GRA 19502
Master Thesis

Hedging Evidence from Oil and Gas Exploration Firms

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Table of Contents

1. Introduction

The motivation behind this study can be summed up in a chart; a chart of historic oil and gas prices. Looking at the massive variability in prices during the last decade we are left wondering in what degree companies with a high exposure manage the risk and in what way they are rewarded for doing so. Do the firms hedge through financial derivatives contracts? What are the determinants of hedging? And; does hedging add value?

According to Miller and Modigliani's irrelevance propositions (1958), risk management should be irrelevant in a world with perfect capital markets. However, real world frictions may prove to contribute with a value premium for firms that hedge. In this paper we wish to investigate both what motivates oil and gas exploration firms to hedge, and whether hedging through financial derivatives contracts add value. Also, in order to make sure we draw valid conclusions on the above research questions, we will investigate to what extent the firms are exposed to oil and gas price fluctuations and whether hedging in fact decreases this exposure.

There has been a great deal of research focusing on these questions in several different industries, but the results are quite diverse. We wish in this paper to contribute to previous research with up-to-date data and both more firms and a longer timeframe than many other previous studies. Our analysis will be conducted in a similar fashion as Jin and Jorion's (2006) study on 119 U. S. oil and gas producers from 1998 to 2001. While Jin and Jorion (2006) verify that hedging reduces the firms' stock price sensitivity to oil and gas prices, they do not find that hedging seem to affect the market value of firms in this industry. Our study will consist of about the same amount of companies as Jin and Jorion (2006), but the timeframe will be 2004 to 2015. With more recent data we are able to not only investigate if the firms receive a premium or not, but also if events like the financial crisis and the recent turbulence in oil and gas prices have changed the outlook of investors. To avoid survivorship bias, we include both firms that are introduced during this time and firms that seize to exist. The latter case will be especially interesting; are there more or less use of financial derivatives contracts in firms that have gone bankrupt?

As argued by Jin and Jorion (2006), oil and gas exploration companies are ideal for studying the relationship between hedging and market values. Firstly, changes in the commodity prices have substantial effects on cash flows and stock prices. Secondly, the exposure of oil and gas companies to energy prices are easy to identify from the companies' financial reports (10-Ks), which means that investors might take a position in such companies to gain exposure to energy prices. While other researchers, such as Carter et al (2006), think this causes biased results, as the investors may prefer the companies to be exposed, Jin and Jorion (2006) argue that it creates a situation closer to that of the Miller and Modigliani assumptions. Thirdly, oil and gas exploration firms are quite homogenous in their firm characteristics but at the same time there are great differences in the firms' hedging ratios. This makes it easier to avoid the problem of omitted variable bias. Fourthly, due to detailed information in the firms' 10-Ks on oil and gas reserves, we are able to create more reliable estimates of Tobin's Q than we can in many other industries. Lastly, oil and gas exploration firms are severely capital intensive, which means that we can investigate the effects of leverage, and possibly even the motives for hedging, like mitigation of underinvestment.

The remainder of this paper is structured as follows. In section 2 we give a review of relevant risk management literature and empirical results. In section 3 we provide the theoretical background. In section 4 we present our hypotheses and methodology of which we will use to estimate the desired relations. In section 5 we include a plan for execution and thesis progression. Later on this spring we will turn in an extended version of this paper where the empirical results are included.

2. Empirical Background

Empirical evidence on whether hedging enhances firm value are diverging in their results. While some empirical evidence supports the economical rationalities of hedging (Allayannis & Weston, 2001; Pérez-González & Yun, 2013; Krause & Tse, 2015; Carter, Rogers, & Simkins, 2006), other suggests that hedging is insignificant for firm value (Guay & Kothari, 2003; Jin & Jorion, 2006) and some suggests that hedging actually affect firm value negatively (Lookman, 2004). Another argument is that the effect of hedging depends on different price trend scenarios (Chang, Lai, & Chuang, 2010).

A study suggesting evidence of a hedging premium is the one conducted by Pérez-González and Yun (2013). Using the introduction of weather derivatives as an exogenous shock to firms' ability to hedge weather risk, the study suggests that the use of derivatives lead to higher valuations, investment, and leverage. Another study suggesting a hedging premium is the one conducted by Allayannis and Weston (2001). Using a sample of 720 large US non-financial firms exposed to exchange rate volatility, the study suggests a hedging premium of on average 4,87% of firm value. Further, Krause and Tse (2015) examine 70 studies in recent risk management theory and suggest that it is becoming increasingly clear that there is value in risk management. The evidence points to the benefits of risk management in the creation of firm value in the way of lower cost of capital and decreased potential cost of financial distress.

In examining risk management in commodity prices, Kruse and Tse (2015) found that higher firm value only seems to accrue to commodity consumers (e.g. airlines) as opposed to commodity producers (e.g. oil and gas producers). Such a hedging premium for airlines was suggested in a study by Carter, Rogers and Simkins (2006). In this study there is found an average hedging premium for airlines in the range 5% to 10%. This value premium suggests that hedging allows airlines greater ability to fund investment during periods of high jet fuel prices. Further, the positive relation between hedging and value suggest that investors view such investment as positive net present value projects.

A study supporting Krause and Tse's (2015) finding of a lack of hedging premium for commodity producers, is the study on 119 U.S. oil and gas companies from 1998 to 2008 by Jin and Jorion (2006). Jin and Jorion (2006) verify that hedging reduces the firm's stock price sensitivity, but find that hedging does not seem to affect the market value of firms in this industry. They argue that the positive value effect of hedging found by Allayannis and Weston (2001) might be hard to interpret because of a biased selection of data. Allayannis and Weston's (2001) sample includes firms across industries, all with assets greater than $500 million. Thus it is unclear whether smaller firms receive a hedging premium as well, or if the hedging premium suggested is due to other effects, like operational hedges, that are correlated with derivatives positions. On the other hand, Carter et al.

4

(2006) criticize the study by Jin and Jorion (2006) as their results may be biased from, by their own admission, selecting a sample in which investors might not prefer firms to hedge.

Guy and Kothari (2003) also question the validity of Allayannis and Weston (2001), and, as Jin and Jorion (2006), they suggest the insignificance of hedging policies. Through investigating 234 large non-financial corporations using derivatives, Guay and Kothari (2003) examine the economic importance of financial derivatives as a part of corporate risk management. They find that the magnitudes of the derivatives positions are quite small compared to cash flows or movements in equity values. This is explained by the fact that much of the overall risk facing non-financial firms cannot be managed through the use of standard derivatives contracts. Further, they point out that some studies, like Allayannis and Weston (2001), do not measure if the derivatives position is sufficiently large to produce benefits for the firms by such magnitudes that are found. Guay and Kothari (2003) conclude that the observed increase in market values is driven by other risk management activities that are positively correlated with derivatives positions, or that the observed increase in market values is spurious.

When it comes to research on whether hedging adds value in oil and gas exploration and production firms, the results also diverge across studies. Similarly to Jin and Jorion, Lookman (2004) also finds no relation between derivatives use and firm value in the aggregate. However, he finds that for exploration and production firms where commodity price risk is a primary risk, hedging contributes with lower firm value. Further, for more diversified firms where commodity price risk is a secondary risk, hedging contributes to higher firm values. Another study, by Chang et al. (2010), measures hedging effectiveness in different price senarios in energy futures markets through eight hedging models. The study suggests that hedging effectiveness of crude oil and gas futures is significantly better during an increasing price pattern than in a decreasing price pattern. Thus to optimize the use of derivatives, firms should switch between different hedging models within different price-movement patterns.

Although the effect of hedging on firm value cannot be clearly established in empirical research, hedging through derivatives is still considered to be an

important part of a firm's risk management strategy. In Carter et al.'s (2006) investigation on hedging in the airline industry, they find that the benefits of hedging are related to capital investments in the way of protecting airlines from underinvesting in bad times. This is in accordance with Froot, Scharfstein and Stein (1993), who suggest that when external finance is costlier than internally generated sources of funds, it can make sense for firms to hedge. However, Carter et al. (2006) find little evidence of hedging benefits from tax convexity, expected and direct bankruptcy cost and increase in debt tax shields. In a study by Guay and Kothari (2003) it is further questioned what determines a firm's decision to hedge. When it comes to characteristics of firms that hedge, they suggest that there is increased use of derivatives for large firms and for firms with greater investment opportunities. There is also increased use of derivatives among more geographically diverse firms and among firms for which the CEO's sensitivity of wealth to stock price is relatively large. Additionally, optimizing firms will use derivatives only if the benefits of the programs exceed the cost.

The determinants of hedging suggested above can also, according to Hausehalter (2000), be applicable to oil and gas producers. Hausehalter (2000) studies the hedging policies of oil and gas producers between 1992 and 1994. He finds that the extent of hedging is related to financing costs in the way that firms with greater financial leverage manage price risk more extensively. This relation is consistent with the argument that risk management reduces financing costs. Further, he suggests that the extent of hedging is related to the size of fims and to the basis risk associated with hedging instruments. The latter refers to the higher likelyhood of firms located primarily in regions where prices have a high correlation with the prices on which exchange traded derivatives are based to manage risks.

3. Theoretical Background
3.1 Miller and Modigliani's Irrelevance Proposition
Miller and Modigliani's irrelevance proposition (1958) implies that hedging should not affect firm value, when assuming no taxes, costs of financial distress, and transaction costs. The reason is analogous to the irrelevance of financing; the value of the company is determined by the value of its assets, i.e. the future cash flows and the required rate of return, not by the way they are financed. Hedging will only add value if the benefit from more stable cash flows is greater than the

subsequent decrease in required rate of return. This will not be the case, as shareholders can hedge at the same costs as the company, either by having a well-diversified portfolio or by entering into derivative contracts.

In reality, hedging through derivatives is considered to be an important part of a firm's risk management strategy. This contradicts MM's irrelevance proposition; if it does not add value, why are firms hedging? More recent risk management theories have tried to answer this question by easing the classical MM-assumptions.

3.2 How hedging can add value

3.2.1 Reduction of expected tax liabilities

One potential source of value comes from the reduction of expected tax liabilities. The benefits derive from the interaction between the reduction in volatility of reported income and the convexity of taxes (Stultz, 1996). Taxes are said to be convex if effective tax rates are an increasing function of the firm's pre-tax income. When a firm facing progressive taxes hedge, the tax increase in situations where income would have been low is smaller than the tax reduction in situations where income would have been high. Hence, hedging can reduce expected taxes and increase future cash flows. If reduced tax liabilities are a determinant of hedging, companies with a higher likelihood of having more income in the progressive range of the tax code, should hedge more.

3.2.2 Reduction of bankruptcy costs

Hedging can also create value by reducing bankruptcy costs. In line with MM, well-diversified shareholders may not be concerned about cash flow variability caused by swings in foreign exchange rates or commodity prices, since they can easily be diversified away. They will however be concerned if those swings materialize into increased probability of bankruptcy (Stultz, 1996). Extreme swings in commodity prices, like those experienced in oil prices in 2014, can reduce the operating cash flows to the extent that leveraged companies no longer are able to service their debt and are forced into bankruptcy or financial distress. If shareholders view bankruptcy as a real possibility, the expected present value of the costs will be reflected in the current market value. A study by Andrade & Kaplan (1998), found the costs to be approximately 10% to 20% of pre-distress

market value. The probability of bankruptcy can be reduced by effective risk management, and can therefore increase the market value of a firm. According to Stultz (1996) eliminating the probability of bankruptcy through risk management should increase the market value by the bankruptcy costs multiplied by the probability of default if the firm remains unhedged. We will test whether this is a possible determinant of a firm's hedging decision by examining the correlation between the firms' hedge ratio and their debt-to-equity ratio.

3.2.3 Mitigation of the Underinvestment Problem

Additionally, risk management can mitigate agency conflicts caused by debt overhang. Drilling companies are capital intensive and often highly levered. This means that the presence of asymmetric information can cause conflicts between shareholders and debtholders, which ultimately lead to higher cost of capital. One cause is underinvestment, which occurs when managers of levered companies choose not to invest in positive NPV projects, since the benefits of the investment almost entirely accrues to bondholders (Aretz, Bartram, & Dufey, 2007). The problem can be mitigated with risk management, since it would stabilize cash flows and ensure that gains from projects are less often below their initial investment plus obligations to bondholders. As a result the required rate of return of creditors and the likelihood of underinvestment will decrease. The likelihood of experiencing underinvestment increases if the internal cash flows generated by the firm are unlikely to cover potential investment projects. Off course, the company also has to have investment opportunities. To measure the effect of underinvestment as a motivation for hedging, you can use a proxy for the investment opportunity set like the earnings-price ratio

3.2.4 Managerial motives

Hedging can also be viewed as a way for risk-averse managers to reduce firm-specific risks in their portfolio. Managers may have a large portion of their assets invested in the firm, since they are likely to receive some form of equity as part of their compensation package and probably need to invest in a lot of company- and industry specific knowledge. Since their ability to diversify their position is severely limited, they can be made strictly better off by reducing the variance of total firm value with hedging (Froot et. Al, 1993). This rationale might explain why firms hedge, even though there is no premium attached. We will follow

Haushalter (2000) and investigate this motive for hedging by using the fraction of outstanding shares held by officers and directors as a proxy, and seeing how correlated that is with the percentage of next year's production that is hedged.

3. 3 Firm value
We will use Tobin's Q as a proxy for firm value. Tobin's Q is defined as the ratio of the market value of a firm to the replacement cost of a firm's assets (Tobin & Brainard, 1977). Tobin and Brainard (1977) argue that if Q is less than 1, i. e. that the cost of replacing a firm's assets is greater than the firm's market value, investors would have incentive to invest. Conversely, if Q exceeds 1 investors would have incentive to disinvest. It is clear that if all such investment opportunities where exploited, Tobin's Q should converge to 1. However, in the presence of intangible assets, like growth opportunities, Tobin's Q will diverge from unity (Ciner & Karagozoglu, 2008).

Compared to other measures of firm value, like stock return or accounting performance measures, Tobin's Q relieves us from having to adjust for risk and any other kind of normalization when comparing the measure across companies (Lang & Stultz, 1994). A possible pitfall is that Tobin's Q is subject to speculation, and overreaction, since it is based on market values (Ciner & Karagozoglu, 2008). This might become especially relevant after the sharp drop in oil prices in 2014.

4. Methodology
In light of the theoretical background and previous empirical studies, we wish to further investigate the hedging activities of oil and gas exploration firms. We will primarily focus on three main hypotheses.

4.1 Hypothesis 1
"Hedging through financial derivatives contracts will reduce oil and gas exploration firms' exposure to oil- and gas price fluctuations"

Guay and Kothari (2003) criticized previous studies for not investigating whether the sample firms' derivatives positions are sufficiently large to produce benefits of the magnitudes that are found. To control for this in our study, we will in this section test whether the firms' returns are in fact exposed to oil and gas price fluctuations and further investigate to what extent hedging affects this exposure.

4.1.1 Exposure

Following Jin and Jorion (2006), we start by testing each firm's exposure to oil and gas prices. Due to the high correlation between oil and gas prices, we chose to use two two-factor models to avoid collinearity, i.e. looking at each exposure's effect on returns separately:

$$R_{i,t} = \alpha_i + \beta_{m,i} * R_{m,t} + \beta_{oil,i} * R_{oil,t} + \varepsilon_{i,t}$$

$$R_{i,t} = \alpha_i + \beta_{m,i} * R_{m,t} + \beta_{gas,i} * R_{gas,t} + \varepsilon_{i,t}$$

Where $R_{i,t}$ is rate of return of company i in month t. $R_{m,t}$ is the monthly return in the stock index (in our analysis we are using S&P 500, since we are looking exclusively at US companies). Both $R_{oil,t}$ and $R_{gas,t}$ are rates of changes in 1-month futures contracts on oil and gas, respectively. The reason for using futures rather than spot is that this is the price faced by most producers in transactions. When retrieving the results, we will be able to see each company's exposure, which will be interesting in light of their hedging decisions.

4.1.2 Effect of hedging

We also want to investigate the extent to which hedging affects exposure. If the firm's hedging decision does not affect their exposure, there is little reason for hedging to affect firm value. Again, we will test for this running two regressions to avoid colliniearity:

$$R_{i,t} = \alpha_i + \beta_{m,i} * R_{m,t} + \left(\gamma_1 + \gamma_2\Delta_{oil,i} + \gamma_3 \frac{oil\ reserve_i}{MVE_i}\right) * R_{oil,t} + \beta_{gas,i} *$$
$$R_{gas,t} + \varepsilon_{i,t}$$

$$R_{i,t} = \alpha_i + \beta_{m,i} * R_{m,t} + \left(\gamma_4 + \gamma_5\Delta_{gas,i} + \gamma_6 \frac{gas\ reserve_i}{MVE_i}\right) * R_{oil,t} + \beta_{oil,i} *$$
$$R_{oil,t} + \varepsilon_{i,t}$$

Where $\Delta_{oil,i}$ is the relative production delta, calculated by aggregating deltas across the contracts used for hedging (futures, options, etc.) and dividing it by next-year's oil production. The exact same procedure is used for the gas equivalent. Both deltas will represent the individual company's hedging. The oil and gas reserves are collected from the firm's financial reports. For the market value of equity (MVE) we use each company's market capitalization.

If hedging does affect exposure to oil and gas prices both γ_2 and γ_5 should be negative, since the stock prices become less sensitive to changes in the commodity prices. Additionally, both γ_3 and γ_6 should be positive. This is because, as Jin and Jorion (2006) point out; "the faction of reserves should be positively related to the stock price exposure to energy prices".

4.2 Hypothesis 2
"Oil and gas exploration firms hedging their oil- and gas price exposure through financial derivatives contracts are reworded with a value premium in the form of a higher Q-ratio"

Previous empirical studies provide conflicting results on the relation between firm value and hedging through financial derivatives contracts. We will add on to previous literature and investigate whether there exists a hedging premium in oil and gas exploration firms during the period 2004 to 2015. Our investigation differs from previous studies in that we use a longer time-frame and include more firms than most other studies.

4.2.1 Univariate Analysis
The univariate analysis in this section will give us a simplistic answer to the question: "does hedging add value?". We will compare the average Q-ratio of firms that hedge to the average Q-ratio of firms that do not hedge, and test if the difference is significant. Our test will be two-sided, with the null hypothesis being that the difference in the Q-ratios is insignificant. If the difference is significantly positive, it indicates that investors reward firms that hedge. If the difference is significantly negative, it indicates that investors flee companies that hedge.

4.2.2 Multivariate Analysis
While a univariate analysis' main purpose is to describe data, the multivariate analysis in this section will be more informative in isolating the effect of hedging on Q-ratios. As in Jin and Jorion (2006), we estimate three spesifications for the regression models:

$$Q_{jt} = \alpha + \beta * Hedging\_dummy_{jt} + \sum_j \sum_t \gamma_{jt} * Control\_variable_{jt}$$
$$+ \sum_t \forall_t Dt_t + v_j + \varepsilon_{jt}$$

$$Q_{jt} = \alpha + \beta * Delta\_production_{jt} + \sum_j \sum_t \gamma_{jt} * Control\_variable_{jt}$$

$$+ \sum_t \forall_t Dt_t + v_j + \varepsilon_{jt}$$

$$Q_{jt} = \alpha + \beta * Delta\_reserve_{jt} + \sum_j \sum_t \gamma_{jt} * Control\_variable_{jt}$$

$$+ \sum_t \forall_t Dt_t + v_j + \varepsilon_{jt}$$

Where v_j is a firm dependent variable, $\forall_t$ is a time dependent variable, Dt_t are annual dummies, and:

$$Hedging\_dummy = \begin{cases} 1 \ if \ company \ hedges \\ 0 \ if \ company \ does \ not \ hedge \end{cases}$$

$$Delta\_production = -\frac{Total \ delta \ oil/gas}{Next \ year \ oil/gas \ production}$$

$$Delta\_reserve = -\frac{Total \ delta \ oil/gas}{Same \ year \ proved \ oil/gas \ reserve}$$

The estimator β will measure the effect of hedging on Q-ratios. The null hypothesis is that β=0, against the alternative hypothesis β≠0.

The first regression will give us a general answer to the question of whether hedging adds value. The hedging dummy does not take into account whether the firm has taken positions in oil or gas derivatives contracts, but simply takes the value 1 if the company hedges and 0 otherwise. The second and third regression takes into account what commodity the company hedges, and additionally we use the ratio of a company's delta to production and delta to reserves of oil/gas to make the hedging variable a relative measure across companies. The variable delta_production gives us the amount of production hedged divided by the actual oil/gas production next year, i.e. it indicates the propotion of next year's production that is hedged. The variable delta_reserve is the amount of reserves hedged divided by the oil/gas reserves for the same year, i.e. it indicates the propotion of this year's reserves that is hedged.

We are subject to both time series and cross-sectional elements, and must thus use a panel estimator approach in our model. As we expect to get an unequal number of time series observations for each cross-sectional unit, our model will be characterized as an unbalanced panel. The model is not balanced because we expect some firms to seize to exist, and other firms to enter the industry, during

our timeframe. If we only include firms that exist throughout our entire timeframe, we suspect our study to suffer survivourship bias. There are broadly two classes of panel estimator approaches that can be used: fixed effects models and random effects models. If the composite error term, $\omega_{jt} = v_j + \varepsilon_{jt}$, is uncorrelated with all explanatory variables, the random effects model will give a more efficient estimate of β than the fixed effects model. If the composite error term is correlated with one or more explanatory variables, the random effects model will give a biased and inconsistent estimator of β and we should instead use the fixed effects model approach. We will apply the Hauseman test to decide between the fixed effects model and random effects model (Brooks, 2014, s. 537).

4.2.3 Estimating Tobin's Q
Traditionally, Tobin's Q is calculated as market value of financial claimes divided by current replacement cost of the firm's assets. The result is a unitless measure that allows for comparison across firms. Due to the need to compute the market value of long term debt and the replacement cost of fixed assets, the estimation of Tobin's Q is quite intricate. However, oil and gas extraction firms provide us with more information than other firms as the major assets are oil and gas reserves. We are able to approximate the replacement cost of oil and gas assets by measures of reserves reported in the firms' financial statements. We will, as Jin and Jorion (2006), construct three different proxies to estimate Tobin's Q:

$$Q1 = \frac{BV\ total\ assets - BV\ common\ equity + MV\ common\ equity}{BV\ total\ assets - BV\ oil/gas\ proved\ reserves\ + NPV\ oil/gas\ proved\ reserves}$$

$$Q2 = \frac{BV\ total\ assets - BV\ common\ equity + MV\ common\ equity}{BV\ total\ assets - BV\ oil/gas\ proved\ reserves\ + MV\ oil/gas\ proved\ reserves}$$

$$Q3 = \frac{BV\ total\ assets - BV\ common\ equity + MV\ common\ equity}{BV\ total\ assets}$$

The three estimates of Tobin's Q share the same numerator; we approximate the market value of the firm by the book value of total assets minus the book value of common equity pluss the market value of common equity. The difference between the two first estimations is that oil/gas reserves are measured by net present value

13

in Q1 and by the current market value in Q2. In Q3, as in previous literature, we use the book value of total assets in the denominator.

We expect that correcting for net present value of oil/gas reserves or market value of oil/gas reserves results in a better measure for Tobin's Q than book value of assets. This is because book value of oil/gas reserves are calculated as the accumulated exploration costs after amortization and depreciation. Arguably, this may not equal the true replacement cost of oil/gas. However, we will note that by construction Q1 will be higher than Q2 since net present value of oil/gas reserves will be lower than market value of oil/gas reserves. When comparing with previous studies, our results using Q3 will be most suitable.

4.2.4 Choice of control variables
When choosing firm characteristics as control variables, we faced the trade-off between parsimony and excluded variable bias. That is, to isolate the effect of hedging, we need to include as many variables that are relevant for Q as possible, without decreasing the efficiency of our estimators. In order to be as exhaustive as possible, we borrowed inspiration from Jin and Jorion (2006) and Allayannis and Weston (2001), and choose the following variables:

1. Firm size: The jury is still out on whether or not size increases accounting profitability (which would increase the Q-ratios), but there is substantial evidence saying that large firms are more likely to use derivatives than small firms (Bodnar, Hayt, & Marston, 1995; Guay & Kothari, 2003; Haushalter, 2000). To control for this, we use the log of total assets.

2. Profitability: We are more likely to see higher Q-ratios for more profitable firms. We use return on assets to control for this effect.

3. Leverage: Capital structure might also be linked to value. To control for capital structure, we follow Allaynnis and Weston (2001) and use long-term debt divided by shareholder's equity.

4. Production costs: Production costs refer to a firm's lifting costs. We expect that firms with higher production costs have lower Q-ratios.

5. Investment growth: Future investment opportunities are likely to be linked with firm value. We use the ratio of capital expenditures to sales as a proxy for this effect. Morck and Yeung (1991) also suggest the percentage of advertising to sales as an alternative measure.

14

6. Access to financial markets: If hedgers have limited access to financial markets, their Q-ratios may be high because they are limited to only undertaking the highest NPV projects. To capture this effect, we use a dividend dummy as a proxy. The intuition is that firms that pay dividends are less likely to be capital constrained. However, due to dividend stickiness, this measure might not be perfect.

7. Time-effects: We also control for time-effects by including yearly dummies. We hope to capture yearly trends, as well as effects from important events like the financial crisis.

8. Firm-specific effects: By including this variable, we are able to capture unobservable firm-specific effects.

We excluded the following variables suggested by Allayannis and Weston (2001):

9. Industrial diversification: Since we are only using exploration companies, we should not need to look at industrial diversification.

10. Geographic diversification: As above we are not including this variable since our entire sample consists of US companies.

4.3 Hypothesis 3

"Oil and gas exploration firms hedge their oil- and gas price exposure to decrease the risk of bankruptcy, tax liabilities, underinvestment and /or managerial motives"

In the theoretical background we highlighted the main rationales for hedging. If hedging adds any value, it will most likely be through one of those channels. We will investigate the relationship between each rationale and the hedging ratio, in order to explain the observed hedging. Specifically, we will run a regression with the percentage of next year's production hedged as the dependent variable and different proxies for the rationales for hedging as the independent variables, together with the control variables outlined above:

$$
\begin{aligned}
Production\ delta_{jt} \\
= \alpha_{jt} + \gamma_1 * bankruptcy + \gamma_2 * tax\ liabilities \\
+ \gamma_3 * underinvestment + \gamma_4 * managerial\ motives \\
+ \sum_j \sum_t \gamma_{jt} * Control\_variable_{jt} + \sum_t \forall_t Dt_t + v_j + \varepsilon_{jt}
\end{aligned}
$$

- Costs of Bankruptcy: As a proxy for bankruptcy's role in risk management, we will use each firm's debt-to-equity ratio, as well as their size. The leverage ratio should be positively related to the probability of default, which should be positively related to the likelihood of hedging. Hence, we expect to find a positive γ_1.

- Tax liabilities: The tax liabilities argument is the hardest to find a proxy for. Borrowing inspiration from Haushalter (2000), we will try to construct an interval for the expected level of pre-tax income, and compare the likelihood of being in the progressive region of the tax code (pre-tax income between \$100 000 and \$10 000 000) to the hedging decision of the firm. As with the two other cases, the correlation with the amount of hedging should be positive, i.e. we expect to find a positive γ_2.

- Underinvestment: There are several different alternatives that can be used to proxy for underinvestment's role in hedging decisions. According to Froot et. Al (1993) two conditions may induce hedging activity; first, the firm must have access to positive NPV-projects. Second, there must be a reasonable probability that the internally generated funds are insufficient to cover the projects. This means that earnings-price can be used a proxy, since it captures the firm's investment opportunity set (Gay & Nam, 1998). If underinvestment is a determinant for hedging, we should find a positive correlation between the amount of hedging and investment opportunities, i.e. we expect to find a positive γ_3.

- Managerial motives: We will use the percentage of officer ownership to see how much managerial risk aversion influences the hedging. With previous research in mind, we expect to find a positive relationship between the amount of hedging and insider ownership. Hence, we expect to find a positive γ_4.

5. Plan for data collection and thesis progression

January:

- Start collection of data
- Continue research on the field

February

- Finish data collection
- Start running the regressions in Stata

March

- Find the results and start analyzing their meaning
- Start writing the empirical results
- Hand in first-draft of master thesis to supervisor

April

- Work on supervisor's feedback
- Turn in final draft to supervisor

May

- Work on supervisor's feedback
- Turn in finalized master thesis

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