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Lever Up and Drill: A Statistical Analysis of Practical Financial Decisions Made by Oil and Gas Industry Executives

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Abstract
This research paper analyzes the results of a survey distributed to 394 oil and gas executives. Respondents were asked to provide their outlook on commodity prices, methodologies for estimating prices, preference for different valuation techniques, and priority of various capital structuring decision factors. The analysis includes single and multi-variable regressions that demonstrate correlations between different survey categories. The analysis suggests that price outlook is on average higher than the public futures market, but the popularities of different price estimation methodologies have no correlation with outlook average price or probability density. Other cross-category findings of note were the positive correlation between use of hurdle rate analysis and priority of setting a target capital structure, the negative correlation between use of IRR/hurdle analysis and priority of comparable company debt levels, the negative correlation between use of NPV and priority of interest tax shields, and the significance of our bankruptcy cost multivariate regression model.

Keywords
Oil, Commodity Prices, Capital Structure

Disciplines
Business

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LEVER UP AND DRILL: A STATISTICAL ANALYSIS OF PRACTICAL FINANCIAL DECISIONS MADE BY OIL AND GAS INDUSTRY EXECUTIVES

By

Zachary Ennis

An Undergraduate Thesis submitted in partial fulfillment of the requirements for the

WHARTON RESEARCH SCHOLARS

Faculty Advisor:

Erik Gilje

Professor, Finance

THE WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA

MAY 2017
ABSTRACT

This research paper analyzes the results of a survey distributed to 394 oil and gas executives. Respondents were asked to provide their outlook on commodity prices, methodologies for estimating prices, preference for different valuation techniques, and priority of various capital structuring decision factors. The analysis includes single and multi-variable regressions that demonstrate correlations between different survey categories. The analysis suggests that price outlook is on average higher than the public futures market, but the popularities of different price estimation methodologies have no correlation with outlook average price or probability density. Other cross-category findings of note were the positive correlation between use of hurdle rate analysis and priority of setting a target capital structure, the negative correlation between use of IRR/hurdle analysis and priority of comparable company debt levels, the negative correlation between use of NPV and priority of interest tax shields, and the significance of our bankruptcy cost multivariate regression model.

Keywords: Oil, Commodity Prices, Capital Structure
INTRODUCTION

This research project is aimed at answering the question of what change, if any, has occurred in capital structure decisions made by oil and gas companies in response to the new, low commodity price environment. In late 2014, OPEC could not come to an agreement on a supply quota and North American production had drastically increased in response to the fracking revolution. The resulting oil glut caused prices to enter free fall, dropping from $107 in July of 2014 to $43 in March of 2015. Many oil and gas companies were unable to meet the interest rate or Debt/EBITDA covenants of their loan agreements, causing a large portion of the industry to seek refinancing opportunities in 2015. As equity prices fell dramatically, banks were simultaneously cautioned to avoid the systemic risk of the oil and gas sector, which effectively closed off equity and low-yield debt markets to most companies. Thus, managers were forced to adopt new capital structures and pursue creative methods of financing capital expenditures.

In 2016, prices began to stabilize and firms were able to lock in new hedges that would support a return to the capital markets. For firms that survived the crisis, this period has presented opportunities for aggressive acquisition strategies that are fueled by a low cost of debt and a need for consolidation in the highly fragmented industry. Many executives are currently deciding how to size their leverage in the wake of the price collapse; is the bad taste of the collapse going to promote caution or will the possibilities of a rebound in conjunction with low interest rates create a higher affinity for debt. These trends are the core focus of the research question and will require an analysis of the commodity price outlook and an in depth look at the oil and gas executive’s capital structuring process.
SIGNIFICANCE

Over 100 bankruptcies have been declared in the oil and gas industry over the last two years, and substantially more firms have had to seek refinancing opportunities in the wake of the commodity price slide. Yet, some firms survived the collapse and were able to continue servicing their debt by de-levering to avoid breach of EBITDA/reserve-based covenants. For oil executives and academics both, the question of why some firms had seemingly less than optimal (or, in hindsight, why some firms had more than manageable) amounts of debt on their books is very significant. This industry is very cyclical, and the global commodity boom-bust cycle will very likely take a turn for the worse again some time in the next decade or two. Thus, it is extremely important to understand the decision making process that survivor firms went through prior to the collapse.

Moreover, this research is applicable to similar commodity driven industries that have sizeable effects on the U.S. economy, especially steal and coal. The coal industry in particular can draw many parallels, though the commodity price collapse in that industry was caused by a sudden cut in forecasted demand after the Clean Power Plan and subsequent Paris climate agreement.

METHODOLOGY

Design

The survey focuses on three areas: price outlook, project valuation methodology, and capital structuring. We developed a survey based on the one administered by John Graham and Campbell Harvey in 1999 ("Graham & Harvey study"), which was industry
generic. Our survey was tailored to the oil and gas industry by including additional questions that focused on the role commodity prices play in corporate financial planning.

The final version of the survey included eleven questions and took on average ten minutes to complete. The first section collected demographic information about the firm. Subsequent sections required respondents to provide their price outlook, agree or disagree with various price prediction methodologies, estimate the usage frequency of various project valuation methodologies and rank the importance of various factors when considering an appropriate capital structure.

Our recipient pool was made up of 394 executives with decision-making roles at 239 different oil and gas firms within the U.S. and Canada. These included CEOs, CFOs and Business Development executives of varying tenures at their respective companies.

**Delivery and Response**

The survey was delivered electronically via email using the Wharton Qualtrics system ("Qualtrics"), which assigns a unique link to each recipient for tracking purposes. The survey was sent to a 21-person trial group on February 9, 2017 to determine if the delivery mechanism was working properly and identify any potential errors in the survey design. After we received one successful response from this group, we were prepared to deliver the survey to the main group. The remaining 373 recipients were emailed the survey on February 21, 2017. One week later, on February 28, 2017, a reminder email was sent to those who had not yet completed the survey.

Fifty-six recipients started the survey, and thirty-five completed surveys were ultimately returned, for a response rate of slightly less than 9%. This compares favorably to
the Graham & Harvey study, which attained a 9% response rate when surveying 4,440 firms in 1999. Unlike that survey, which was a part of the quarterly mailings regularly distributed by the Financial Executives Institute (FEI), our email was a one-time request for information with no prior interaction.

PRICE BUCKETING

Design

Respondents were given 15 potential price outcome buckets, which started at <$15 and incremented up in $5 sections to >$80 (i.e. <$15, $15-20…$75-80, >$80). They were asked to provide a percent probability that the January 2018 WTI contract would close within each bucket, such that the sum of all the buckets would be equivalent to 100%.

Results

I. Aggregate Price Outlook
Aggregate probabilities were created by averaging these percentages across all thirty-five respondents. The summary results below indicate a strong inclination toward the contract’s going price as of the survey’s distribution - $54-55. It is clear that firms are generally neutral or optimistic when viewing market data regarding future prices.

The analysis was also able to estimate an individual respondent’s “composite price” by multiplying the midpoint of each bucket by the probability of its occurrence and then summing these probability-adjusted values. Composite prices ranged from $46.25 to $62.50 and had a standard deviation of $3.96.

The analysis measured density within buckets as a metric of what firm executives believed regarding price volatility going forward. To do this, this study took the average of all non-zero bucket probabilities within an individual respondent’s set. The average density was 20.17%, ranging from 8.33% to 50% with a standard deviation of 7.75%. From this information one can conclude that the firm executives have a general consensus regarding price, but are significantly less homogenous in their views regarding volatility. An underlying variable that skews this would be the time taken to think about and answer this question. Respondents that took more time would be more precise in addressing the probability of fringe cases, and thus have a lower density. Unfortunately Qualtrics does not provide data regarding the time to complete an individual question, only the entire survey, so we will not be able to determine if the spread in density can be attributed to inconsistent views regarding volatility or time spent developing a probability spread.
PRICE ESTIMATION RATIONALE

Design

This study also sought to gain perspective on how firm executives typically develop their price outlooks and whether or not these different methodologies can significantly predict discrepancies in composite price or average density.

Respondents were asked to rate five different statements regarding forward price estimation on a six-point scale from “Strongly Disagree” (1) to “Strongly Agree” (6). The statements were:

- “Prices are too volatile to estimate going forward”
- “Commodity futures curves are a good estimate of what actual future prices will be”
- “Historical price volatility can be helpful in predicting future prices”
- “Research reports regarding future macroeconomic factors (supply, demand etc.) are valuable to price predictions”
- “The price of call options and other hedging instruments can be used to improve estimates of future volatility”

The study included these statements to determine the complexity of analysis different executives employ when estimating prices. For example, reverse solving for implied future volatility given the details of a call option is a more complex technique that would be rarely employed. In contrast, it was believed that many executives would anchor their estimates to the commodity futures curve because they can hedge at that level.
Results

II. Viability of Price Estimation

Average responses ranged from 3.1 (Slightly Disagree) to 4.8 (Agree) with little to no difference in standard deviation, which was between 1.3 and 1.45 for all of the statements. Respondents on average slightly disagreed that commodity futures curves are a good estimate of what actual prices will be (3.1). This is very interesting, as the average composite price was in such close proximity to the current futures curve. Thus, despite executives on average disagreeing with the accuracy of the curve their quantitative responses are in strong alignment. Executives were, on average, most in favor of research reports regarding macroeconomic factors (4.8). The second most agreed on statement was that future commodity prices are too volatile to predict (4.3). Perhaps this general sentiment explains why executives tend to fall back on the futures curve regardless of the fact that they disagree with its usefulness in developing a price outlook.
After examining these summary statistics the study used regression models to analyze the correlation between price estimation methodologies and the price bucketing results. This research found that the agree-disagree rating on the methodology statements were correlated with neither their composite price nor their bucket density (see Exhibit 1).

Only one correlation had a p-level below 0.1: the negative relationship between bucket density and “Historical price volatility can be helpful in predicting future prices”. Respondents that believed historical volatility could be helpful tended to have a tighter spread in their buckets. This suggests that a subset of the respondents may predict lower volatility in the future price landscape, in part, because of high volatility in the year prior to the survey.

VALUATION METHODOLOGY

Design

Similar to the Graham & Harvey study, this section focuses on how oil and gas firms value potential projects. The survey asked company executives about the traditional methods of valuation like IRR and NPV, as well as the less commonly used methods – adjusted present value, payback period, discounted payback period, profitability index, and accounting rate of return. Following the Graham & Harvey study, the survey also included an earnings multiple approach, simulation analysis, value at risk, and the value of real options embedded in the project. In addition to the methodologies included in the Graham & Harvey study, the survey included a hurdle rate analysis. Background research indicated that private equity firms commonly use this method to determine if an investment will meet the needs of its portfolio and investors.
Respondents are asked to rate each method based on how frequently they employ it when valuing a project. The methods are rated from 1 to 4 (1 meaning “never”, 4 meaning “always”). Similar to the Graham & Harvey study, these responses represent beliefs. The survey has no way of verifying that these responses coincide with actions.

Results

![Image of bar chart]

Similar to the Graham & Harvey study and in accordance with our hypothesis, NPV (3.91) and IRR (3.88) are the highest rated methods. Gitman and Forrester (1977) states that only 9.8% of firms use NPV analysis in comparison to the 53.6% that value projects using IRR, while the Graham & Harvey study found the two methods to be almost identically rated. NPV is the primary valuation method for oil and gas projects because of the prevalence of net asset valuation when valuing an oil and gas company at the corporate level.
Outside of these two methods, the next most popular valuation technique is the payback period (3.16). The Graham & Harvey study found a similar result and was surprised because this method fails to incorporate the time value of money or cash flows after the payback threshold.

Hurdle rate was the fourth most popular analysis used by executives. It was surprising to find that this technique was also not significantly correlated with a firm being publicly traded. Since hurdle rates can stem from a variety of rationales, the survey asked respondents that employ a hurdle rate analysis to provide the origin or reasoning behind their selected hurdle rate. Many firms indicated that their private equity sponsor established the hurdle rate at the time of the company’s formation, while one executive noted that this method is used particularly when in negotiations with a private equity firm. Other executives based their hurdle rate on cost of capital, specifically, “IRR is compared against cost of capital and used to rank different projects.” One executive provided a more complex hurdle rate by stating that the firm tests for a minimum 10% IRR when WTI is at $40.

Only one valuation methodology was significantly correlated with a firm’s publicly traded status: earnings multiple approach. Publicly traded firms were found to be significantly less likely to use the earnings multiple approach to value projects compared to private firms. This was also surprising, as the initial hypothesis was that public firms would be more concerned with peer-relative metrics. Public equity holders typically have options between competitive firms and should make decisions based on the relative strength of a company’s asset portfolio. Private firms may be more likely to use an earnings multiple approach because they have more volatile projects that will produce difficult to estimate
cash flows. Thus, an earnings multiple approach that bypasses long term cash flow estimation may provide them with a better indication of a project’s value were it to be sold to a large strategic. It is also important to note that even in random data sets correlations will be present, so this hypothetical explanation is not necessarily evidence for a true difference between public and private firms.

CAPITAL STRUCTURING

Design

This section was the main focus of our survey, in which we asked respondents to rank order the most important factors contributing to their capital structuring decisions. Factors would be given rankings from 1 to 11. The responses are the beliefs of the executives and the actual capital structures may not reflect the same priorities. The survey presented the following factors:

- Interest expense deduction for tax purposes
- The costs of bankruptcy or financial distress
- Your firm’s target capital structure
- Credit rating
- Financial flexibility
- Previous quarter commodity price volatility
- Commodity price futures curve
- Interest rate and inflation risk
- Market signaling of debt sizing (equity price response)
- Equity market availability
Debt levels of comparable competitors

In traditional trade-off theory, the benefit of additional leverage is the tax savings from interest, while the cost is financial distress and the potential of bankruptcy (Modigliani & Miller 1958, Miller 1977). Similar to the Graham & Harvey study the survey included more complex factors in the trade-off calculation, but it also incorporated oil and gas specific factors. Graham & Harvey differ from this survey as they used a scale rating, but this study focuses more on relative priority of the different factors as opposed to usage frequency.

Results

Financial flexibility (2.0) was the clear leading factor when determining how much debt is appropriate for the firm. It would be interesting to continue distributing this survey year over year to see if flexibility becomes less important as cash flows in the oil and gas
industry increase to pre-crisis levels. It was surprising that flexibility was rated so highly, but the cost of bankruptcy (6.9) was of significantly lower importance to executives. Despite the number of bankruptcies in North America over the last two years, equity market availability (6.3) and interest rate/inflation risk (6.5) had higher rankings.

Commodity futures curve (5.3) was ranked highly as well. This may be because the futures curve not only estimates future EBITDA for the purpose of debt serviceability, but also provides the outlook at which firms can hedge and effectively lock in a risk profile.

**CROSS-CATEGORY ANALYSIS**

One of the first cross-category relationships this study looked at was the correlation between popularity of individual valuation methodologies and importance of individual capital structure factors. The analysis included a single variable regression for each possible pair of responses (one valuation methodology with one capital structure factor) and reviewed the 132 results to determine which relationships were statistically significant (See Exhibit 1).

The first significant relationship to highlight is the increased likelihood of firms that use a hurdle rate when valuing projects to set a target capital structure for their firm. Hurdle rate analysis is popular amongst privately sponsored E&P’s, which are usually provided with strict guidelines regarding appropriate leverage levels. Moreover, firms with target capital structures typically maintain a tighter cost of capital range, allowing them to more consistently incorporate a return threshold in their analysis.

In addition, firms that always use a hurdle rate or IRR analysis to value projects are significantly less likely to incorporate the debt levels of competitors in their analysis.
Specifically in the oil and gas space, we believe that firms are more focused on generating competitive asset-level returns in their portfolio and less focused on corporate-level peer comparison. As a result, the study suggests that E&P firms use financing strategically to find the best projects as opposed to aligning their risk profile with the industry average.

Another trend the analysis discovered was that firms using the accounting or book rate of return on investment were more likely to incorporate previous quarter price volatility and the futures curve in their capital structuring decisions. This method of valuation is rarely used, but it may be a useful tool for firms that wish to demonstrate financial strength to their investors via public filings. Thus, aligning their capital structure to reflect historical (last-quarter or last-year) stability would require a review of historical prices. Accounting return also includes the value of hedges, which are marked to market using the futures curve. Moreover, the futures curve also determines the value of a firm’s reserves and thus their available borrowing capacity. Ultimately, the analysis suggests that this trend is representative of firms that are concerned with the outward appearance of their financial health.

One of the trends that refuted traditional financial theory was that NPV-focused firms were significantly less likely to incorporate interest rate, inflation risk, or interest tax shields into their capital structuring decisions. Prior to this analysis, it was thought that executives would heavily analyze the discount rate and value of tax savings in a net present valuation and that the importance of this analysis would have residual effects on the priority of those components when determining capital structure. In contrast, this result suggests that the discount rate and tax shields are not relevant in valuing projects; rather, firms use a fixed discount rate and assume no tax shields to simply rate projects relative to
one another. This discovery exemplifies the concept that financial practice differs greatly from the academic theory and textbook methods.

The next and most anticipated relationship this study examined was how price outlook affects the importance of the capital structuring decision factors. The analysis included a regression model that took in multiple price outlook data points and tested the model on each dependent capital structuring variable. Ultimately, the analysis found that the model with the highest predicting power included Composite Price, “High View”, “Low View”, “Tail 10” and Private vs. Public. The analysis found this model to be most effective at predicting the importance of bankruptcy cost in a firm’s capital structuring decisions (See Exhibit 2).

Composite price is the sum product of the probability weightings and the midpoint of their respective price buckets. High View is the probability a firm executive assigned to prices above $60. Low View is the probability a firm executive assigned to prices below $40. Firms designated a 10% probability of prices falling below the level represented by Tail (in this case 10). Public vs. Private was represented by a binary variable.

It was initially surprising to find that firms were more likely to rank the cost of bankruptcy highly if their outlook had a high composite price. The starting hypothesis was that firms with a lower price outlook would foresee a greater chance of bankruptcy and thus prioritize those costs when selecting a capital structure. However, this analysis indicates that those firms with a low price outlook may actually be more prepared for a downturn (due to hedges or operational diversity) and thus not prioritize bankruptcy because they believe they will be able to weather a price drop.
In contrast, firms that presented an outlook with a high probability of prices surpassing $60 were less likely to rank bankruptcy costs as a priority. This fits better with the initial hypothesis and suggests that firms will ascribe little to no likelihood of bankruptcy if they believe prices have strong upside potential. Interestingly, the Low View variable has substantially less explanatory power.
### Exhibit 1

<table>
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<tr>
<th>Price Spread</th>
<th>Prices are too volatile to estimate going forward</th>
<th>Commodity futures curves are a good estimate of what actual future prices will be</th>
<th>Historical price volatility can be helpful in predicting future prices</th>
<th>Research reports regarding future macroeconomic factors (supply, demand etc.) are valuable to price predictions</th>
<th>The price of call options and other hedging instruments can be used to improve estimates of future volatility</th>
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<tbody>
<tr>
<td>R</td>
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<td>-0.02509</td>
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<td>R Standard Error</td>
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<td>0.0271</td>
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<table>
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<th>Composite Price</th>
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<th>Research reports regarding future macroeconomic factors (supply, demand etc.) are valuable to price predictions</th>
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<td>Upper 95% CI</td>
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**ANOVA**

Bankruptcy Cost = 74.9785 - 1.48809 * Composite Price - 0.35948 * Low View + 0.35494 * High View + 0.17403 * Tall + 0.2058 * PHY/PHD

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Regression Statistics
REFERENCES


