship between market return and acquisition probability.

3.2.2 CBOE volatility index

VIX is referred to as the "investor fear gauge" (Whaley 2000). It is a measure of the implied volatility of S&P 500 index options, and therefore serves as a proxy for expected stock market risk. To the best of our knowledge, this variable has not been investigated in the takeover literature before. Increased stock market uncertainty may lead oil and gas companies to wait for uncertainty to be reduced before deciding to expand their operations through acquiring another company. We therefore expect this variable to be negatively correlated to acquisition probability.

3.3 Industry-specific factor

3.3.1 Oil price

Weston *et al* (1999) point out that oil price instability has characterized the petroleum sector for decades, and is a likely determinant of corporate restructuring.[2] Lower oil prices give lower profit margins, and cuts in costs become necessary. In times of high oil prices, oil and gas companies may seek to increase production. A quick route to increased production capacity is through acquisitions. Higher oil prices give rise to optimism in the industry, and oil and gas companies invest more in exploration projects (Mohn 2008). We therefore expect to see a positive relationship between oil price and takeover probability. However, there might also be a negative relationship between the oil price and acquisition probability: in times of low oil prices, companies may turn to acquisitions to achieve further growth. In addition, companies may be forced to merge as a way to cut costs if the merged company can operate with fewer employees. This explanation is consistent with observations in the oil and gas industry at the time of writing. We find in this paper that the lagged oil price has a higher significance level than the current oil price in the takeover model, and therefore include this variable in lag form.

4 DATA

Our sample of international oil and gas companies (1997–2015) is drawn from the John S. Herold Company's (IHS Herold) oil and gas financial database.[3] The Herold

[2] Recent research also suggests that oil price changes have a substantial impact on oil company returns (Ramos *et al* 2017).

[3] Founded in 1948, John S. Herold Inc. is an independent research firm that specializes 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 500 oil and gas companies (see https://ihsmarkit.com).

TABLE 1 Pearson correlation coefficients for explanatory variables.

	ROE	Turnover	Sales growth	Growth in reserves	D/E	FCF/ assets	Market value	Reserves	Tangible assets	Oil price	Market return	Book-to-market
Turnover	0.2201*											
Sales growth	0.0152	−0.1958*										
Growth in reserves	−0.0523*	−0.1926*	0.3587*									
D/E	−0.2325*	−0.2968*	0.0185	0.0730*								
FCF/assets	0.2709*	0.1218*	−0.0369	−0.1184*	−0.1552*							
Market value	0.12	0.54	−0.12	−0.15	−0.28	0						
Reserves	0.1219*	0.5336*	−0.1168*	−0.1040*	−0.2090*	−0.0089	0.8204*					
Tangible assets	0.0714*	0.0176	0.0507*	−0.0327	−0.0793*	0.0552*	−0.0431	0.1692*				
Lagged oil price	−0.0856*	−0.1314*	−0.0510*	0.0489*	−0.004	−0.0456*	0.0706*	0.0009	−0.4197*			
Market return	−0.0546*	−0.0216	−0.0314	−0.0188	0.0725*	−0.0044	−0.0435	0.0021	−0.0381	0.0035		
Book-to-market	−0.0985*	−0.0889*	−0.0291	0.0217	0.3138*	−0.0987*	−0.0986*	−0.0068	−0.1276*	0.2028*	0.1486*	
VIX	0.0513*	0.0540*	0.0408*	0.0058	0.0236	0.0367	0.0383	−0.0084	0.0762*	−0.1746*	−0.6301*	−0.0729*

ROE is the net income divided by shareholder equity. Turnover is sales divided by total assets. Growth in sales and growth in reserves are the average three-year historical growth rates. D/E is long-term debt divided by the market value of equity. FCF/assets is cashflow from operations divided by the book value of total assets. Market value is the market value of equity. Reserves is the total oil and gas year-end reserves in barrel-of-oil equivalents. Tangible assets is fixed assets divided by total assets. Market return is the return on the S&P 500. Lagged oil price is the end-of-year oil price in the year before the acquisition. Book-to-market is the book value of equity divided by the market value of equity. VIX is the implied volatility of the S&P 500 index options. The asterisk indicates Pearson correlation coefficients that are significantly different than zero at the 5% level (two tailed tests).

TABLE 2 Descriptive statistics.

	Mean	SD	Minimum	Maximum
ROE	0.12	0.28	−2.04	2.30
Turnover	0.48	0.34	0.07	2.12
Sales growth	0.30	0.44	−0.38	4.60
Growth in reserves	0.20	0.50	−2.24	13.49
D/E	0.23	0.17	0.00	0.98
FCF/assets	0.15	0.08	−0.34	2.41
Reserves	1541	3883	0.49	40 607
Tangible assets	0.11	0.10	0.00	0.93
Lagged oil price	65.84	33.72	11.31	112.93
Market return	0.07	0.18	−0.38	0.31
Book-to-market	0.68	0.66	−1.88	14.87
VIX	20.23	7.10	11.56	40.00

ROE is net income divided by shareholder equity. Turnover is sales divided by total assets. Growth in sales and growth in reserves is the average three-year historical growth rate. D/E is long-term debt divided by market value of equity. FCF/assets is cashflow from operations divided by the book value of total assets. Reserves is the total oil and gas year-end reserves in barrel-of-oil equivalents. Tangible assets is fixed assets divided by total assets. Market return is the return on the S&P 500. Lagged oil price is the end-of-year oil price in the year before the acquisition. Book-to-market is the book value of equity divided by the market value of equity. VIX is the implied volatility of the S&P 500 index options. SD denotes standard deviation.

database consists of financial and operating data from annual financial statements of more than 500 publicly traded energy companies worldwide. Table 1 reports Pearson correlation coefficients for the explanatory variables. We observe that reserves and market value have a correlation of 0.82, and therefore these variables will not appear together in the econometric takeover model. Descriptive statistics for the variables in our model are reported in Table 2.[4]

The database has an entry that indicates whether a company has been acquired, and the year of acquisition. A total of 296 companies were acquired in the sample period. Of these, 229 had data on reserves and 157 had data on all variables. As control firms, we selected all oil and gas companies with the necessary data available that were not acquired in the sample period. The resulting control sample consisted of 257 oil and gas companies. We observed that some of the research applying logit models in the takeover literature and the bankruptcy literature uses a control group that is the same size as the treatment group, while others use all available firms in the control group. Our impression is that there are more studies using the latter approach, so this is why we chose to include all firms in the control group.

[4] We winsorize 0.5% of the upper and lower tail of the distribution of all company-specific variables to avoid any outliers influencing our results.

TABLE 3 Number of oil and gas companies acquired per year.

Year	Number of companies acquired
1997	3
1998	7
1999	7
2000	12
2001	18
2002	10
2003	6
2004	10
2005	10
2006	9
2007	11
2008	3
2009	6
2010	9
2011	4
2012	9
2013	10
2014	7
2015	6

The average number of acquired companies in the sample was 8.3 per year (Table 3). We observed that there were periods of high and low acquisition activity. From 2000 to 2002 there were on average 13.3 acquisitions per year. In the period leading up to the financial crisis, 2004–7, we observed another wave of acquisition activity, with an average of ten per year. We observed periods of low activity immediately after both periods of high merger activity.

In Table 4, we compare acquired firms with control firms when it comes to firm-specific variables. Specifically, we test for equality of means between acquired companies and control companies, performing a Welch (1947) t-test.

We observe that acquired firms have significantly lower mean ROE (five percentage points lower) than nonacquired firms. This indicates that management inefficiency, ie, management not being able to generate enough ROE for the shareholders, may lead to the company becoming a target for acquisition. We also find that acquired firms have significantly lower amounts of reserves (59% lower). This lends support to the hypothesis that firm size is negatively correlated to acquisition probability. The smaller the company, the easier it can be to acquire it. Furthermore, the acquired

TABLE 4 Mean values of company-specific variables for acquired and control companies.

Variable	Acquired	Control	Acquired/ control	t-test
ROE	0.07	0.12	0.58	2.50**
Turnover	0.44	0.48	0.92	1.37
Growth in sales	0.34	0.30	1.13	−1.05
Growth in reserves	0.22	0.19	1.16	−0.44
Debt ratio	0.24	0.23	1.04	−0.47
Free cashflow/total assets	0.15	0.15	1	−0.13
Reserves	658	1602	0.41	5.87***
Tangible fixed assets/total assets	0.13	0.11	1.18	−2.09**
Book-to-market	0.74	0.67	1.10	0.7

Return on equity (ROE) is net income divided by shareholder equity. Turnover is sales divided by total assets. Growth in sales and growth in reserves are the average three-year historical growth rates. Debt ratio is long-term debt divided by market value of equity. Free cashflow/total assets is cashflow from operations divided by the book value of total assets. Reserves is the total oil and gas year-end reserves in barrel-of-oil equivalents. Tangible fixed assets/total assets is the ratio of tangible fixed assets to the book value of total assets. Book-to-market is the book value of equity divided by market value of equity. t-test is the t-test for difference in mean values (negative t-values indicate that the mean number of acquired firms is higher than for control firms, and vice versa). *, ** and *** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively.

firms group has a significantly higher ratio of mean tangible assets to total assets than the control group (18% higher than control firms). For the other firm-specific variables, we cannot reject the null hypothesis of no difference in means between the two groups. Table 4 is mainly for information and data description, as we cannot infer causal relationships from such an analysis. Therefore, we now turn to the estimation results for the logit model presented in Section 3, to investigate which firm-specific, industry-specific and macroeconomic factors can predict takeover targets in the oil and gas industry.

5 RESULTS AND DISCUSSION

As we observe in Table 5, several of the significant variables are industry related (either firm-specific such as reserve size, or common such as the oil price). Oil prices, reserves, ROE and stock market returns are negatively correlated to takeover likelihood. Interestingly, implied volatility is also negatively correlated to takeover activity.

The logistic slope coefficients in the third column of Table 5 can be interpreted as showing how a unit change in the explanatory variable affects the log of the odds when the other variables in the model are held constant. The last column of Table 5 shows the odds ratios, which are interpreted as the effect of a unit change in explanatory variable

TABLE 5 Estimation results.

Variable	Expected sign	Coefficient	Odds ratio
ROE	−	−0.84** (0.01)	0.43
Turnover	−	0.1 (0.73)	1.11
Sales growth	−	0.16 (0.41)	1.17
Growth in reserves	+	0.05 (0.76)	1.05
D/E	−	−0.77 (0.2)	0.46
FCF/assets	+	0.60 (0.50)	1.82
Reserves	?	−0.001** (0.02)	0.999
Tangible assets	+	−0.72 (0.51)	0.49
Lagged oil price	?	−0.02*** (0.00)	0.98
Market return	−	−1.79*** (0.00)	0.17
Book-to-market	+	0.32*** (0.01)	1.38
VIX	−	−0.04*** (0.01)	0.96
Constant		−0.76 (0.16)	0.47
Pseudo R^2		0.05	

ROE is net income divided by shareholder equity. Turnover is sales divided by total assets. Growth in sales and growth in reserves are the average three-year historical growth rates. D/E is long-term debt divided by market value of equity. FCF/assets is cashflow from operations divided by the book value of total assets. Reserves is the total oil and gas year-end reserves in barrel-of-oil equivalents. Tangible assets is fixed assets divided by total assets. Market return is the return on the S&P 500. Lagged oil price is the end-of-year oil price in the year before the acquisition. Book-to-market is the book value of equity divided by the market value of equity. VIX is the implied volatility of the S&P 500 index options. p-values are given in brackets. *, ** and *** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively.

on the predicted odds ratio when the other variables in the model are held constant. The odds ratio is calculated by taking the exponential of the logistic slope coefficient. An odds ratio below 1 indicates a negative relationship between the explanatory variable and takeover probability. An odds ratio above 1 indicates a positive relationship. When interpreting the odds ratio it is helpful to look at how much it deviates from 1. If an

odds ratio for an explanatory variable is 0.75, then a unit increase in this variable reduces the odds of acquisition by 25% ($0.75 - 1$).

The negative coefficient on the oil price is surprising. We would expect that it is more attractive to take over other companies when the oil price is high. One hypothesis consistent with this result is the following: when the oil price is low, companies turn to acquisitions to achieve further growth. When the oil price is high, companies become more focused on accelerating production from existing fields, and are also focused on carrying out more exploration (Mohn 2008) rather than looking for companies to acquire to achieve further growth. It may also be the case that potential takeover targets will resist takeover more when oil prices are high, in order to take advantage of more favorable market conditions and improve their profitability. Previous studies clearly show that oil company profitability increases with the oil price, and that this has a strong influence on market values (Osmundsen *et al* 2006; Dayanandan and Donker 2011; Misund *et al* 2008; Misund and Osmundsen 2015).

As mentioned in Section 4, there is a high degree of correlation between the market value and size of reserves. Therefore, these two explanatory variables cannot appear together in the empirical model. In order to decide which of the these two variables to include, we ran two separate regressions, one with the market value as an explanatory variable, and the other with the size of reserves as an explanatory variable. The results showed that while market value had a p-value of 0.051, the size of reserves had a p-value of 0.02. We therefore included the size of reserves instead of the market value in our final takeover model. Both variables are negatively correlated to takeover probability. In previous studies (for a review see Dietrich and Sorensen (1984)), market value was also found to be negatively correlated to acquisition probability. Dietrich and Sorensen (1984, p. 396) theorized that "smaller-sized firms decrease acquisition costs and facilitate ease of acquisition". This may also serve as an explanation for the negative correlation between reserve size and acquisition probability. Moreover, oil and gas reserves are closely linked to market values (Ewing and Thompson 2016).

The significant negative coefficient on ROE is consistent with the management performance explanation. ROE is used as a proxy for management performance. A low or negative ROE is interpreted by shareholders as management failing to maximize their shareholder value, and they seek to replace the management team with more efficient managers (Palepu 1986).

The only variable with a positive association to acquisition probability is the book-to-market ratio. A high book-to-market ratio indicates the undervaluation of a company. Undervalued companies may be attractive takeover targets, especially if the valuation error is expected to be corrected in the near future. However, it is important to mention Palepu's criticism of the hypothesized association of market-to-book ratio with takeover probability (see Palepu 1986): firms with low market-to-book ratios

are not necessarily cheap buys. This is because the book value of the firm does not necessarily provide a good estimate of the replacement value of the assets.[5]

Macro factors, such as market return and the VIX, also significantly affect the acquisition probability of oil and gas companies. We find that market returns are negatively correlated to acquisition probability. It may be that investors who seek to increase growth in times of negative market returns acquire oil and gas companies. The VIX also negatively affects acquisition probability: the higher the expected stock market risk, the lower the probability of an acquisition in the oil and gas industry. One interpretation consistent with this result is that in times of high stock market risk potential acquirers prefer to defer the decision to acquire (or not) at a later point in time when the uncertainty has been reduced to an acceptable level. To the best of our knowledge, this variable has not been investigated in the takeover literature before.[6]

6 CONCLUSIONS

In this paper, we have shown that acquisition probability in the oil and gas industry is affected by different factors than those revealed in previous cross-sectional studies. We applied a logit model on company-specific, industry-specific and macroeconomic factors hypothesized to influence to acquisition probability. Our results suggest that several of the significant explanatory variables are industry specific. Oil price, reserves, ROE, implied volatility (VIX) and stock market returns are negatively correlated to takeover likelihood, and the book-to-market ratio has a positive association with acquisition probability.

Moreover, the oil price is negatively correlated to takeover probability, suggesting that, as the oil price reduces, companies change their investment policy, turning to acquisitions to achieve further growth. As the oil price increases, companies become more focused on accelerating production from existing fields, and invest more heavily in exploration projects (Mohn 2008).

Further, the size of reserves is negatively correlated to acquisition probability. As Table 1 shows, the size of reserves is highly correlated with the market value of oil and gas companies. Firms with large reserves are bigger (in terms of market value), and in a takeover of a larger company there may be higher acquisition costs (Dietrich and Sorensen 1984).

We also find a significant negative coefficient on ROE. This is consistent with the management performance explanation. If management is unable to deliver a satisfactory return on shareholders' equity, the probability of a takeover increases. Low or

[5] Issues related to accounting book values in the oil and gas sector are discussed by Harris and Ohlson (1987), Osmundsen *et al* (2006, 2007), Misund *et al* (2008, 2015) and Misund (2016).

[6] A related topic, the relationship between stock market uncertainty and investments in the oil and gas sector, is studied in, for example, Mohn and Misund (2009).

negative returns on equity are also interpreted by shareholders as failure of the existing management to maximize shareholder value, and investors may seek to replace the management team with a more efficient one (Palepu 1986).

Market return is also negatively correlated to acquisition probability. When market returns are negative, it might become easier to take over a company. It may also be that investors seek to increase growth in times of negative market returns by acquiring oil and gas companies. The VIX is the last of the significant variables. The higher the expected stock market risk, the lower the probability of an acquisition in the oil and gas industry. To the best of our knowledge, this variable has not been investigated in the takeover literature. One explanation that is consistent with this finding is that in periods of high uncertainty investors looking for takeover targets prefer to wait until the uncertainty is reduced to a low level before considering acquiring another company.

Our paper also illustrates an important point that should be considered when conducting research on acquisition probability: it is important to use industry-specific factors in predicting takeover targets. Most of the research on corporate takeover is conducted with cross-sectional data, and industry-specific control variables are left out of the estimation. In the oil and gas industry several of the significant factors are industry specific, eg, oil price and reserve size.

An important policy implication emerges from this research: if a company in the oil and gas industry wants to avoid being acquired, it should enhance its antitakeover measures in the following business environments: in times of low oil prices, low stock market volatility expectations, negative stock market returns or when its stock is undervalued.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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