HOW AN EXPLORATION AND PRODUCTION SHOULD HEDGE BASED ON THEIR CAPITAL AND GROWTH STRUCTURE?

by

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ABSTRACT

Oil and gas companies and the necessity for hedging is of growing importance in the industry and the proper way to hedge is often debated. When building a hedge book, many upstream companies view hedging from an isolated viewpoint. Rather than taking a wholistic approach to hedging, exploration and production companies only consider one to two variables, such as the breakeven point of their operations. When developing a hedging plan, a company should consider their capital structure, flexibility of operations, projected production growth, and return based development. This thesis begins with an introduction to hedging and the different instruments utilized by upstream oil and gas companies. Current industry practices are discussed: how much of a producer's production is hedged, what commodity price the companies are hedged at, and what types of positions are used to hedge. Why an upstream company wants to hedge is debated, followed by the different hedging tactics used over different time horizons of oil and gas company production profiles. The four variables of (1) capital structure, (2) flexible operations, (3) production growth, and (4) return based development, and their interrelationships to hedging are discussed. Data supporting why these variables are critical for oil and gas companies to consider is then summarized. A peer group of oil and gas companies was constructed. All data used to analyze the peer group originates from public filings and press releases. Concluding thoughts relate to the current oil and gas commodity environment and how hedging (or the lack of it) is impacting the future of the upstream industry.

INTRODUCTION

Risk management is often considered a foundational element of a commodity driven business model. Specifically, looking at the upstream oil and gas business, variables such as the correct price to hedge production, the amount of production to hedge, and the implementation of a hedge timeline are crucial questions that influence boards of directors, investors, and management.

Research has been conducted on the relationship between hedging and firm valuation, individual variables that impact an oil and gas company's hedging profile, and crude oil hedging strategies. G. David Haushalter states that "larger companies and companies whose production is located primarily in regions where prices have a high correlation with the prices on which exchange-traded derivatives are based are more likely to manage risk" (The Journal of Finance). In this case, Haushalter is analyzing two specific influences of a hedging profile, size and location. Praveen Kumar and Ramon Rabinovitch speak to how hedging is "positively related to factors that amplify chief executive officers (CEO) entrenchment and free cash flow agency costs" (Cambridge Core). Again, only analyzing one specific element of what influences a hedging profile. Rather than analyze a specific aspect of an exploration and production company's hedging profile, a more holistic approach should be taken when evaluating a firm's risk management and hedging tactics.

As sellers of commodities the upstream producers are price-takers. Over the past five to six years, despite the "shale revolution," US upstream producers have not shown an ability to generate returns on capital that are above their weighted average cost of capital. The paper will show how, over the past decade, most upstream oil and gas companies have not been able to generate returns above their weighted average cost of capital. In addition, the economic value

added (EVA) model and its relationship to a firm not consistently being able to generate returns over its weighted average cost of capital will be discussed.

Publicly traded upstream oil and gas companies have underperformed the broader stock market by a significant amount, and many have gone or are going bankrupt. The stock market efficiency theory states the price of the asset reflects its true value and considers all possible data that could affect the pricing of the firm. The negative economic value added experienced by many oil and gas producers, along with many other elements that will be discussed in this paper, is acknowledged, and has drastically impacted the current stock price of many upstream oil and gas companies.

Furthermore, many of the upstream companies do not consistently generate free cash flow due to the volatility of commodity prices and unstable development expenses. Free cash flow of the firm helps fund the growth opportunities without having to rely on external sources of financing. Due to this inability to generate free cash flow, upstream oil and gas companies are required to heavily rely on sources of external financing, such as bank loans or bond and equity issuances. In the current environment of negative EVA and falling commodity prices, the incentive to provide capital to oil and gas producers has declined.

The combination of these challenges faced by oil and gas producers creates a pessimistic environment surrounding the oil and gas industry. Investors are questioning the current value in investing in the oil and gas industry, causing an overall lack of access to capital while simultaneously causing many exploration and production companies to go or are going bankrupt. A second result of the challenges faced by oil and gas companies is the theme of consolidation, which will be discussed in this paper.

The specific research question that this thesis seeks to answer is how can, in a volatile commodity market, an exploration and production company utilize a disciplined risk management strategy to enhance the company's capital structure while enabling a strategic plan, and how can operational risk mitigation be enhanced with commodity derivatives? Can a holistic approach to risk management improve a price-takers' execution and thereby help provide access to the capital needed to grow?

Before detailing a holistic risk management strategy, it is necessary to first define the different derivative instruments utilized by exploration and production companies. What tools are commonly used to hedge oil and natural gas prices? How are these positions structured? What trading tactics are used to create the positions? Do large companies generally hedge their commodities in different ways than small independents? To explore those questions, the paper will briefly present evidence of how well-known exploration and production companies are currently positioned. Which companies use what hedging tools? Are the tactics consistent with the major risks those companies face? The paper will also explore some of the research that has been conducted related to oil and gas hedging, as well as provide commentary on the current oil and gas environment.

Once this foundation has been built, the thesis will turn to developing a more robust, holistic approach to risk management. This approach will take into consideration three critical aspects of upstream businesses. First, risk management decisions must consider the company's capital structure. Does the company have debt? How much debt and what is the carrying cost of the debt? Second, the company's operational flexibility must be considered. If commodity prices change, can the company slow down operations, or is it "stuck"? Finally, what returns the upstream company's assets can generate under different pricing environments must be

considered. If the price of oil declines by 20%, excluding the impact of hedges, can the company earn its cost of capital? What if oil drops by 40%?

These considerations are neither independent of nor linear in relation to each other. Hedging, or more accurately strategic risk management, can bridge how these aspects of a price-taker's business interact. If done correctly, risk management should enable businesses to make better tactical and strategic decisions, leading to a more consistent performance. It has been the lack of consistency and poor operational performance that has caused capital to flee the exploration and production industry. A holistic approach to risk management may help reverse that course.

PRELIMINARY RESEARCH

The first tool that provides the most foundational hedge is the swap. A "swap" is a derivative instrument that creates an agreement between the buyer and seller at a fixed commodity price at a point in the future. The duration can range from a few months to a few years out and is often notated as CAL 20, CAL 21, CAL 22, etc. and can be thought as a promised future price. Unlike ~~F~~futures contracts that are settled by delivery of the physical commodity, swaps are "paper" agreements settled with cash. If the spot price of the commodity at settlement is higher than the swap, the buyer of the swap profits. Conversely, if the spot price settles below the price of the swap, the seller will receive the swap price and avoid the loss. Upstream oil and gas companies typically sell swaps to lock in a known price in the future.

A second hedging tool is a put. A "put" is a derivative instrument that gives the owner the right to sell the commodity at a set price over the term of the contract. Effectively, a put can be thought of as a "floor" in that an E&P would not sell their commodity for less than the strike

price of the put. Upstream oil and gas companies typically buy puts, but some sell puts to create "3-ways" as well (more on this will be discussed later).

A third derivative commonly used by E&Ps as part of their hedging strategies is a call. A call gives the owner the right to buy the commodity at a set price over the term of the contract. The seller of the call is obligated to sell the commodity at the strike price if/when the call is exercised by the owner of the call. Essentially, a sold call has the opposite effect of an owned put. Rather than setting a "floor," it sets a commodity price "ceiling." A sold call would define the maximum price that an E&P would receive for their commodity.

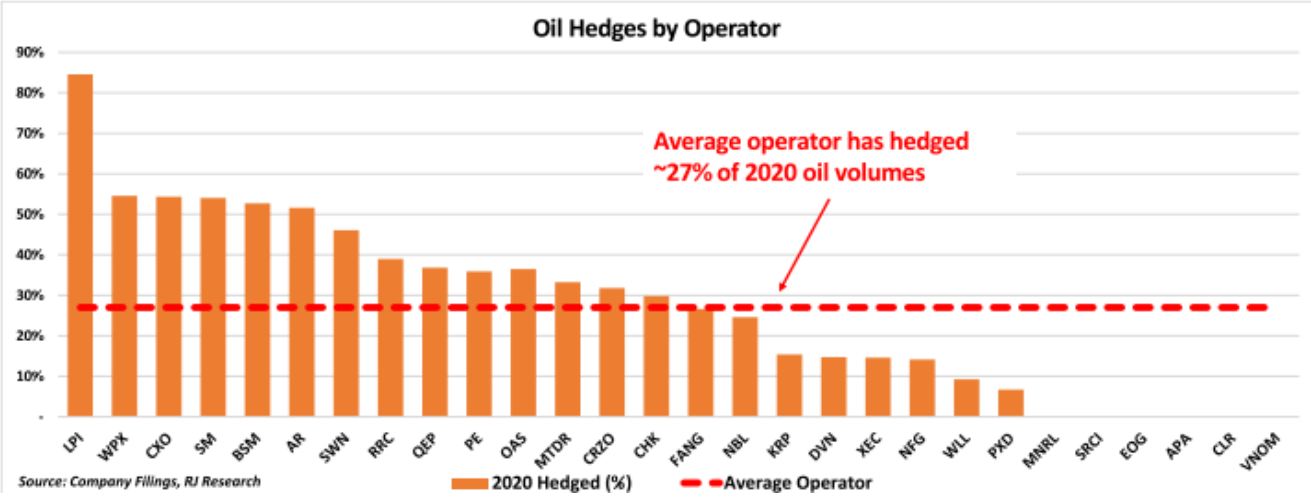
A "collar" is created when E&Ps sell calls in combination with purchasing puts. A "zero cost collar" is when the proceeds from the call completely offset the cost of the puts. The diagram below helps describe the effect of a long-put acting as a "floor" and the short call setting the "ceiling" for the commodity. As the commodity price ("Stock Price" in the diagram) moves up, the E&P will realize the increased price up to the strike of the call. Above that price, the owner of the call would exercise the contract and the E&P would have to sell the commodity at that price regardless of how high the commodity went. Conversely, if the commodity price declines, the E&P will realize the lower price down to the strike of the put. Because the E&P can sell the contracted volumes at the put's strike price, the E&P does not have price risk below that level (for production hedged).

A swap is easy to understand because you are simply agreeing to a fixed price for a commodity. Buying a put is the equivalent of buying insurance, because they will get no less than strike price of the put. A collar is a bit more complex. If the commodity goes down, you can sell at the strike price of the put. However, if the commodity goes above the call's strike the price, the E&P must sell at the strike of the call.

There are many variations of these structures. Hedging can digress further into the weeds when evaluating a "3-way" (combination of selling a put, buying a put, and selling a call), a "butterfly" hedge, an "enhanced collar", a "double up", etc. However, in order for simplicity and to advance the high-level overview, a "zero cost collar" will remain the main instrument focused on in this paper.

Most large corporate E&Ps and "Integrated" oil and gas companies (i.e. the Exxon's of the world) do not hedge. There are many reasons for the lack of hedging, but the primary reason is operational diversification. Companies like Exxon Mobil Corporation or Chevron are vertically integrated. These large integrated operate upstream assets, midstream assets, and downstream operations. By having integrated operations there is a natural hedge built within the company. For example, if the commodity price were to decrease this would have an adverse effect on the upstream operations of vertically integrated oil and gas companies. However, since this vertically integrated E&P is also engaged in refining the oil, the decrease in oil prices would have positive effect on this section of business operations. The input cost to the refinery would less, however the price of gasoline could remain constant. Theoretically, the loss on the upstream assets could be offset by the gain on the downstream assets. This diversification reduces the overall commodity price risk to a company; therefore, hedging is not required.

Because small to mid-sized E&Ps operate in only the upstream segment of the industry, they have a much larger exposure to commodity price volatility. Therefore, most hedging occurs with small- to mid-cap E&Ps that are not as diversified as large, integrated oil and gas companies (Raymond James).



WHY HEDGE?

The importance of hedging within a small- to mid-cap E&P is that these companies are price takers; their revenues are directly correlated to commodity prices, and they do not generate revenues from midstream fees or downstream operations. Being in a commodity business, they have no control over the price point at which the company can sell their product. If oil prices were to plummet, this would drastically affect the E&P's revenue (and bottom line). Thus, most of the E&Ps hedge to reduce risk of oil and natural gas price volatility, and by doing so increase the certainty of expected revenues.

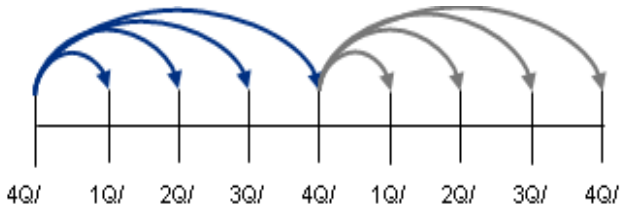
Their primary concern is if or when the commodity price goes down. E&Ps are extremely capital intensive. For example, a typical multi-well, shale oil horizontal pad can require $50 - $100 million of capital investment before that pad produces anything. If a typical DJ Basin well costs $4 million to drill and complete, a 16 well pad would cost $64 million. All drilling and

completion activities must be completed before the first well starts producing oil. Additionally, these pads can take approximately 6 months to complete. Thus, in this example, $64 million must be invested over six months before any revenue is generated. The investment is justified by the expected future cash flows that would be generated by the wells. These expected cash flows are projected based on several variables, with the main variable being commodity price. If the commodity price were to take a dip, then this could greatly affect the expected rate of return on the investment. Therefore small- and mid-cap E&Ps want to hedge, especially over the first year or two post the drilling and completion investment. Hedging allows the E&P to reduce or eliminate price volatility over the term of the hedge contracts, which helps diminish the uncertainty surrounding rates of return.

HEDGE TRADING TACTICS

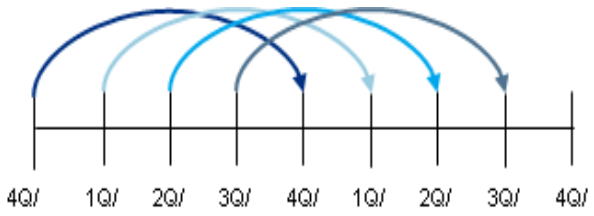
The three most common trading tactics practiced by E&Ps are: a static approach, rolling approach, and layering approach. Each approach offers a unique set of advantages and disadvantages to the E&P. These tactics can be used with swaps, puts, calls, and/or collars.

First is the static approach. The static approach can be thought of as a "set it and forget it" approach. As depicted to the right, the hedges for an E&P are set at the end of each year. These year-end hedges are implemented at a single point and time and utilize initial budget production volumes. The static approach can be advantageous in this way. Rather than implementing hedges each quarter, required in layering and rolling strategies, setting hedges at year-end provides a simplistic and possibly cost-effective method to an E&P's hedging

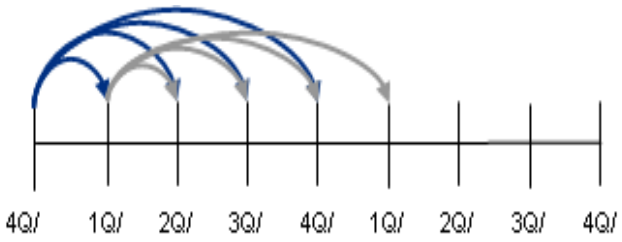


strategy. The downside to this approach is the there is no response to market volatility. For example, if at the end of the first quarter OPEC were to announce supply cuts the price of oil would probably rise. Under a static program, the E&P would not respond to the price movement and the E&P's hedging profile could be essentially obsolete. This "set it and forget it" approach, while simple, could potentially be more "costly" to the E&P in comparison to a rolling or layered approach.

The second approach is a rolling strategy. In a rolling approach, hedges are implemented four quarters out as the current quarter rolls off. The main advantage to the rolling approach is the ability to respond to changing forward forecasts. In comparison to a static approach, there is more freedom to respond to increases or decreases in market price. The main drawback to this strategy is when implementing a rolling hedging profile, the E&P tends to be "chasing" the market price. Although there is a heightened ability to respond to market change in a rolling profile, the reaction each quarter could have a delayed response.



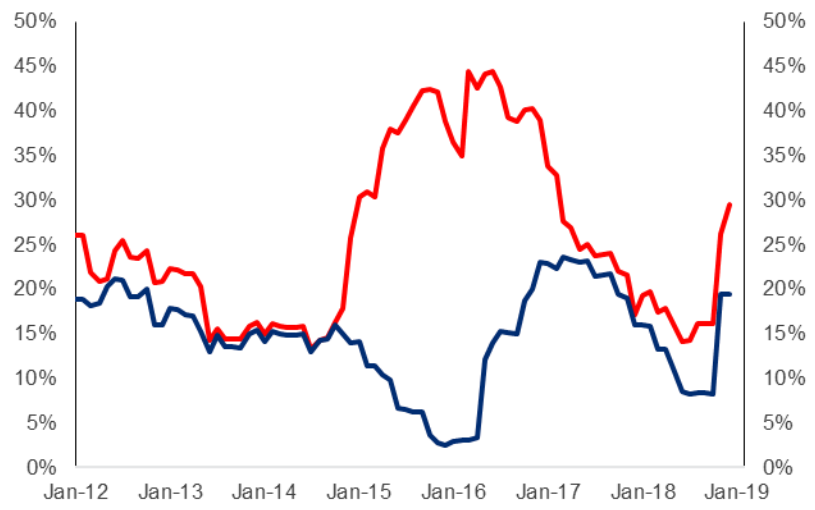
Layering is the last main approach that is utilized by E&Ps. A layered approach implies that hedges are systematically increased over time. This approach offers the most advantages in comparison to a static or rolling approach. Hedges are layered on top of each other over time. This results in the nearest quarter having the highest amount of volume hedged while the furthest out quarter will have the least hedged. Layering allows for accelerated response to forecasts and market volatility. Additionally, layering allows for



discretionary, multi-quarter adjustments that cater to both the market and the E&P anticipated activity levels. It is the most dynamic tactic of the three.

A recent analysis performed by Citigroup considered which tactic was most successful at reducing volatility and increasing effective price. When comparing static, rolling, and a layering approach it was found that the layering tactic generated a similar average realized price but significantly reduced annualized volatility (**Citigroup Energy**). According to the study, as shown in the figure below, the difference between hedged and unhedged price realizations are not significant:

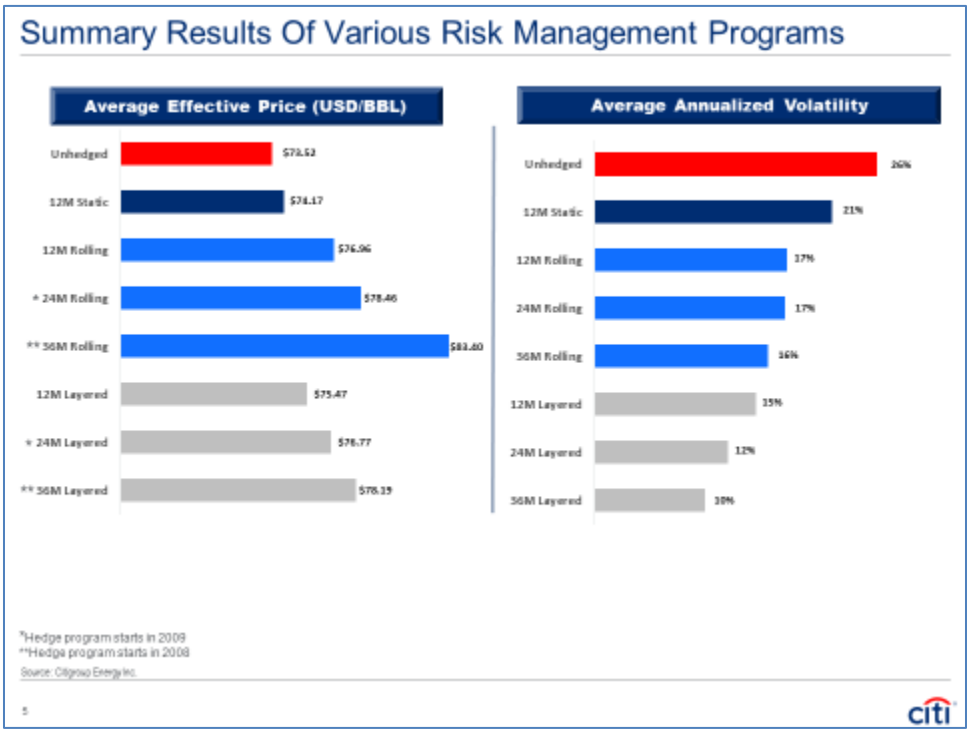
However, as shown in the next figure, the realized volatility is significantly lower using the layering strategy:



Red = Unhedged Volatility

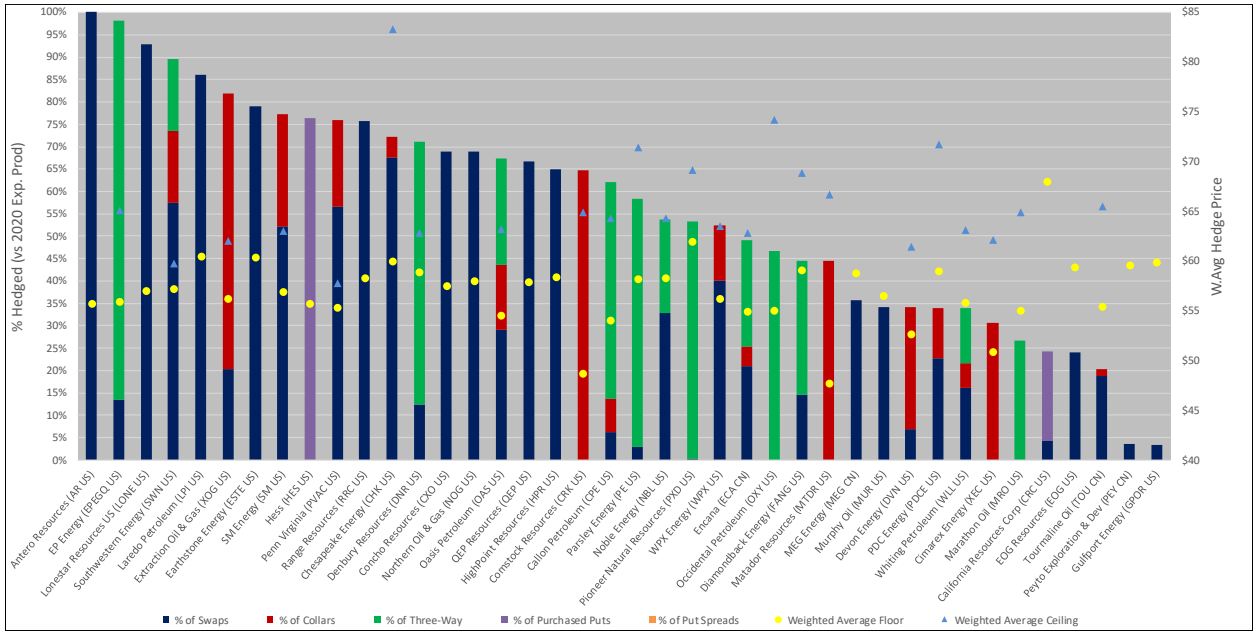
Black = Hedged Volatility

The Citigroup study summarized the results in the following figure in which a 12-month layering program generated a realized price approximately 3% *better* than the unhedged program while volatility was reduced by almost 60%.



E&Ps are required to file summaries of their quarterly hedge positions with the SEC. Within these reports, E&Ps disclose the different hedging instruments utilized and what strike prices the hedges contain. Highpoint and QEP provide two unique hedging examples. Both are small- to mid-cap E&P companies that report their hedging metrics publicly. What makes their hedging strategy unique is the use of only swaps. Highpoint's swaps have a strike price of approximately $59 while QEP's have a strike price of approximately $56. Other E&Ps engage in hedging with collars. Two examples of E&Ps that only use collars are Matador Resources and Comstock Resources. For 2019, Matador's put strike price is roughly $48 while their call strike price is approximately $67. Comstock Resources has similar strike prices, puts struck at approximately $55 and calls being struck around $70. The utilization of only one specific derivative instrument is rather unique, as most E&Ps employ a strategy that uses a variety of instruments. For example, E&Ps such as Parsley, Oasis and Chesapeake utilize swaps, puts, and collars in their hedging profile. Very few E&Ps solely rely on a single derivative instrument to hedge. Below is a table summarizing E&P 2019 hedging profiles compiled by Capital One (permission to use in this report was obtained prior to inclusion).

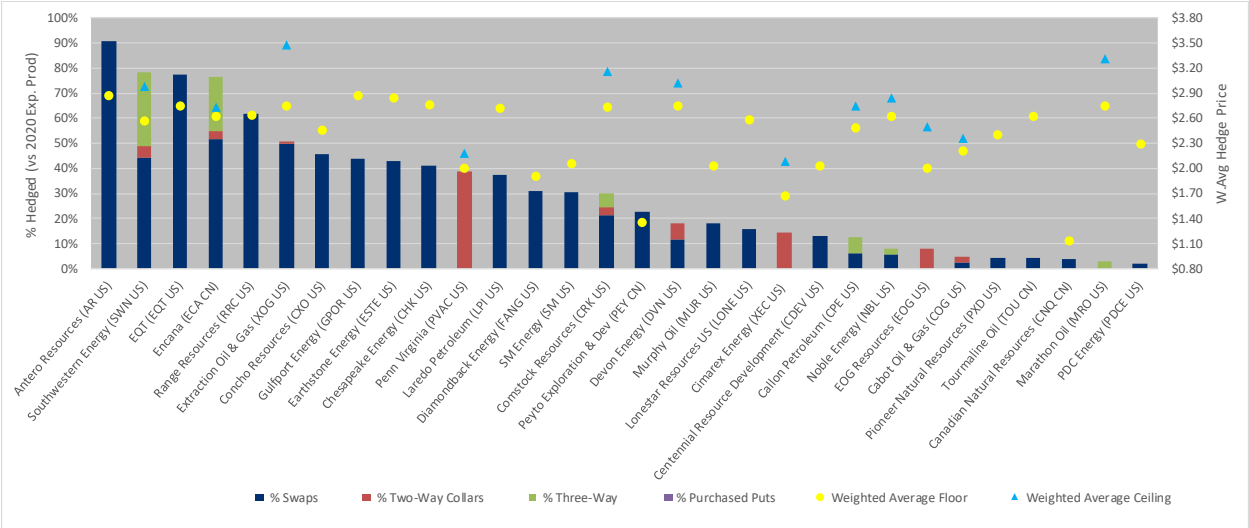
Source: Capital One based on 4th Quarter 2019 SEC filings



While this report focuses on oil, it is important to evaluate the difference between the hedging profiles of companies that produce predominately oil and companies that produce predominately natural gas. For example, Diamondback Energy is mainly a Permian oil producer. As of the fourth quarter of 2019, Diamondback Energy had hedged about 45% of their 2020 oil production using swaps and 3-ways as derivative instruments. Another example of a Permian oil producer is Concho Resources. In Concho's case, by the end of the fourth quarter of 2019, they had hedged about 69% of their 2020 oil production with the use of swaps. Oasis is another large Permian player that hedged 67% of their 2020 oil production. Oasis's production is hedged using swaps, collars, and three-ways. These three examples provide for an overarching view of the amount of production typically hedged in the small- to mid-cap "oily" E&P space.

Looking at E&Ps that produce primarily natural gas, Range Resources, Antero Resources and Chesapeake Energy are all small- to mid-cap natural gas producers. Range Resources uses swaps and had hedged approximately 62% of their 2020 natural gas production by the end of the fourth quarter of 2020.

Source: Capital One based on 4th Quarter 2019 SEC filings



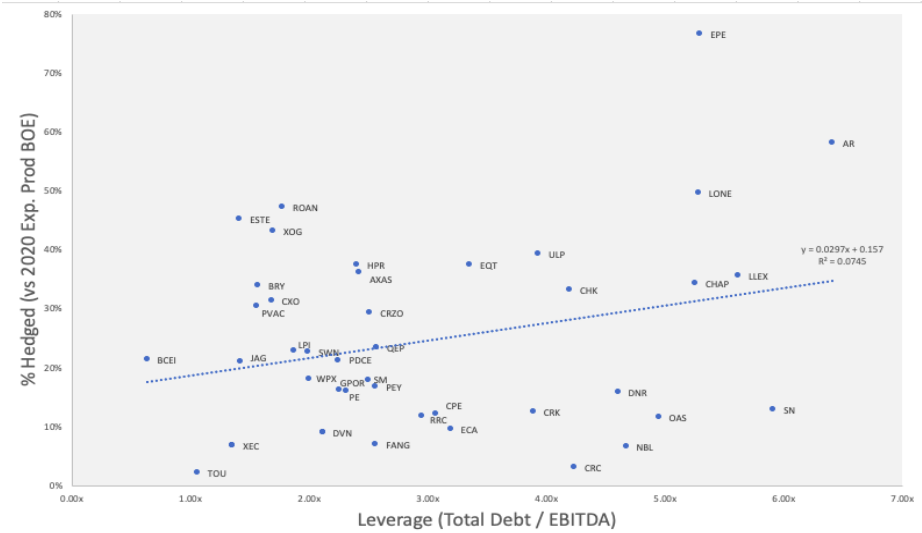
Antero Resources had hedged approximately 91% of their 2020 natural gas production through swaps at the end of the fourth quarter of 2019. Lastly is Chesapeake Energy. At the end of the fourth quarter, Chesapeake Energy had hedged approximately 41% of their 2020 natural gas production using swaps. These examples help develop the idea of that, within the natural gas space, the average amount of production hedged is larger than that of the primarily oil producing E&Ps. These selected E&Ps provide context to the overview of the current hedging profiles that are reported across the industry.

VARIABLES OF A HEDGING PROFILE

The use of hedging must be analyzed within the context of an E&P's financial and operational profile. In addition to what commodity is the most important to the E&P in terms of revenue, the main variables that should dictate an E&P's hedging program are: capital structure, operation flexibility, expected returns, production growth, and cash flow expectations. Hedging decisions are dependent upon the interplay of these variables. Each E&P will structure their hedges differently depending on their unique profile and how they think about the various risks within their business.

Capital Structure

Capital structure is the first component that directly relates to how a company thinks about hedging tactics. The critical aspect of capital structure as it relates to hedging is the amount of leverage an E&P uses. Within the small- to mid-cap E&P space, there is a correlation between an E&P's use of leverage and the volume of production hedged. Based on publicly available data, Cimarex Energy had an estimated leverage ratio (Debt divided by consensus EBITDA) of approximately 1.5x and hedged approximately 7% of its 2019 production as of the end of the first quarter of 2019. Similarly, Concho Resources had a leverage ratio of just under 2.0x and had hedged approximately 30% of its 2019



production. Conversely, Antero Resources had a leverage ratio of approximately 6.0x and has hedged about 60% of its production. Likewise, EP energy has a leverage ratio of approximately 5.0x and has hedged about 75% of its production. The higher the leverage ratio, the more the E&P needs cash flow to insure it can pay interest on its debt. This in turn suggests highly leveraged E&Ps should hedge more to increase the certainty of commodity prices.

The relationship between a firm's leverage, amount of production hedged, and shareholder returns, is important to consider when developing a hedging profile. Upstream oil and gas companies that are highly leveraged "face greater difficulties in accessing capital markets" (David Haushalter) due to concern of investors and lenders over a company's default risk and future ability to repay its debt. To reduce this uncertainty over future solvency, upstream oil and gas producers that are highly leverage "tend to hedge a greater fraction of their output than firms with lower leverage ratios" (David Haushalter). The reason for greater amount of hedging is to "ensure sufficient cash flows to finance future investment opportunities" (David Haushalter).

Hedging also reduces the perceived risk by both bond holders and equity investors. By having secure cash flows through hedging, firms can maximize liquidity, lower counterparty risk of the firm, and guarantee a minimum return on operations. The relationship between corporate risk management through hedging and minimizing investors' concerns is an integral element of an exploration and production's hedging profile. By hedging, oil and gas producers reduce the market's concern over the firm's default and allows more security in the firm's ability to repay its outstanding debt.

There are other issues surrounding the amount of leverage a company uses other than the value of the firm's debt. One is the ability for an upstream oil and gas producer to properly refinance their short-term debt. If a company has a significant amount of debt maturing in two years, the firm will refinance this debt to take advantage of a better interest rate or consolidate its maturities. Although this firm has the ability to pay their coupon payments on the maturing debt, if the commodity price has fallen below a point where operations are profitable, concerns about the firm's capacity to repay its principle and/or ability to properly refinance its debt increases. If a company is unable to repay or refinance its debt obligations, the firm goes into bankruptcy and must restructure. By hedging, a firm can reinforce its ability to repay debt obligations. By locking in cash flows at a specific amount above its breakeven commodity price through hedging, exploration and production companies can reduce their risk of default and decrease the exposure of investors and counterparties.

Secondly, hedging can provide liquidity to a firm through bank credit facilities. Reserve based lending offers credit facilities to companies based off the value of a company's oil and gas reserves and a certain set of covenants; two covenants being the price and the amount of volume hedged by the company. By abiding by covenants related to hedging, oil and gas can often increase their borrowing base available by hedging a specific amount of expected production at an attractive price. If a company has hedged their 2021 production at $55 when the commodity price is $45, this greatly reduces the probability of default. Due to this decreased risk, the bank will lend the oil and gas company more money. Increasing the borrowing base available to a firm through hedging increases their access to capital.

Operation flexibility

Operational flexibility should be an integral element of the hedging profile. The flexibility to ramp up or down drilling and completion activity and how that impacts capital expenditures should be considered in determining how much to hedge. E&Ps that enter long-term drilling rig contracts or employ completion crews for multiple years may not be able to slow down activity as commodity prices fall. These E&Ps would need to insure they can cover the cost of continuing activity and thus, may need to hedge more. This suggests those with more flexibility, having the ability to quickly respond to changing commodity prices, would have less need for hedges. Whether the E&P can increase capital spending with an uptick in the market occurs versus decreasing the capital spending in a downturn greatly influences the overall flexibility and directly affects the hedging profile. Operational flexibility and risk management are innately tied.

Offshore drilling contracts started for "less than USD 100,000 per day at the beginning of 2002, rig rates for high-spec semi rigs have now reached more than USD 400,000 per day. This reflects the oil industry boom sparked by high price of crude…" (Osmundsen, Petter, Terje Sorenes, and Anders Toft). When the upstream producer enters into long-term drilling contracts, the company has committed to spend a specific amount of capital over the term of the contract. For example, companies like Transocean, the world's largest offshore drilling contractor, specifies a date rate of roughly "$225,000," with a rate that depends on which drilling rig is being offered to the E&P company. Transocean specifies a contract duration of a range from "120 days to 365 days" (Veazey, Matthew). Assuming the E&P enters the one-year contract, it has committed to spending over $82 million in capital. In turn, this limits the firm's liquidity

and reduces the amount of funds available from free cash flow and creates a larger need for capital for other aspects of the company.

Another critical element of drilling and completion activities are marketing and midstream commitments. Marketing and midstream companies are firms that transport the crude to Cushing Oklahoma or other hubs for the upstream producers. E&Ps enter into mid- to long-term contracts with midstream companies to ensure their production can move to end markets. These agreements require E&Ps to deliver production to the midstream gathering and transportation systems regardless of the price of commodity. Even if the E&P decides to not produce oil or natural gas due to the commodity price, the operator must pay the midstream company.

These "minimum volume commitments" are commitments of oil and gas producers to provide an explicit number of barrels of crude oil or particular volume of natural gas to marketing and midstream companies and create another potential limit to liquidity. For example, Whiting Petroleum Corporation, an upstream oil and gas company, paid "$61 million to the counterparty … to settle all future minimum volume commitments under an agreement" (Whiting Petroleum 10K). These examples establish heavy capital expenditures that upstream oil and gas producer must incur to operate daily business.

"Companies that have obtained long-term contracts were accordingly left with all downside but no upside" (Osmundsen, Petter, Terje Sorenes, and Anders Toft). When a producer's capital is constrained by long-term drilling contracts or minimum volume commitments, it increases the difficulty of pursuing other potential growth opportunities and makes overall operations less flexible. Setting a hedge offers a form insurance that grants

coverage on multiple issues related to a flexibility of a firm's operations. An effective hedge can cover the penalties associated with minimum volume commitments should the E&P decide to reduce production, and while not increasing accessible capital, hedging ensures capital will not be reduced. Additionally, hedging reduces perceived counterparty risk. For example, if Transocean sees that Whiting Petroleum Corporation is hedged at $55 per barrel of oil, this decreases the likelihood of Whiting Petroleum Corporation of going bankrupt, assuming $55 is above Whiting's breakeven point on operation. This makes Transocean more likely to do business with Whiting Petroleum Corporation. Hedging helps reduce observed risk by other companies when engaging in operations, like drilling contracts, and decreases the firm's counterparty risk.

Expected Return

Expected returns is the third element in determining an E&P's hedge profile. Economic Value Added (EVA) is an essential consideration when evaluating expected returns. EVA "attempts of account more properly for your cost of capital" and is made up of two company elements: Weighted Average Cost of Capital (WACC) and Return on Invested Capital (ROIC). In the oil and gas industry, the firm's ROIC is primarily determined by its capital expenditure budget and realized commodity price. A company's capital expenditure budget includes the growth opportunities the company is considering and other necessary expenditures that allow the producer to continue its operations. The realized commodity price is the price the upstream oil and gas company will receive for the crude oil and natural gas that is produced. In ROIC, the controllable components are a company's capital expenditures and the realized commodity price, if the company hedges. The second element of EVA is the firm's weighted average cost of capital. WACC is based on how much it costs a company to raise capital in the debt and equity

markets and is weighted by the relative amount of debt and equity the company uses. It "represents the minimum return that a company must earn on an existing asset base to satisfy its creditors, owners, and other providers of capital, or they will invest elsewhere…" (Fernandes). A firm's WACC is relatively controllable because a company can choose the amount of debt or equity they issue to raise capital. However, it also depends on how the capital markets evaluate a company's risk.

EVA capital programs are undertaken if on the expected ROIC is above the E&P's WACC. If the ROIC falls below the WACC, the E&P should stop development activity as EVA would be negative. As commodity prices decline, the ROIC for an E&P falls but the company's cost of capital may not change. Thus, the spread between rate of return and cost of capital decreases. Additionally, if an E&P operates in a lower rate of return environment, for example the fringe area of a basin, the spread between ROIC and WACC may already be low. Hedging can reduce the volatility of ROIC and help insure the ROIC stays above WACC.

One challenge as it relates to returns is that most E&Ps only hedge two to three years out. Because ROIC is based on the life of the production, which can be 20+ years, a significant portion of the return is beyond the hedged time frame. However, the spread between ROIC and WACC is still critical in determining how an E&P should hedge.

When the company's perceived risk rises due idiosyncratic factors that affect every upstream oil and gas, the cost of equity and debt can increase significantly which would cause the company's weighted average cost of capital to increase. If commodity prices are falling simultaneously with an increase in weighted average cost of capital, the company's EVA could quickly turn negative. Maintaining a strong hedge book can help bridge this shock.

Although a firm has hedged a downfall in the price of the commodity, even if the producer is receiving a higher realized price than its competition, it is critical to compare the company's realized returns to their weighted average cost of capital. If these returns are below the weighted average cost of capital, despite having a higher realized commodity price in comparison with competition, the upstream oil and gas producer should not invest its capital. An example of an upstream oil and gas company ignoring the importance of its weighted average cost of capital is Highpoint Resources. Highpoint Resources is currently hedged "at ~95% of its 2020e crude production, swapped at $58/bbl" (Coker Palmer Institutional). Although being hedged at a higher level than most of their peer group, Highpoint Resources debt is currently yielding approximately 28%, which is significantly higher than Noble Energy's bonds of similar maturities. Because of such a high yield, Highpoint Resource's cost of debt and weighted average cost of capital are extremely high. In contrast to a high cost of capital, Highpoint has only cut their spending level by "approximately 40% lower than 2019" (Highpoint Resources). This would suggest that Highpoint is generating a negative EVA on their remaining capital expenditures even with a significant hedge which is helping their ROIC. In comparison, their peers have cut their capital expenditure budgets by approximately 70% while maintaining a lower weighted average cost of capital than Highpoint. In evaluating expected returns, it is crucial to consider the firm's weighted average cost of capital. In many cases, especially given the current oil and gas environment, if ROIC and WACC are not both considered, it could cause the producer to go bankrupt. Highpoint Resources may be

HPR 8.75 '25	49.000	(0.031)	28.03%	Jun 15 '25	2769
NBL 3.9 '24	88.959	0.061	6.75%	Nov 15 '24	642
NBL 3.85 '28	76.500	0.000	7.98%	Jan 15 '28	741
NBL 3.25 '29	71.250	0.000	7.55%	Oct 15 '29	698
NBL 6 '41	80.000	0.000	7.98%	Mar 01 '41	681
NBL 5.25 '43	69.750	(3.250)	8.16%	Nov 15 '43	699
NBL 5.05 '44	71.125	0.000	7.68%	Nov 15 '44	651

an example as they have a significant amount of debt due in 2022 and they may not be able to refinance it given the current commodity market.

Production Growth

Production growth and free cash flow is the final factor that influences an E&P's hedging profile. High growth E&Ps, historically, have spent more on capital expenditures than they have generated in EBITDA (a measure of cash flow). This negative cash flow must be financed, which in turn increases the E&P's risk profile. Due to the risk generate by outspending cash flow to increase growth, hedging should become more prominent within high growth E&Ps.

Historically, investors desired high production growth as an attractive investment metric in the oil and the gas industry. Post shale revolution, what investors are seeking from an oil and gas company changed significantly. Currently, shareholders are more concerned with returns and potential consolidation rather than production growth from the oil and gas industry.

Major acquisitions such as Carrizo Oil and Gas being acquired by Callon Petroleum Company in late 2019, SRC Energy merging with PDC Energy in August 2019, or, most notably, the Anadarko and Occidental merger, solidify consolidation has been and will continue to be a major theme within the oil and gas industry.

The methodology and reasoning behind consolidation is fixed cost absorption. Fixed cost absorption is increasing the total revenue of the combined company while eliminating the fixed costs associated with the acquired company. However, when a merger occurs, the buyer must take over all the target company's problems, such as interest payments. In doing so, the buyer should consider how to adjust their hedging program based on the pro-forma structure of the combined companies. If leverage is dramatically increased, additional hedges should be

considered. Likewise, if the combined company has a lower ROIC, the company may want to increase hedges to help ensure their return expectations are met.

Callon Petroleum is a good example of a company not appearing to have adjusted their hedging strategy upon the acquisition of Carrizo. Callon bought Carrizo for approximately $3 billon including taking on Carrizo's $1.7 billion in debt. This dramatically increased Callon's leverage ratio. However, it appears Callon did not significantly change their hedging strategy. Post-merger, the combined company's leverage ratio increased to ~4.0x but their hedge appears to have only increased from approximately 12% to approximately 20%. Similarly leveraged E&Ps typically have hedges covering a significantly higher percentage of their production. With commodity prices now down dramatically since they acquired Carrizo, given a very high leverage ratio and the market's concern they might not be able to pay back the debt, Callon's stock has been among the worst performing oil and gas companies in the industry. If Callon had increased their hedges at the time they bought Carrizo, they might be in a much better position today and their stock might be much higher.

The second source of growth is at the drill bit. A firm that is pursuing growth opportunities is likely to be outspending its EBITDA on capital expenditures. Thus, the delta between the firm's capital expenditures and EBTIDA, their "outspend", must be financed by outside sources, such as a credit facility or issuing debt. For example, if the oil and gas company has incurred $500 million in capital expenditures annually, and the firm's EBITDA is $500 million, then all growth prospects can be financed internally. When commodity price falls, the company's EBITDA falls simultaneously (excluding hedging revenues), and if capital expenditures remain consistent, then there would be a need for outside financing. This idea ties directly to another hedging variable, flexible operations. If a firm has a significant amount of

flexibility in its operations, meaning the ability to decrease its capital expenditures with decreasing commodity price, then there is less risk involved. However, if the firm is inflexible in relation to its capital expenditures with a changing commodity price, they may need additional outside capital. As mentioned earlier, minimum volume commitments can further limit a company's ability to adjust production and therefore adjust capital spending. To mitigate these innate risks in relation to growth, firms must stabilize cash flows through prudent hedging strategies.

Capital structure, operation flexibility, expected returns, production growth, and cash flow expectations are all part of every E&P and are paramount to consider when an E&P is developing a hedging program.

DATA ANALYSIS

Data analysis was conducted using publicly available data that is filed with the Securities and Exchange Commission. Research was conducted using the following steps. An "oily" peer group was created using a random sample of small to mid-cap upstream oil companies that had publicly available data. Some producers in this peer group produce oil and gas, which could create some noise in the results. The first step was to gather all raw data related to the upstream companies. Raw data inputs included the firm's market capitalization as of April 20, 2020, the company's leverage ratio, and the stock prices from January 2, 2020 through April 20, 2020, and the amount of oil production the company had hedged for 2020. A regression analysis on the individual company's overall returns versus crude oil's (as measured by prices of West Texas Intermediate) overall returns was performed. The regression analysis of each individual stock found the stock's "oil beta," "oil alpha," t-statistic, and r^2. These outputs were then used to

perform univariate and multivariate analysis to provide empirical evidence of how the amount of production a company has hedged, and their financial leverage influences the overall returns of a stock. It is critical note that this analysis was done during historical times in the oil and gas industry. On April 19th, 2020, "U.S. crude oil futures collapsed below $0…" an unprecedented event that has never occurred prior to 2020 (Reuters). Looking at variables such as leverage, and hedging are extremely topical and create an interesting analysis of how leverage and production hedging influence returns when oil prices go to $0.

Theoretically, the more leverage a firm has, the more prudent it is for the company to hedge a higher percentage of their production. To maintain a definite cash flow to have the ability to consistently make interest payments on the upstream company's outstanding debt, the firm should hedge a higher amount of their production. Exhibit 1 shows the relationship of a firm's leverage ratio and the amount of production the company has hedged. A linear relationship between the amount of leverage a firm has to the amount of production hedged can be drawn. However, much of the peer group is concentrated around a similar leverage ratios and percentage of production hedged which suggests that there could be an optimal amount of leverage and hedging. Although there appears to be a linear relationship between leverage and amount of production hedged, the regression between leverage and production hedged has a r^2 of 0.0022. A r^2 implies .22% of the variation in production hedged is related to the leverage of a firm. Therefore, it can be concluded that the decision to hedge depends on more than simply the amount of leverage a company has.

In Exhibit 2, the year-to-date stock prices compared to crude oil's year-to-date commodity price was analyzed. Although this is seemingly unrelated to a firm's leverage ratio and the amount of production they have hedged, a key part of the data analysis involves the

relationship between how much the stock is correlated to the movement in oil and if there is a difference between those correlations based on how levered a firm is and how much production the company has hedged. Given the current oil and gas environment, it creates an interesting graphic to depict how the COVID – 19, Russia, and OPEC have influenced the price of crude. As Russia and OPEC flooded the market with supply and COVID – 19 destroyed demand, there has been a dramatic amount of lost value within the oil and gas industry that has cost oil and gas workers their jobs and caused companies to go bankrupt. Another notable point of this chart is how crude oil prices went negative on April 20, 2020, which was caused primarily by the mass selling of crude oil futures contracts.

Percentage of production hedged versus oil beta illustrates the influence that hedging has on a firm's exposure to commodity price risk in Exhibit 3. Oil beta can be thought of as an upstream oil and gas company's commodity risk. The graph depicts an extremely weak influence that hedging has on a firm's exposure to commodity price risk. Within this chart specifically, there could be some noise related to the fact that some upstream companies that are part of the peer group produce both oil and natural gas, rather than purely just oil. Much of the peer group hedges between 10% to 25% of their production with similar oil betas of roughly 1.00x to 1.40x. Percentage hedged versus oil beta has an r^2 of .22%, meaning an extremely small percentage of the firm's oil beta can be explained by the amount of production the company has hedged. The lack of the relationship between the two variables is important.

Much of the peer group has an oil beta between 0.80x to 1.20x, which is a smaller range that what would have been expected. Theoretically, highly hedged companies should have oil betas much lower than the low end of the observed range, meaning the market should eliminate the influence of commodity price volatility on stock prices. One reason the r^2 might be low is

because the sample group of names does not include many companies that are highly hedged. Likewise, as mentioned above, most oil and gas companies only hedge 12 to 24 months of forecasted production. Perhaps the market "recognizes" the limited time the hedges protect the company and the market is discounting the longer-term implications of falling oil and gas prices. The difference between the oil beta of those companies with only near-term hedges and the oil beta of those companies with long-term hedges was not analyzed.

In Exhibit 4, a firm's leverage ratio as compared to the company's oil beta shows a slightly stronger linear relationship, with a r^2 of 0.522%. There appears to be a weak linear trend between how much leverage an oil and gas company has and their oil beta. Logically, the higher the leverage of the upstream company the higher the oil beta the company would have, but the r^2 of 0.522% suggests otherwise. There is the possibility of some noise created from how some of the peer group produces both and oil and gas.

Exhibit 5 depicts the comparison of each individual oil and gas company's excess return over the year-to-date return of crude to the firm's oil beta. The relationship shows an approximate inverse relationship between the company's excess return and the oil beta. As the firm's oil beta increases the excess return over crude oil price decreases. Many of the producers that are part of the peer group outperformed oil by a significant margin. The companies' excess returns over the return of crude can be seen in Exhibit 9.

A firm's oil beta, theoretically, would be an accurate predictor the excess return of the company over the price of crude. However, exhibit 6 depicts a r^2 of .04%, meaning that only .04% of the variability in a company's excess return is explained by its oil beta. Like other exhibits, there is a cluster of the oil and gas peer group that has an oil beta of approximately one

with an average excess return that ranges from $0.30 to $0.40. The trendline that was calculated for the scatterplot does not seem to accurately follow the actual trend of the data. The actual trend seems to a much stronger inverse linear relationship between oil beta and excess return. It is possible that outliers, such as CHAP or TOU.TO, significantly influence the trendline, equation, and r^2 of exhibit 6.

Leverage is compared to the firm's excess return in Exhibit 7. There is a relatively stronger linear relationship in comparison to other variables. As the leverage ratio of the oil and gas company increases, the firm's excess return over the year-to-date returns of crude oil increase. The slope of the trend line is 0.0564 while the graph has an r^2 of 0.0349. Exhibit 7 is related to the expected return a company has and their overall capital structure.

Exhibit 8 compares the amount of production the upstream company has hedged to the r^2 of each firm in the peer group. This is a critical piece of analysis because it illustrates how the amount of production a company has hedged explains the variability in the company's stock price in relationship to the year-to-date return of crude oil. The graph depicts a strong inverse relationship between the amount of production hedged and the oil and gas company's r^2. The more the company has hedged the less variability there is in the company's stock price related to commodity price fluctuations. Exhibit 8 shows an r^2 of 29.03% and a slope of roughly -0.50. This ties directly to a main point, the better ability an oil and gas company must maintain stable cash flows and utilize active risk management, the relatively better the stock should do as commodity prices fall.

Exhibit 9 is integral when analyzing the r^2 of each individual firm. When analyzing the r^2, it is critical to consider the r^2 of each individual security. Individual regressions showed that

each company had a r^2 that ranged from 62.17% (TOU.TO) to 91.64% (CRC) which can be seen in Exhibit 9. These individual regressions illustrate a much different story; the heavy influence crude has in predicting the overall returns of an individual oil and gas company. Leverage ratio and oil beta are innately tied. The more debt the company has outstanding the higher the oil beta will be.

Multivariate tests were also conducted. For each multivariate analysis, the explanatory variables are the amount of production a company had hedged and the leverage ratio of the firm. In Exhibit 10, each firm's oil beta is compared to the firm's leverage ratio and amount of production it has hedged. The $r^2$of the multivariate regression is approximately 0.05, meaning that five percent of the variability in the oil beta is related to the amount of leverage a firm has and the amount of production hedged. R^2 in this case is rather insignificant. The reasoning for this is the noise that was created when using a regression to determine the oil beta. Some firms that are a part of the peer group produce both oil and gas. Hedging gas production is a similar process but has some influence over the outcome of the oil beta regression.

Exhibit 11 analyzes the total returns for each company in comparison to the oil and gas company's leverage and production hedged. The r^2 of this multivariate regression is approximately 25%, meaning that 25% of the company's overall return is explained by the firm's leverage ratio and amount of production hedged. This number is much higher than compared to Exhibit 10's r^2 because overall year-to-date return does not involve any estimation in calculation while the oil beta does.

Exhibits 1, 2, 3, 8, and 11 provide the most essential data that supports a holistic approach to hedging. Each one of these exhibits relates the four variables of capital structure,

flexible operations, production growth, and return based development. Exhibits 4, 5, 6, 7, 9, and 10are important to consider, but are biased due to the data inputs. Oil beta is sensitive to multiple biases and estimations that influence the displayed relationship.

Exhibit 1

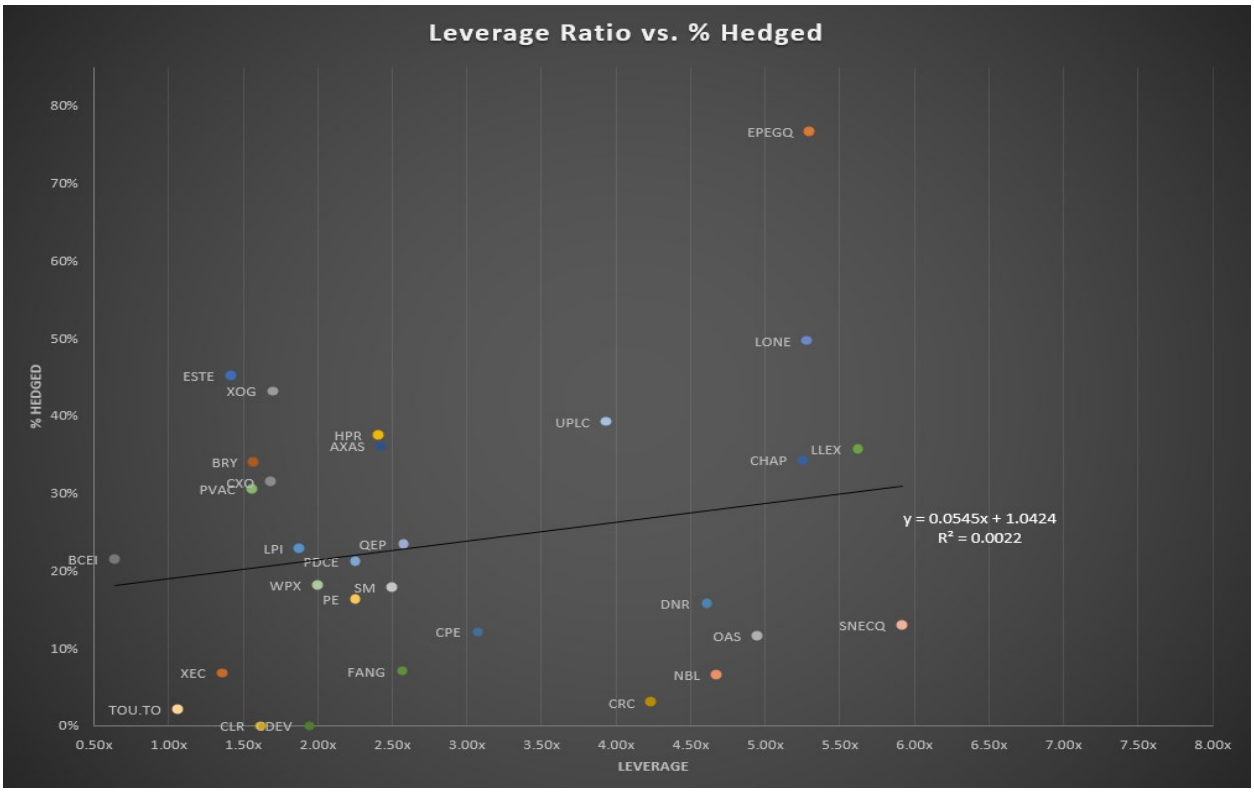


Exhibit 2

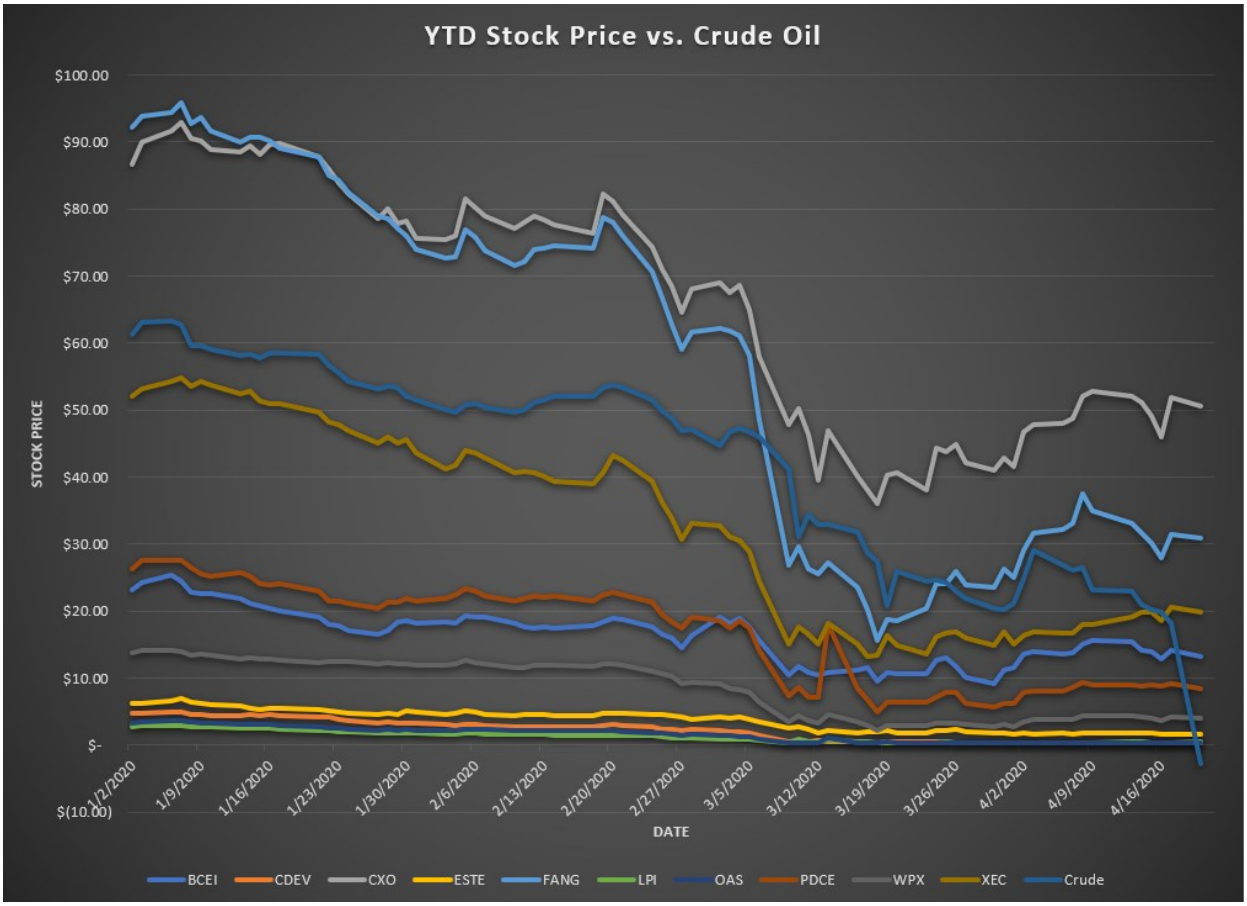


Exhibit 3

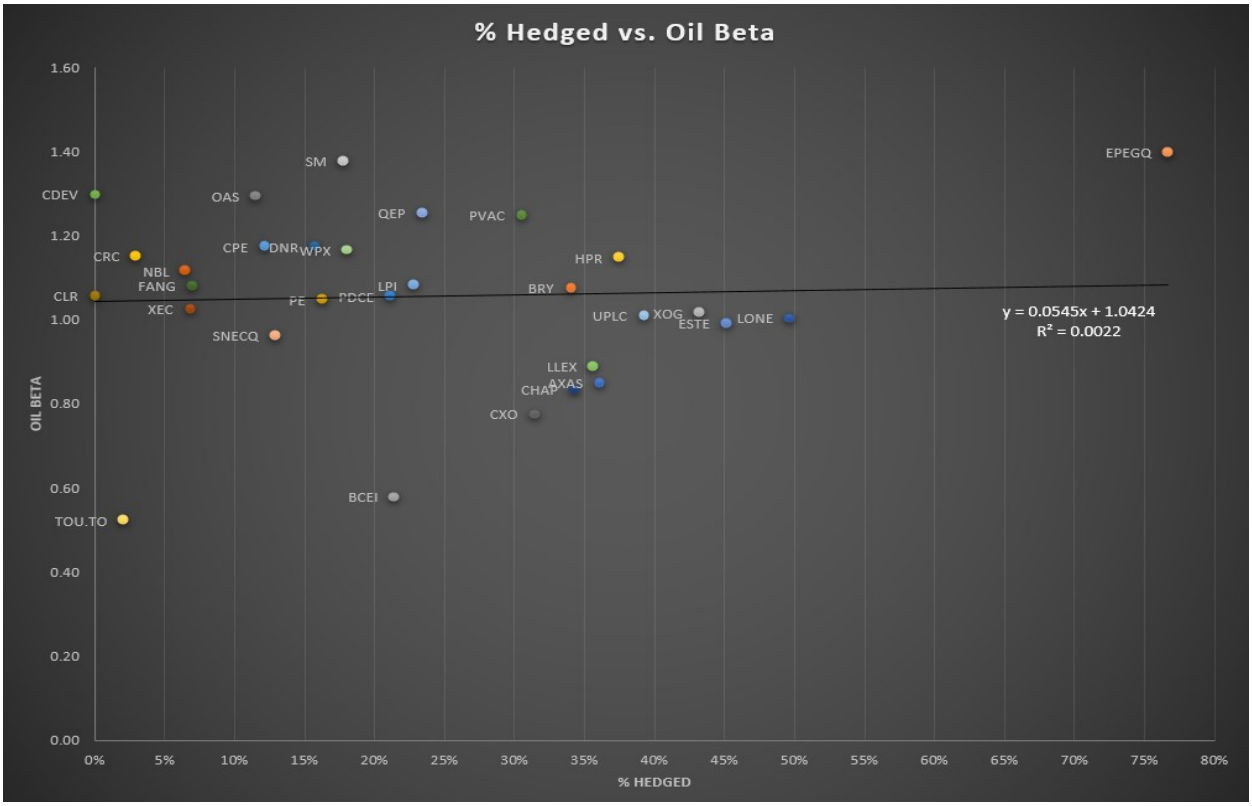


Exhibit 4

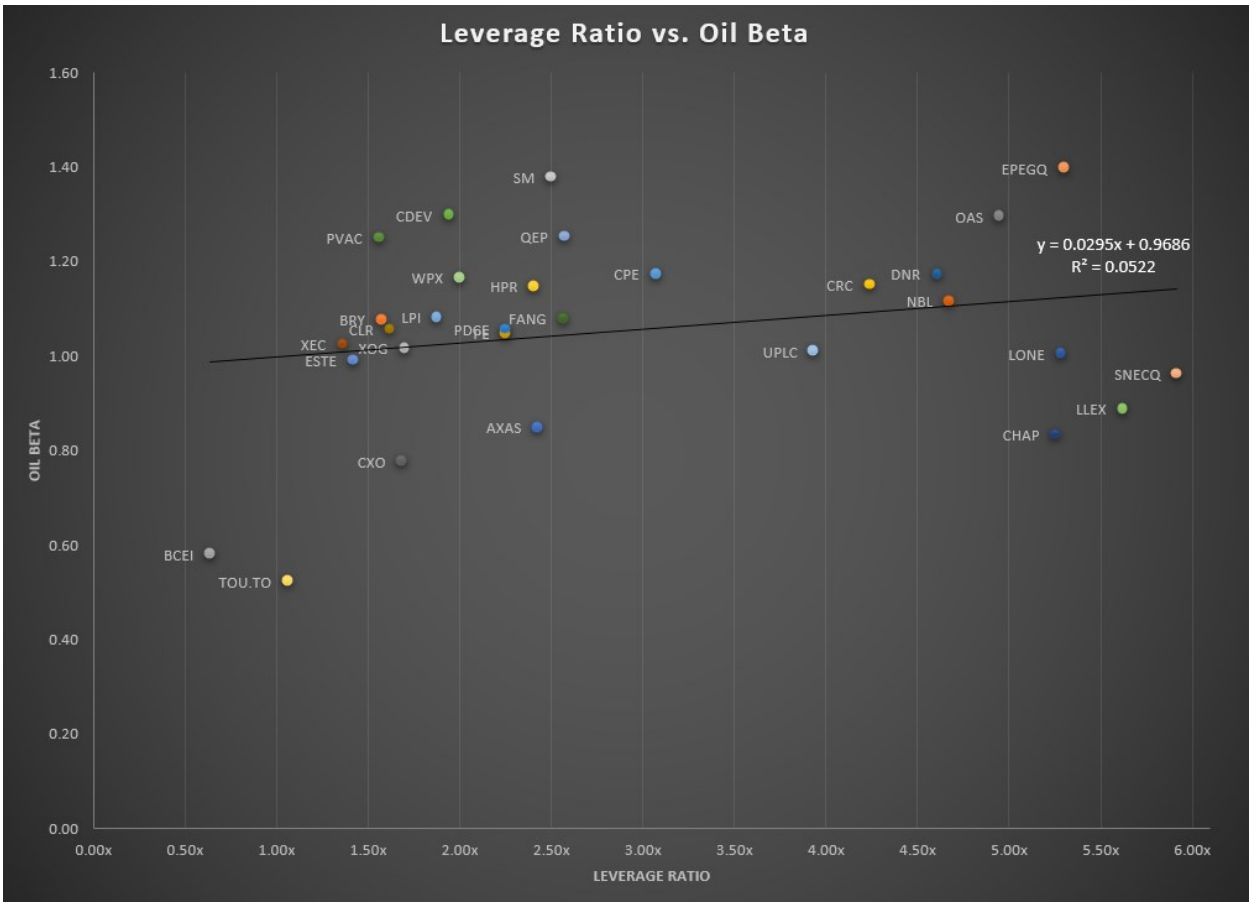


Exhibit 5

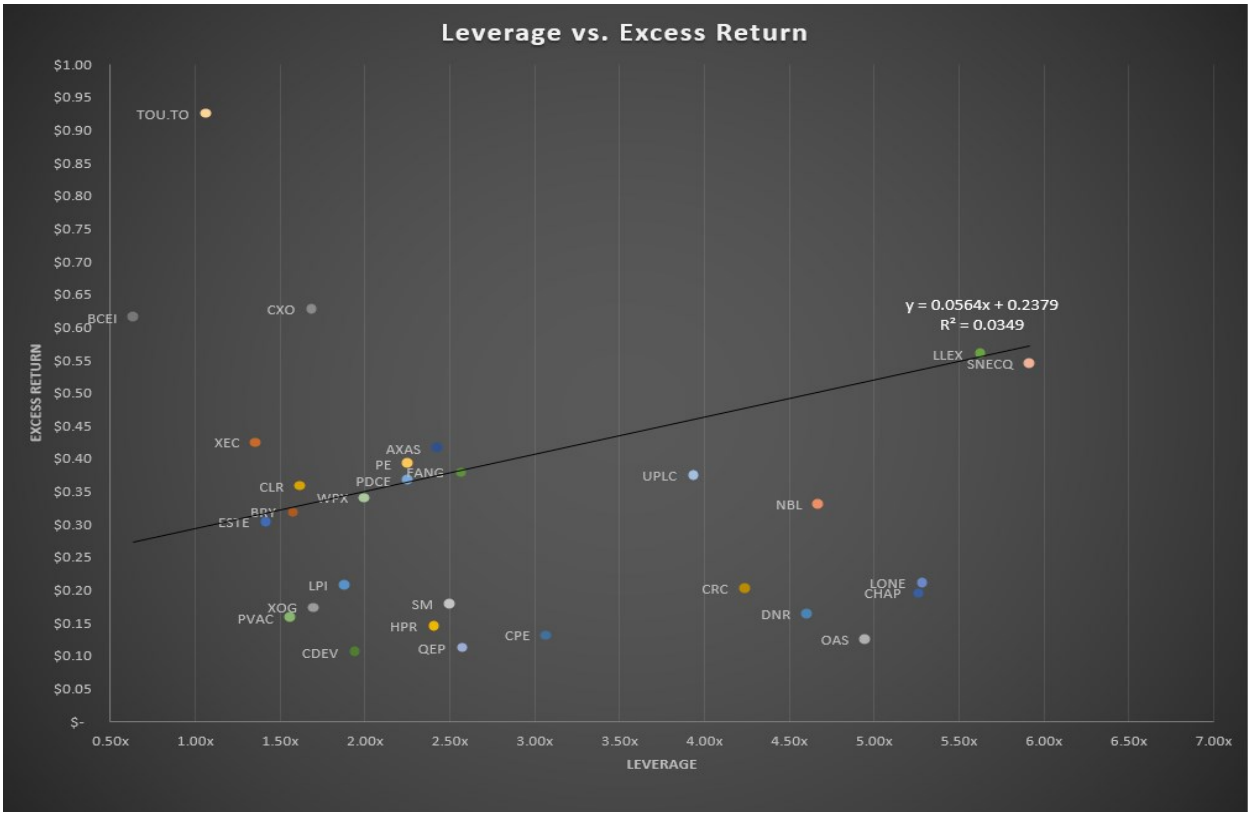


Exhibit 6

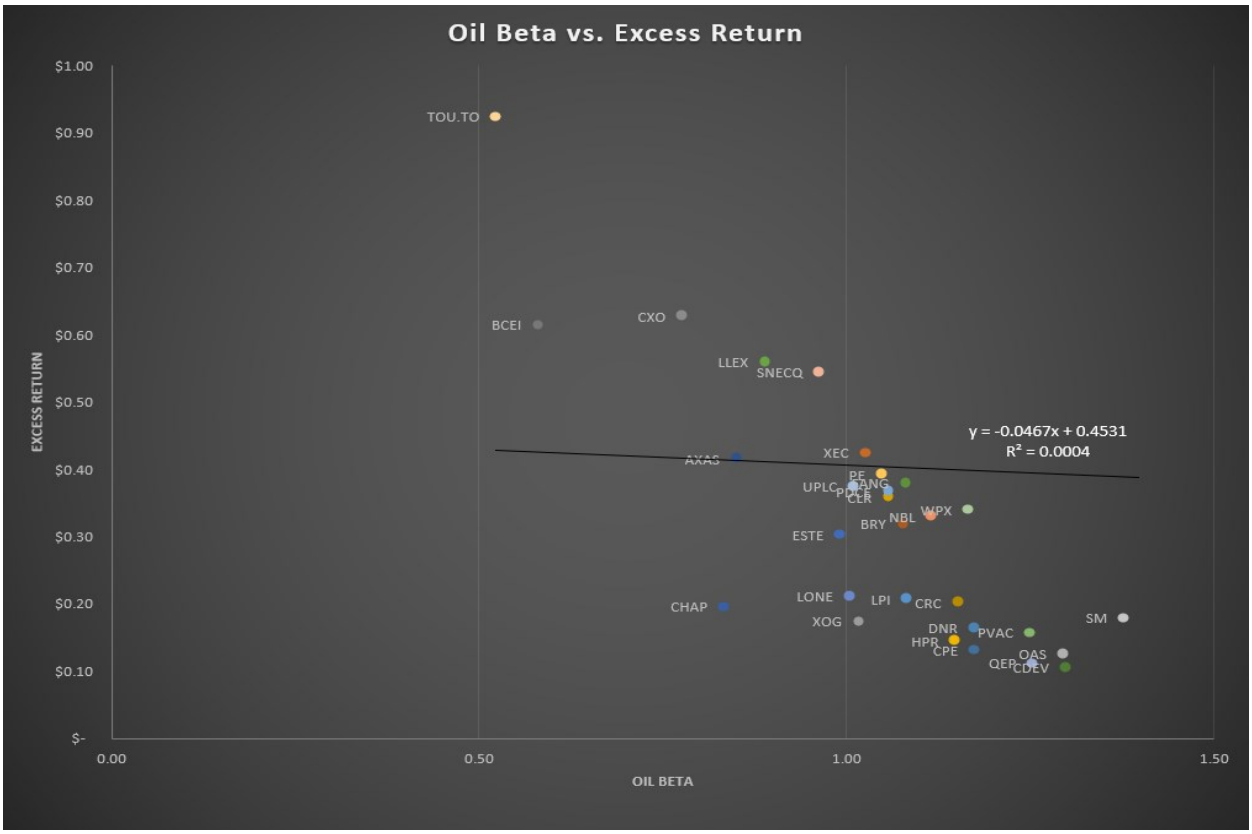


Exhibit 7

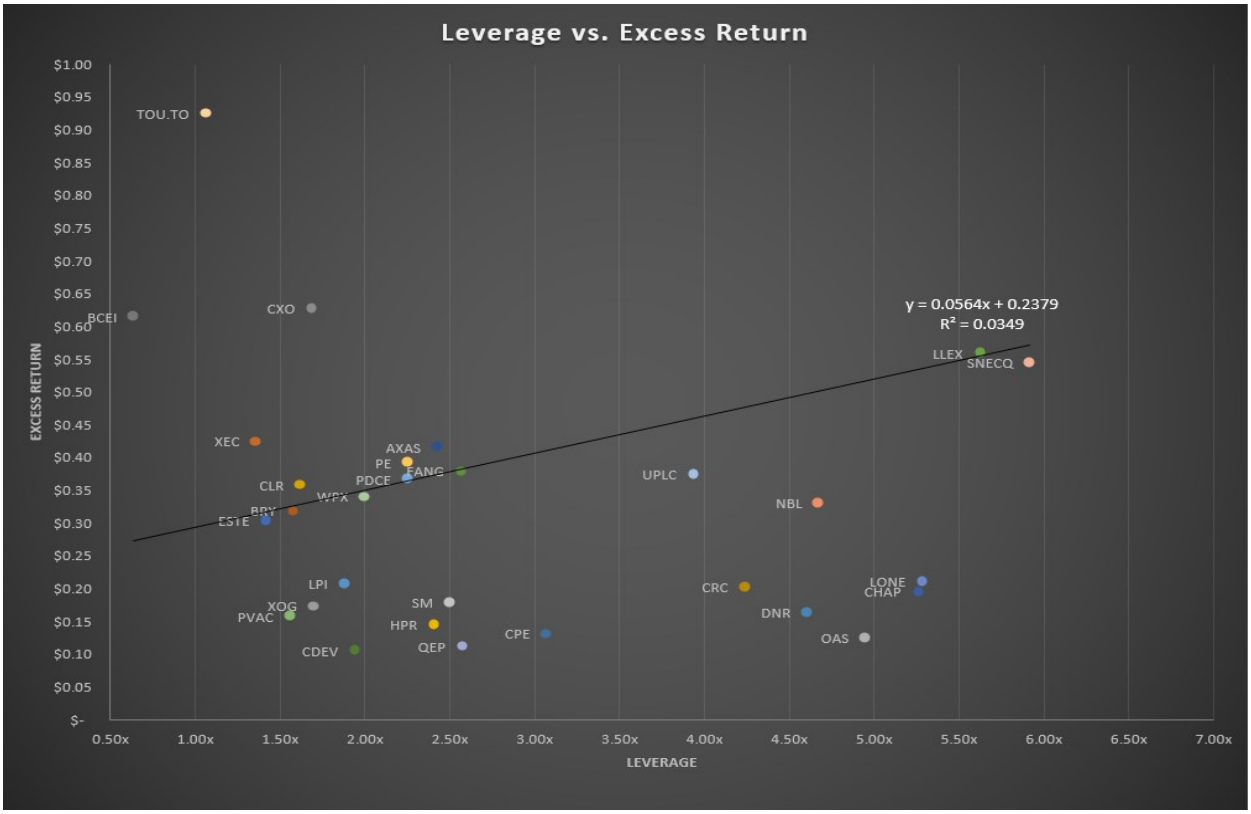


Exhibit 8

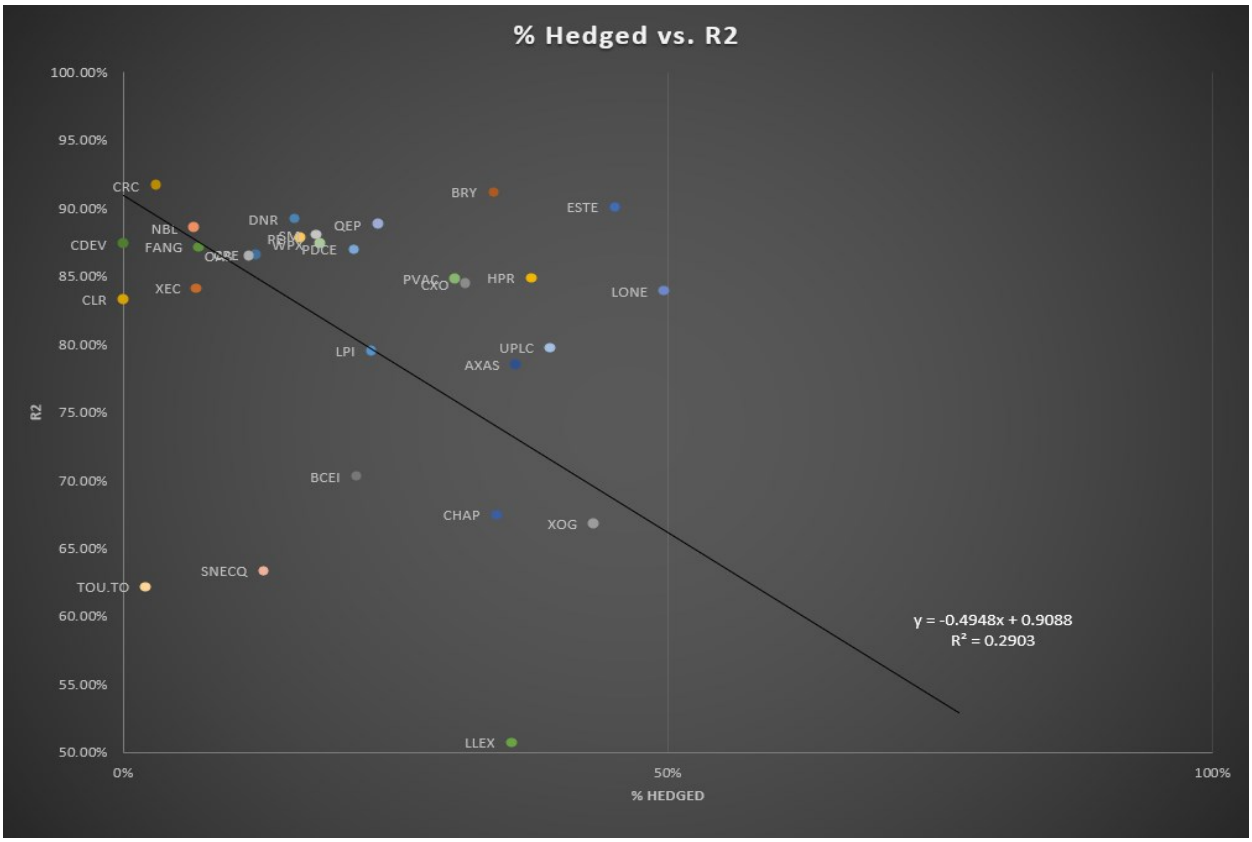


Exhibit 9

% Hedged	Leverage	oil alpha	oil beta	t - stat	r2	overall return	excess return over crude
36%	2.43x	0.02	0.85	16.47	78.51%	$ (0.63)	$ 0.42
34%	1.57x	-0.14	1.08	27.64	91.16%	$ (0.73)	$ 0.32
21%	0.64x	0.31	0.58	13.27	70.30%	$ (0.43)	$ 0.61
3%	4.24x	-0.23	1.15	28.50	91.64%	$ (0.84)	$ 0.20
12%	3.07x	-0.35	1.17	21.86	86.57%	$ (0.91)	$ 0.13
0%	1.94x	-0.43	1.30	22.65	87.37%	$ (0.94)	$ 0.11
34%	5.26x	-0.05	0.83	12.43	67.48%	$ (0.85)	$ 0.20
7%	1.36x	-0.07	1.03	19.82	84.12%	$ (0.62)	$ 0.43
31%	1.69x	0.23	0.78	20.05	84.42%	$ (0.42)	$ 0.63
0%	1.62x	-0.13	1.06	19.23	83.29%	$ (0.69)	$ 0.36
16%	4.61x	-0.29	1.17	24.77	89.22%	$ (0.88)	$ 0.16
7%	2.56x	-0.12	1.08	22.43	87.16%	$ (0.66)	$ 0.38
45%	1.42x	-0.07	0.99	25.96	90.09%	$ (0.74)	$ 0.30
77%	5.30x	1.75	1.40	3.48	13.05%	$ 1.68	$ 2.72
43%	1.70x	-0.23	1.02	12.25	66.83%	$ (0.87)	$ 0.17
37%	2.41x	-0.33	1.15	20.43	84.91%	$ (0.90)	$ 0.15
23%	1.88x	-0.28	1.08	16.97	79.51%	$ (0.84)	$ 0.21
36%	5.62x	0.15	0.89	8.79	50.78%	$ (0.48)	$ 0.56
50%	5.29x	-0.19	1.00	19.66	83.90%	$ (0.83)	$ 0.21
7%	4.67x	-0.16	1.12	23.92	88.53%	$ (0.71)	$ 0.33
12%	4.95x	-0.40	1.29	21.77	86.47%	$ (0.92)	$ 0.13
16%	2.25x	-0.07	1.05	23.08	87.78%	$ (0.65)	$ 0.39
21%	2.25x	-0.10	1.06	22.26	86.98%	$ (0.68)	$ 0.37
31%	1.56x	-0.38	1.25	20.33	84.79%	$ (0.89)	$ 0.16
23%	2.57x	-0.40	1.25	24.24	88.80%	$ (0.93)	$ 0.11
13%	5.92x	0.17	0.96	11.35	63.34%	$ (0.50)	$ 0.54
18%	2.50x	-0.40	1.38	23.37	88.05%	$ (0.87)	$ 0.18
2%	1.06x	0.42	0.52	11.07	62.17%	$ (0.12)	$ 0.93
39%	3.94x	0.11	1.01	17.10	79.75%	$ (0.67)	$ 0.37
18%	2.00x	-0.18	1.17	22.65	87.37%	$ (0.70)	$ 0.34

Exhibit 10

SUMMARY OUTPUT (Oil beta is y)

Regression Statistics	
Multiple R	0.228446598
R Square	0.052187848
Adjusted R Square	-0.018020459
Standard Error	0.205542672
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.062807988	0.031403994	0.743328675	0.485009983
Residual	27	1.140690335	0.04224779		
Total	29	1.203498323			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.969274193	0.088589205	10.94122236	1.99193E-11	0.787504158	1.151044227	0.787504158	1.151044227
% Hedged	-0.004328817	0.224007102	-0.019324465	0.984724368	-0.463953425	0.45529579	-0.463953425	0.45529579
Leverage	0.029588334	0.024790572	1.193531749	0.243043182	-0.021277717	0.080454386	-0.021277717	0.080454386

Exhibit 11

SUMMARY OUTPUT (Overall return is y)

Regression Statistics	
Multiple R	0.491705988
R Square	0.241774779
Adjusted R Square	0.185609947
Standard Error	0.429771805
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.590202284	0.795101142	4.30473614	0.023838343
Residual	27	4.987002718	0.184703804		
Total	29	6.577205001			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1.017107793	0.185232303	-5.490984974	8.16834E-06	-1.397173086	-0.637042501	-1.397173086	-0.637042501
% Hedged	1.271278183	0.468379317	2.714206494	0.011432093	0.310243208	2.232313159	0.310243208	2.232313159
Leverage	0.025422915	0.051834924	0.490459191	0.627771319	-0.080933563	0.131779393	-0.080933563	0.131779393

CONCLUSION

How an E&P should hedge does not have one simple solution. There is no "one-size fits all approach" to hedging. An E&P's hedging profile varies widely due to how each for the four variables - capital structure, operational flexibility, development returns and production growth - impacts the E&P as commodity prices change. By analyzing each variable and their interdependencies an E&P can conclude on how to properly hedge. In today's financial markets, E&P stock prices have seen a large decline. Investors are now wanting companies to not outspend their EBITDA. They also want consolidation to improve cost structures and overall returns on invested capital. The result of this is slowed growth within the E&P field. To be ensure that an E&P has a higher probability of having a positive cash flow, hedging may be more important going forward. Regardless, how an E&P hedges, and why they hedge, continues to be a critical aspect in determining the overall risk profile of the company. Multivariate analysis is limited in providing "the right answer" given the limited ability to analyze how companies adjust capital programs to changes in commodity prices and how changes in commodity prices impact individual company's cost of capital. Most of the variables that are being analyzed in the regressions are interdependent. Thus, using a regression analysis to analyze interdependent variables could create noise in the analysis. Using a holistic approach of adjusting activity, hedges, and capital structure while trying to maintain a positive EVA should provide a more prudent way to approach risk management.

It is meaningful to discuss COVID-19, OPEC, and Russia's recent actions and their influence on the oil and gas industry. In early March 2020, Russia announced that it would no longer adhere to production cuts they agreed to and in response, Saudi announced they would be flooding the oil market with excess supply, which caused crude oil prices to plummet. In

response to this, OPEC announced that it would no longer be acting as a cartel and each member could produce whatever they wanted to produce. This further increased the oversupply, causing prices to dive even further. When supply is increased without an increase in demand, prices fall. When supply is projected to increase as significantly as currently expected, because two of the most dominant players announced they would be flooding the marketplace with oversupply, price falls significantly.

The second variable in the recent collapse in oil prices is COVID-19. COVID-19 has caused an unprecedented demand shock to the oil and gas industry. When demand falls, prices decrease. These two variables, significant increase in supply with a simultaneous drop in demand, are what caused the oil price to trade down from approximately $70.00 per barrel to approximately $20.00 per barrel. What is unprecedented was these dramatic impacts happened together, and the speed at which the commodity price declined.

Oil is a commodity and when facing a price this low, it is critical to consider the highest marginal cost producer. What highest marginal cost means is that the exploration and production companies that have the highest relative cost to drill and complete new wells or simply the highest cost to operate existing wells. It is these companies that should be the first to stop activities (and possibly go bankrupt) in a low-price environment. This in turn will lower supply and help balance supply and demand.

The companies with the highest marginal cost per barrel are the U.S. shale companies. There have been many theories related to OPEC and Russia and their possible collusion to drive the price of oil down to bankrupt the U.S. shale companies. This prompts the question of when will demand come back or the amount of oil supplied to the market decrease? The U.S. has

introduced a $2 trillion stimulus plan to reenergize the economy. This is a decisive point in history for not only the U.S., but oil and gas companies as well. There has never been an unprecedented demand shock that occurred at the same time two of the most influential players in the global energy market created a supply shock. As of May 4th, while Saudi and Russia have agreed to new production cuts, and the rest of OPEC seems to be accepting the terms of the agreement, oil has not recovered from its multi-decade low. Crude oil inventories around the globe are still increasing as demand continues to fall. Until the COVID-19 pandemic subsides and demand increases to a point where inventories start to draw down, oil will most likely stay below the marginal cost to produce it.

I believe that many of the small- to mid-cap oil and gas companies will go bankrupt because of the price shock to the industry. Whiting Petroleum was the first victim, and since then the offshore drilling company Diamond Offshore has defaulted on its debt. There are and will be more examples.

The world is at pivotal point in its history. COVID-19 has an unprecedented impact on the global economy that will have many long-term effects on companies and individuals. The amount of value that was destroyed by the pandemic is unmeasurable and widespread. The world needs innovation to remedy its current state.

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