# ROLE OF RISK MANAGEMENT IN THE OIL AND GAS INDUSTRY: THE EFFECT OF DERIVATIVE CONTRACTS USED TO MANAGE OIL AND GAS PRICE RISK ON STOCK PRICE SENSITIVITY IN THE OIL AND GAS INDUSTRY DURING A PERIOD OF DECLINING OIL AND GAS PRICES

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ROLE OF RISK MANAGEMENT IN THE OIL AND GAS INDUSTRY:

THE EFFECT OF DERIVATIVE CONTRACTS USED

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## ABSTRACT

This study focuses on the various risk management policies used by oil and gas producers in the energy industry. Oil and gas producers are highly exposed to commodity prices. Commodity prices are highly volatile and can fluctuate immensely with changing market conditions. Given the most recent commodity price downturn (June 2014 – December 2015), this study aims to analyze how different risk management policies can affect the stock price sensitivity of oil and gas producers during a commodity price downturn.

This study will focus specifically on derivative instruments used by oil and gas producers to minimize their oil and gas price exposure, and whether or not these derivative instruments have any effect on the stock price sensitivity during a period of declining oil and gas prices. This study analyzes a sample of 50 North American oil and gas producers, their risk management policies and use of derivative instruments, and determines if there is a relationship between stock price sensitivity and use of derivative instruments during the most recent commodity price downturn.

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# INTRODUCTION

Oil and Gas (O&G) price volatility is the largest risk O&G producers face (EIA, 2002). Businesses can manage this risk by diversifying business operations into other industries, or by entering into derivative contracts to transfer this O&G price risk to parties willing to bear it. Diversification of business operations decreases O&G producers' reliance on O&G prices, while the use of derivative contracts shifts the O&G price risk away from producers to parties willing to bear it. Diversification tends to be capital intensive, and usually only feasible for large international businesses. A majority of O&G producers use derivative contracts to manage their firm-specific commodity price risks.

According to the Energy Information Administration (EIA), (2002), "Derivatives are financial instruments (contracts) that do not represent ownership rights in any asset but, rather, derive their value from some other underlying asset (pg. 1)." When used effectively, derivative contracts can take the O&G price risk faced by O&G producers, and transfer it to another party willing to bear it. Risk management in the O&G industry is relatively new following the deregulation of energy prices over the last two and half decades, and has continually evolved as O&G producers find new ways to manage their energy price risk (EIA, 2002).

O&G producers' revenue and cash flow is heavily dependent upon the price of oil and natural gas. In order for O&G producers to effectively manage their overall risk, firms must be able to accurately predict their revenue, future cash flows, and profitability of future investments. When used effectively, derivative contracts can allow O&G producers to successfully manage, and reduce, the volatility of their cash flows and business operations.

Given the extreme volatility of O&G prices, and various methods by which O&G producers' can manage their energy price risk, I am going to examine whether the use of derivative contracts by O&G producers to reduce O&G price risk has a significant effect on stock price sensitivity during a period of declining O&G prices.

One prior research report examined the hedging policies of O&G producers from 1992-1994. This prior study concluded the extent of hedging by O&G firms is related to financing costs, the likelihood of hedging is related to economies of scale when managing hedging costs, and firms with less basis risk are more likely to manage energy price risk more effectively (Haushalter, 2000). One study analyzed by Jin and Jorion (2006) evaluated the effect of hedging on 119 O&G producers from 1998-2001, and whether hedging with derivative contacts had any effect on firm market value. This research concluded that hedging does not increase the market value of an O&G firm, but did in fact reduce the stock price sensitivity to oil and gas price movements (Jin and Jorion, 2006). This paper will further examine the findings of Jin and Jorion, and determine if the use of derivative contracts used to manage O&G price risk has any effect on stock price sensitivity during a period of declining O&G prices.

O&G producers are constantly looking for ways to manage their commodity price exposure. This paper will focus on the most recent O&G price drop using various price indices for O&G around the world. West Texas Intermediate crude oil (WTI - NYMEX) was priced at $107.26 on June 20, 2014, and dropped to a closing price of $59.61 on June 19, 2015. Brent Crude Oil (ICE) was priced at $114.81 on June 20, 2014, and dropped to a closing price of $63.02 on June 19, 2015. Natural Gas (NATGAS - NYMEX) was priced at $4.53 on June 20, 2014, and dropped to a closing price of $2.81 on June 19, 2015 (Bloomberg, 2015). All of the prior indices portray the dramatic O&G price drop the energy industry has experienced over the last year. This paper will analyze a sample of O&G companies risk management policies, specifically the use of derivative contracts to manage energy price risk, and determine the effect, if any, of these derivative contracts on stock price sensitivity during the most recent O&G price decline.

## LITERATURE REVIEW

### Energy Price Risk

Businesses generally take on five different forms of risk defined by the EIA: Market risk (unexpected changes in stock prices, commodity prices, interest rates, and exchange rates), credit / default risk (unexpected chance that borrowers / lenders default on loans or prior obligations), operational risk (for O&G firms, equipment failure, dry holes, fraud, exploration risk), liquidity risk (ability to cover short term liabilities, ability to buy / sell commodities at quoted prices), and political risk (regulations, geopolitical events, expropriation). The level of risk each company faces, and types of risk each company faces, are all dependent upon the given industry a business operates in. The O&G industry can be broken down into four broad sub-sectors. Each company in the O&G industry faces different types of energy price risk dependent upon the sub-sector a company operates in. The upstream (E&P / producers) O&G sector focuses on the exploration and production of O&G. The midstream O&G sector focuses on the transportation and storage of O&G. The downstream O&G sector focuses on the refining and marketing of crude oil into finished products (gasoline, fuel oil, jet fuel, methane, butane, kerosene, etc.). The oil field services (OFS) O&G sector focuses on providing a wide range of services to O&G businesses across the whole O&G industry (EIA, 2002). This paper will focus on O&G companies engaging in the production of O&G, the E&P subsector. O&G producers' face high levels of market risk. Market risk in the O&G industry mainly refers to extreme volatility of O&G prices. O&G is the most volatile commodity in the world (EIA, 2002). Large integrated O&G gas companies operating across all four sub-sectors have multiple risks to manage. They are faced with energy price risk throughout their whole value chain, ranging from the price risk faced in the production of O&G all the way to price risk faced by their refining operations. O&G producers seek protection against low O&G prices, while refiners seek protection against high O&G prices as inputs for their refining operations. For the purpose of this paper, I will focus on O&G producers, seeking to minimize exposure to low O&G prices. Historically, when energy prices fall, O&G firms receive less for the O&G they produce. When this happens, cash can become scarce, new investment projects can become unprofitable, and debt covenants can tighten. The use of derivative contracts can allow firms to decrease the volatility of cash flows by locking in future prices for a given commodity, solidifying credit arrangements, and minimizing exposure to commodity price swings. This is only the case when derivative contacts are used effectively. The opposite can occur when derivatives are not used effectively, or not used at all. Following the deregulation of energy prices, firms have had to develop ways in which they can effectively minimize their energy price exposure (EIA, 2002).

The EIA outlines two basic approaches to risk management for O&G producers. One approach for businesses to minimize energy price exposure is to diversify business operations across industries. For example, an O&G producer facing a period of declining O&G prices can minimize their reliance on high O&G prices by expanding operations into another sub-sector of the O&G industry, such as the refining and marketing sub-sector. The refining operations will benefit from the low O&G prices, because it will cost less for the refining operation to purchase crude oil for refining. This can potentially offset any losses faced by production at low O&G prices by increasing the margins the refining operations will achieve with low O&G prices. Diversification can also include expanding operations outside of the O&G industry into a completely different sector, such as retail. Diversifying business operations into another industry will decrease a firm's reliance on O&G prices by entering into a different industry that is not heavily dependent on O&G prices. Diversification decreases the specific risk O&G producers face with volatile energy prices by minimizing their reliance on high O&G prices, but is also very expensive for companies to effectively execute. Diversification requires large amounts of capital to expand business operations into other industries, and can take many years to prove effective. The large amounts of capital required to diversify business operations, paired with length of time to establish new operations, makes diversification only viable for large corporations, such as the integrated majors (Royal Dutch Shell, Exxon Mobil, BP, Chevron, ConocoPhillips and Total S.A) (EIA, 2002). The second approach the EIA outlines is the use derivative contracts to hedge O&G price exposure. Derivative contracts are financial instruments that derive their value from an underlying asset (O&G for the purpose of this study) (EIA, 2002). The underlying asset can range from any physical asset, to foreign currencies, bonds, stocks, and indices. Derivative contracts have proven to be a viable option for O&G producers to effectively isolate, and transfer, their O&G price risk to a party willing to bear it.

## Hedging with Derivative Contracts

Derivative contacts allow O&G companies to hedge their exposure to O&G prices without having to diversify business operations into other industries and business segments. Phil Baratz discusses the difference between hedging and speculation. Hedging is commonly misunderstood for speculation. Baratz defines speculation as, "Playing the odds (pg. 1)." He simply defines hedging as, "A method to manage uncertainty (pg. 1)." Baratz further discusses hedging as a way of using derivatives to do everything in your favor to transfer your specific risk to a party willing to bear it (Baratz, 2015).  The EIA gives a basic overview of the derivative trading environment, and the three necessary participants that allow the derivative market to function properly. Hedgers, enter into derivative contracts to offset a specific risk faced by an underlying asset, which in the case of O&G producers is energy (O&G) price risk. Speculators, "Take unhedged risk positions in order to exploit informational inefficiencies and mispriced instruments, or to take advantage of their risk capacity (pg. 46)." Arbitrageurs, take the opposite position, in any mispriced instruments to potentially earn a riskless return. The derivatives market cannot function properly unless all three of these players (Hedgers, speculators, and arbitrageurs) are actively participating in the derivative trading environment (EIA, 2002). This study will focus on the O&G firms that use derivative contracts, to hedge, not speculate, and firms that do not use derivative contracts to hedge. It is key to understand whether a derivative is being used to hedge O&G price risk, or being used to speculate about future O&G prices.

## Accounting for Derivatives as Hedges

In order to determine whether a given O&G firm is using derivative contracts to hedge their O&G price risk, one must understand when a derivative is being used to actually hedge a specific risk, and not speculate. There are set accounting guidelines that determine whether a derivative instrument is being used to actually hedge an underlying asset. Derivative instruments can be used to hedge, speculate, and used for arbitrage opportunities. For the purpose of this study, I need to determine which companies in the given sample are using derivatives to hedge their energy price exposure. The classification of a derivative instrument is very important. US GAAP requires any derivative contract to be recognized at fair value each reporting period, with changes in the fair value of the derivative instrument recorded currently in earnings (Frankamp and Randolph, 2013). FASB accounting statement 133 outlines specific criteria that must be met by a company aiming to use a derivative contract to hedge an underlying asset to classify their derivative contract as a true hedge (EIA, 2002). To classify a derivative contract as a true hedged contract, the company must identify and document at the inception of a hedge, the following: The hedging relationship (the underlying asset the firm is hedging, and how the given derivative contract hedges the potential risk the firm is seeking to reduce), the derivative contract being used (type of derivative contract used), the hedged item (the underlying asset a firm is seeking to hedge), the nature of risk being hedged (what risk a firm is seeking to reduce, for this study, O&G price volatility), and that the effectiveness of the hedging instrument will be assessed on a continual basis (continual assessment of any change in the fair value of the instrument being used, and overall effectiveness of hedged instrument) (EIA, 2002). This has to be done at the inception of the derivative contract. This means a firm can't enter into a derivative contract on the basis of speculation, and then later try to reclassify the derivative instrument as a hedge to shelter any potential losses resulting from speculating incorrectly (EIA, 2002). The above criteria allows O&G producers to classify their derivative contracts as hedges. Once a true hedge has been established, O&G firms can qualify for special accounting treatment of these hedges, called hedge accounting (EIA, 2002).

Hedge accounting is a special accounting treatment for companies that use derivative contracts to hedge a specific risk. Hedge accounting requires derivative instruments to be marked to fair value (marking to market) and recognized each reporting period in the financial statements. Changes in the fair value of derivative instruments can cause earnings to fluctuate, dependent upon any gains and losses on derivative contracts held by a given company. Hedge accounting allows companies to reduce the volatility of their earnings resulting from any change in the fair value of each derivative instrument utilized. US GAAP allows a company to use hedge accounting if their derivative instruments fall under one of the three qualifying distinctions: Cash flow hedge, fair value hedge, or foreign currency hedge. For the purpose of this paper, I will focus on cash flow and fair value hedges. A *Cash Flow Hedge* is defined as hedging any cash flow exposure from a potential change in market prices that will result in the variability of future expected cash flows, from a future transaction. In short, it converts a future variable cash flow to a fixed future cash flow by locking in a fixed future price for the asset being hedged (Frankamp and Randolph, 2013). A cash flow hedge is recognized on the financial statements at fair value, with any gains and losses on the derivative instrument recognized in current earnings (EIA, 2002). A *Fair Value Hedge* is defined as a hedge to protect against fair value exposure of any asset, liability, or firm commitment. A fair value hedge protects against any change in the fair value of the hedged item resulting from any change in the market price of the item being hedged (Frankamp and Randolph, 2013). Gains and losses on fair value hedges are recognized in current in earnings, with the current value reflected on the balance sheet (EIA, 2002). When analyzing the stock price sensitivity of O&G producers during a period of declining O&G pricecs, it will be critical to understand the various types of hedging distinctions different companies use. The different accounting treatments used by different O&G firms can significantly impact an O&G firm's current earnings. Differences in financial reporting between companies can deeply affect the market reaction and stock price sensitivity during a commodity price drop. Understanding these differences will allow further examination into the effectiveness of derivatives used to hedge O&G price exposure. Due to the various accounting treatments for derivative instruments on the balance sheet and income statement, I plan to use two different metrics to analyze the role of derivative instruments. The first metric will be net fair value of derivative instruments on the balance sheet, and the second metric will be total derivative gain (loss) recorded at each quarter end. These two metrics will allow me to analyze the amount of derivatives used, and the effectiveness of the derivative instruments used on an annual and quarterly basis.

## Types of Derivative Contracts

To understand how O&G producers use derivative contracts to hedge their O&G price exposure, it is key to understand the basic types of derivative contracts O&G producers can enter into to manage their O&G price risk. The EIA outlines the basic types of derivative contracts O&G producers can use to hedge their energy price exposure. A *forward contract* is an agreement between two parties to buy (sell) a given quantity (amount of O&G) and quality (type of O&G) of a given good at an agreed upon future date and set price. For example, an O&G producer can enter into a forward contract that guarantees the producer a set price for the O&G the producer produces, at a set date, set quantity, and set quality, all determined at the contract's inception. Forward contracts are traded Over-The-Counter (OTC). OTC contracts are not traded on a centralized exchange, are customized to meet the buyers and sellers demands, and are not as liquid as other derivative contracts. *Futures contracts* are similar to forward contracts, but instead of trading in the OTC market, futures contracts trade over centralized exchanges. This means futures contracts are standardized, and more liquid than forward contracts because they are traded more frequently over centralized exchanges. To buy or sell a future contracts, one does not need to own the underlying asset. If the buyer of a futures contract needs to exit their position, the buyer of the contract simply sells the same contract on the centralized exchange. An *option contract* gives the buyer of the contract the right to buy (a call option) or sell (a put option) at a specified price (strike price) over a specified period of time. When used effectively by O&G producers, option contracts can create a price floor, a price ceiling, or a price floor and ceiling, locking in a specific range of prices the producer can sell the O&G for. While options are effective tools to manage energy price risk when used properly, option contracts tend to be more expensive for firms to use. Options can be traded over centralized exchanges or in OTC markets, and similar to a futures contracts, the buyer and seller of an options contract does not need to own the underlying asset. A *swap agreement* is an agreement between two parties to exchange a series of cash flows produced by the underlying assets. For example, a firm with a variable cash flow can enter into a swap agreement with a firm that has a fixed cash flow. A swap agreement exchanges the two different cash flows between the two parties in the agreement. Swap agreements are traded OTC (EIA, 2002).

While all these listed contracts can be used by O&G firms to isolate and transfer risk, all of these contracts can also be used to speculate. The availability of these contracts depends on various market conditions. While all of these contracts might exists in the market, these contracts might not always reduce the risk a specific firm is trying to manage. Understanding that not every derivative instrument offered in the market can help reduce a firm's price exposure is one of the main reasons I am going to compare the stock price sensitivity of firms that hedge using derivatives, to firms that do not hedge using derivatives. This will allow to me to examine if the use of derivative contracts to reduce O&G price exposure has a meaningful impact on the stock price sensitivity of O&G producers when O&G prices drop dramatically.

This study is focusing on the use of derivative contracts to hedge O&G price exposure. Understanding the different types of derivative instruments used by each sample company will provide me with an opportunity to further analyze the effectiveness of each type of derivative instrument, and its effect on stock price sensitivity. As explained earlier, I am focusing on two different derivative measures (Total derivatives on balance sheet, and net gain (loss) on derivative instruments), but understanding the different types of derivative instruments a company uses will provide me, and others, further opportunities to analyze the effect of different derivative instruments on stock price sensitivity.

## Decision to Hedge Using Derivatives

### Financing Costs

As discussed earlier, the O&G industry is one of the most capital intensive industries in the world (EIA, 2002). Financing costs play a huge role for O&G producers. O&G producers are not able to fund future exploration and production growth if financing costs are too high. As O&G prices decline, O&G companies can face financial distress if financing costs are too high, or if a given company has high exposure to low energy prices. A study performed by Chen and Lee in 1996 examined the survival time of 175 sample O&G producers from 1981-1986, a period in time where oil dropped from $35 a barrel in 1981 to $10 a barrel in 1986 (Chen and Lee, 1996). Their study focused on examining how long an O&G firm can survive during a period of declining energy prices until it reaches the point of financial distress. They studied the survival rate of a firm based on various factors: Financial structure, operational structure, ownership structure, age, and size of firm. This study includes valuable information worth analyzing in regards to this paper. The study concluded that financial structure plays a key role in the survival time of a firm during periods of declining O&G prices. Operationally, they found that operational aggressiveness (aggressiveness of future exploration), and ability to find O&G reserves, does not play a key role in firm survival time, but diversification of operations throughout the energy industry (Upstream, midstream, and downstream) does contribute largely to a firm's survival time. They also concluded that the age, and size of the firm are highly related, thus making it difficult to separate out their individual effects on firm survival time. They also concluded that ownership structure has a minimal effect on firm survival time (Chen and Lee, 1996). As a result of the most recent energy price decline (July 2014 – August 2015), many O&G producers have seen their stock price drop dramatically. The variables examined in the previous study (Financial structure, operational structure, ownership structure, age and size of firm) will allow me to further differentiate and identify other factors, aside from the use of derivative contracts to reduce O&G price risk, that can lead to a large decline in a given firm's stock price. After examining the stock price sensitivity of O&G firms that hedge with derivatives, and firms that don't hedge with derivatives, I can further analyze how financial structure affects stock price sensitivity when O&G prices dramatically decline. Taking the characteristics discussed above (Financial structure, operational structure, ownership structure, age and size of firm) into consideration will help me to further distinguish whether the implementation of derivative contracts as a form of risk management is a leading factor in stock price sensitivity, or if there are other factors, such as financial structure, that contribute to the stock price sensitivity during a period of declining O&G prices.

The decision for an O&G producer to hedge energy price risk using derivatives is a very complex and complicated decision. David Haushalter performed a study on the hedging policies of 100 O&G producers during the years 1992-1994. This research hypothesized risk management was purely a financial transaction. This research examined three different factors that contribute to a firm's decision to hedge; 1) To alleviate financial contracting costs, 2) To reduce expected taxes, 3) To reduce manager personal risk exposure. Haushalter concluded that financing costs are directly related to the extent a firm hedges. Further, the percentage of production hedged by a producer is positively related to the ratio of debt to total assets (Haushalter, 2002).

Another study analyzed by Smith and Stulz examined the same three factors studied in David Haushalter's paper. The determinants of a firms hedging strategy can be broken down into three categories, 1) taxes, 2) financial contracting costs, and 3) managerial risk aversion. In regards to financing costs, and debt, Smith and Stulz concluded that hedging can reduce a firm's potential bankruptcy costs. While adding debt to the capital structure increases the total value of the firm, it also increases the risk taken on by shareholders. The increased risk arises from higher potential bankruptcy costs the firm encounters when financed with increasing amounts of debt. As more debt is added to the capital structure, more lenders will need to be repaid prior to equity shareholder repayment in the event of bankruptcy. In the event of bankruptcy, shareholders will recover the value of the bankrupt firm after all debt holders have been paid back. Thus firms with higher debt levels in their capital structure will have higher bankruptcy costs. Many lenders require in their debt covenants that firms borrowing must hedge to reduce the volatility of future expected cash flows, and ensure debt can be repaid. Hedging provides lenders with more certainty they will get paid back, minimizing the volatility of future cash flows. This reduces the risk to lenders, and reduces the cost of debt financing. A company that has a reputation of hedging will receive higher debt valuations because of the reduced risk associated with hedging, thus increasing the total firm value. They concluded that hedging reduces the overall risk faced by shareholders, as it reduces potential bankruptcy costs the firm might encounter (Smith and Stulz, 1985). These findings play a key role in analyzing the sensitivity of stock prices during a period of declining commodity prices. Companies with higher leverage ratios should be viewed as more risky by the market, and should experience more stock price sensitivity to lower commodity prices. But if the firm hedges, it should experience a reduction in perceived risk by the market, and experience less stock price sensitivity to declining commodity prices compared to companies that do not engage in hedging. I plan to incorporate these findings on the relationship between leverage and hedging by analyzing and incorporating a leverage metric into my study. This will allow me to include the effect of leverage taken on a by a given firm, and whether or not leverage contributes to stock price sensitivity during a period of declining commodity prices. It will also allow me to determine if there is any significant relationship between leverage and hedging with derivative contracts.

The O&G industry is the most capital intensive industry in the world (EIA, 2002). This means that financing costs are very important for every O&G producer. A firm with lower financing costs can expand operations more effectively using cheaper sources of capital compared to firm's that have higher financial contracting costs. When analyzing the stock price sensitivity of the sample O&G firms, it will be important to analyze each firms financing costs. Understanding each firms' financing costs will potentially allow further examination on why a given O&G firm hedges, and will provide further insight on the motives behind the amount of production that given firm hedges.

## Basis Risk

Another important factor that influences a firm's decision to hedge their O&G price risk using derivatives deals with basis risk. Basis risk is defined by Haushalter as, "The risk a company encounters when the settlement price of the hedging instrument is different from the price of the underlying asset being hedged (pg. 115)." The level of basis risk a firm encounters can deeply impact the effectiveness of a hedging instrument. Location of production, and the type of derivatives used can deeply affect the level of basis risk a firm encounters. Derivatives that are traded on centralized exchanges derive their price from the spot market in which the given derivative is being traded on. Spot prices for O&G can vary dependent upon the exchange the O&G is being traded on, thus, increasing the basis risk for a firm dependent upon location of production, and location of the spot market where the derivatives and O&G are being traded. This means the effectiveness of a given hedging instrument can vary significantly depending on the location of the spot market being used (Haushalter, 2002). O&G derivatives are traded on numerous exchanges around the world. Each spot market can have different prices for the same commodity depending on the supply and demand at the given spot market where the O&G is being traded. When analyzing the stock price sensitivity of O&G producers that use derivatives to hedge, it will be important to analyze which spot market the derivatives, and physical O&G, derive their values from. As spot market prices vary in relation to other spot markets around the world, it will be important to examine the effectiveness of a given derivative instrument based on the particular spot market where the value of the O&G is being derived.

### Ownership Structure and Employee Stock Option Based Compensation

Prior research has studied the relationship between option based compensation for executives, and risk taken on by the firm (Smith and Stulz, 1985, (Tufano, 1996)). Rajgopal and Shelvin performed a study in 2002 that examined the influence of ESO risk incentives for CEO's in the O&G industry. They specifically examined the risk taking activities of O&G firms, the level of risk, and the impact risk incentives have on a firm's decision to take on more risk. They hypothesized that because ESO compensation values are based on current stock prices, and stock price volatility, managers that have ESOs with greater risk incentives will take actions that increase overall risk to the firm (Rajgopal and Shevlin, 2002). Rajgopal and Shevlin concluded in their study that there is a positive relationship between the level of ESO risk incentives and the level of exploration risk taken on by a given firm, and they also concluded that highly levered firms appear to take on greater exploration risks. Harris and Raviv had previously concluded in 1991 that leverage creates incentives for managers to assume riskier projects (Harris and Raviv, 1991). Smith and Stulz further examined this topic in 1985 by examining the role hedging plays into executive compensation and the decision to minimize firm risk, or increase firm risk. Smith and Stulz concluded that managers who are compensated by incentives to take on more risk will hedge less, compared to managers who do not have compensation plans with risk incentives (Smith and Stulz, 1985). While all of these prior studies show the role of compensation policies on decisions to hedge, I have decided to not include their findings in this study. I want to focus on the use of derivatives. Further analysis can be performed by analyzing differing compensation plans, but for this study, I want to focus on derivative use, and not the decisions made to use derivatives to hedge.

## Hedging and Market Value

A study performed by Jin and Jorion in 2006 examined whether or not hedging activity by O&G firms has any effect on the market value of the firm. A prior study performed by Allaynnis and Weston tested the relation between foreign currency derivatives and firm value of a sample of US multinational firms. This research concluded that, on average, firms that used derivatives to hedge currency risk had a 5% higher valuation (Allayannis and Weston, 2001). Another study performed by Carter, Rogers, and Simkins studied the same criteria, hedging and firm value, but instead focused on fuel hedging in the US airline industry. This study concluded that a higher premium exists, 14%, for companies that hedged their fuel price exposure (Carter, Rogers, and Simkins, 2005). Jin and Jorion performed a study focusing on 119 US O&G producers from 1998-2001. Their study found that O&G betas are negatively related to the extent of hedging by O&G firms. This means the market recognizes the presence of derivatives used to hedge. This study then went to analyze whether the market rewarded the sample companies that hedged with a hedging premium, a higher market valuation. The study concluded that there is no change in firm value between a firm that hedges and a firm that does not hedge (Jin and Jorion, 2006). This study refutes prior research concluding the existence of a hedging premium for companies that hedge their foreign currency risk, and companies that hedge their fuel price exposure in the US airline industry. Jin and Jorion continued to discuss the reasons behind their findings, and discussed an important difference between their study and prior research on firm market value and hedging. The risk O&G firms are seeking to minimize with the use of derivatives is O&G price risk. O&G price risk is very easy for the individual investor to identify and hedge in their own given portfolio. Foreign currency risk, on the other hand, is very hard for the individual investor to identify for all holdings in their given portfolio, and let alone very hard to minimize their foreign currency exposure on their own (Jin and Jorion, 2006).

## DATA AND METHODOLOGY

My goal of this study is to analyze whether the use of derivative instruments to hedge energy price risk has any significant effect on stock price sensitivity during a period of declining commodity prices.

### Methodology Process

- Develop sample of O&G E&P companies
- Calculate and analyze required financial metrics from Bloomberg
- Analyze and calculate derivative metrics from company 10-K and 10-Q filings
- Analyze exploratory and statistical tests
- Formulate conclusion

**Sample**

In order to have to have a comparable sample of O&G companies, I analyzed 79 companies that are constituents of 5 different Bloomberg O&G indices. I wanted the sample to contain companies that have a majority of their operations within North America to better compare companies that have been significantly affected by the commodity price downturn. These 5 indices analyzed include: 1) US Crude Oil Producers, 2) North American Independent Exploration and Production, 3) North American Diversified Oil and Gas Exploration and Production, 4) International Diversified Crude Exploration and Production, 5) Global Integrated Oils. These indices included companies from all over the world with market capitalizations ranging from $500 million to $152 billion. To develop a comparable sample I eliminated foreign companies that do not operate within North America. The remaining sample included 65 companies. I then eliminated companies with market capitalizations below $1 billion for fiscal years (FY) 2013 and FY 2014. The remaining sample ranged from 35-40 companies. To construct a statistically significant sample of 50 companies, I added companies that had market capitalizations that fluctuated above and below the $1 billion threshold for FY 2013 and 2014, and had a majority of their operations within North America. The resulting sample consisted of 50 companies.

- APACHE CORP
- ANADARKO PETROLEUM CORP
- ANTERO RESOURCES CORP
- CHESAPEAKE ENERGY CORP
- CONTINENTAL RESOURCES INC/OK
- CABOT OIL & GAS CORP
- CONOCOPHILLIPS
- CARRIZO OIL & GAS INC
- CHEVRON CORP
- CLAYTON WILLIAMS ENERGY INC
- CONCHO RESOURCES INC
- DENBURY RESOURCES INC
- DEVON ENERGY CORP
- ENCANA CORP
- ENERGEN CORP
- EOG RESOURCES INC
- EP ENERGY CORP-CL A
- EQT CORP
- DIAMONDBACK ENERGY INC
- GOODRICH PETROLEUM CORP
- GULFPORT ENERGY CORP
- HESS CORP
- HUSKY ENERGY INC
- LINN ENERGY LLC-UNITS
- LAREDO PETROLEUM INC
- MAGNUM HUNTER RESOURCES CORP
- MEMORIAL RESOURCE DEVELOPMEN
- MARATHON OIL CORP
- MATADOR RESOURCES CO
- MURPHY OIL CORP
- NOBLE ENERGY INC
- NEWFIELD EXPLORATION CO
- OASIS PETROLEUM INC
- OCCIDENTAL PETROLEUM CORP
- PDC ENERGY INC
- PIONEER NATURAL RESOURCES CO
- QEP RESOURCES INC
- ROYAL DUTCH SHELL PLC-A SHS
- RICE ENERGY INC

- RANGE RESOURCES CORP
- RSP PERMIAN INC
- SANDRIDGE ENERGY INC
- SM ENERGY CO
- SOUTHWESTERN ENERGY CO
- UNIT CORP
- ULTRA PETROLEUM CORP
- WHITING PETROLEUM CORP
- WPX ENERGY INC
- CIMAREX ENERGY CO
- EXXON MOBIL CORP

## Data Collection

The data analyzed for the given sample includes stock price returns, commodity price returns for crude oil (NYMEX WTI) and natural gas (NYMEX NATGAS), market betas, select financial ratios, and derivative ratios. The time period analyzed was FYE 2013 through Q3 2015. This period was chosen to reflect the financial position of the sample prior to the commodity downturn, and the resulting financial effects of the commodity price downturn. Given every company produces the same commodities (crude oil and natural gas), I wanted to develop a firm specific return for commodity production. The firm specific commodity price return is defined as (% oil produced * WTI return) + (% NATGAS produced * NATGAS return). This will allow me to analyze whether a given company's production mix has any effect on stock price sensitivity. All return data analyzed (stock price returns, commodity price returns, and market betas) were taken from Bloomberg.

To analyze the role and effect of derivative instruments used by the sample companies I analyzed and recorded the net derivative position on the balance sheet for 2013, 2014, and three quarters of 2015. This metric signified open derivative positions each company had in place to hedge their commodity price exposure. I then analyzed and recorded the net derivative gain or loss each company experienced in 2013, 2014, and three quarters of 2015. This metric portrayed the effectiveness of open derivative positions as commodity prices declined over the sample period. In order to successfully compare these metrics I calculated two different ratios, 1) Net derivative position on balance sheet – total assets, 2) Net derivative gain (loss) – total revenue. All derivative figures were pulled from SEC annual and quarterly filings, while all total asset and revenue figures were taken from Bloomberg.

To analyze other factors that might contribute to stock price sensitivity (based on prior research from the preceding literature review), I analyzed and used metrics studied in previous studies, and other factors I believed might contribute to increased stock price sensitivity. Prior studies focused on the relationship between hedging and financial contracting costs. Specifically the role of risk management using derivatives as a financing decision to reduce bankruptcy transaction costs, and reduce the risk a firm takes on with increasing amounts of leverage (Haushalter, 2002, and Smith and Stulz, 1985). Their findings concluded leverage does play a significant role in the decision a firm makes to hedge. To incorporate their findings I wanted to analyze the role and effect of leverage on the sample companies. The effect of hedging is already accounted for within the derivative metrics explained above. To incorporate leverage into my analysis I calculated a leverage ratio (total liabilities / total assets) for each company for 2013, 2014, and three quarters of 2015. The leverage figures were taken from Bloomberg.

To further analyze other factors that could possibly contribute to stock price sensitivity during a commodity price downturn, I calculated and analyzed three other ratios. The first ratio is an interest expense ratio defined as interest expense / revenue. The next ratio analyzed is a ratio to analyze the role of production costs and its effect on stock prices sensitivity. The production ratio is defined as annual production costs / total revenue. The interest expense ratio, production ratio, and derivative gain (loss) ratio share a common denominator, revenue. This gives the interest ratio, production ratio, and derivative gain (loss) ratio a scalable base for comparison, revenue. My final ratio analyzed is lifting costs per barrel of oil equivalent (BOE). This ratio allows me to further analyze the effect of operational efficiencies (cheaper production costs), and whether the cost of production during a declining commodity price environment impacts stock price sensitivity. The following table summarizes the different variables (ratios) included in my analysis.

| | |
|---|---|
| Stock Price Return | (End Price / Beginning Price) - 1 |
| Firm Specific Commodity Return | (% oil produced * WTI return) + (% NATGAS produced * NATGAS return) |
| Net Derivative Position | Net Derivative Position on Balance Sheet / Total Assets |
| Net Derivative Gain / Loss | Net Derivative Gain (Loss) / Total Revenue |
| Interest Expense | Annual Interest Expense / Total Revenue |
| Leverage | Total Liabilities / Total Assets |
| Production Costs | Annual Production Costs / Total Revenue |
| Lifting Costs per BOE | Annual Production Costs / Annual BOE Produced |

### Correlation Matrices

| FY 2014 | 2014 RETURN | COMMODITY PRICE RETURN | LEVERAGE RATIO | NET DERIVATIVE POSITION - TOTAL ASSETS | INTEREST EXPENSE - REVENUE | PRODUCTION COSTS - REVENUE | DERIVATIVE GAIN/(LOSS) - REVENUE | BETA |
|---|---|---|---|---|---|---|---|---|
| 2014 RETURN | 1.00 | | | | | | | |
| FIRM SPECIFIC COMMODITY PRICE RETURN | -0.10 | 1.00 | | | | | | |
| LEVERAGE RATIO | -0.60 | 0.18 | 1.00 | | | | | |
| NET DERIVATIVE POSITION - TOTAL ASSETS | -0.34 | 0.26 | 0.22 | 1.00 | | | | |
| INTEREST EXPENSE - REVENUE | -0.64 | 0.06 | 0.51 | 0.21 | 1.00 | | | |
| PRODUCTION COSTS - REVENUE | -0.21 | -0.01 | 0.15 | 0.20 | 0.11 | 1.00 | | |
| DERIVATIVE GAIN/(LOSS) - REVENUE | -0.22 | 0.16 | 0.09 | 0.91 | 0.24 | 0.20 | 1.00 | |
| BETA | -0.22 | -0.31 | 0.17 | -0.16 | 0.19 | 0.07 | -0.25 | 1.00 |

| Q1 – Q3 2015 | 2014 RETURN | COMMODITY PRICE RETURN | LEVERAGE RATIO | NET DERIVATIVE POSITION - TOTAL ASSETS | INTEREST EXPENSE - REVENUE | PRODUCTION COSTS - REVENUE | DERIVATIVE GAIN/(LOSS) - REVENUE | BETA |
|---|---|---|---|---|---|---|---|---|
| 2014 RETURN | 1.00 | | | | | | | |
| FIRM SPECIFIC COMMODITY PRICE RETURN | -0.13 | 1.00 | | | | | | |
| LEVERAGE RATIO | -0.65 | 0.17 | 1.00 | | | | | |
| NET DERIVATIVE POSITION - TOTAL ASSETS | 0.08 | 0.32 | 0.11 | 1.00 | | | | |
| INTEREST EXPENSE - REVENUE | -0.56 | 0.03 | 0.50 | -0.05 | 1.00 | | | |
| PRODUCTION COSTS - REVENUE | -0.22 | 0.11 | 0.16 | 0.21 | 0.07 | 1.00 | | |
| DERIVATIVE GAIN/(LOSS) - REVENUE | 0.08 | 0.33 | 0.05 | 0.93 | -0.04 | 0.23 | 1.00 | |
| BETA | -0.59 | -0.21 | 0.43 | -0.02 | 0.50 | 0.14 | -0.06 | 1.00 |

The two figures above show the significant correlations between the given variables analyzed. Given this study is focused on stock price sensitivity, it is important to analyze the significant correlations to equity price return. As portrayed by the two matrices, leverage and interest expense have significant negative correlations to equity price return. These matrices also show that our two derivative ratios don't show any significant correlation to equity price return. The remaining significant correlations portrayed by these matrices are expected. Derivative positions on balance sheet are positively correlated to derivative gains and losses, while leverage is positively correlated to interest expense. Larger open derivative contracts on the balance sheet will result in more gains and losses on derivative instruments, while higher leverage will require increasing levels of interest payments.

## Regression Analysis

To analyze the relationships between the various variables analyzed, I ran multiple multi-variate regression models to analyze which variables, if any, have the most significant effect on stock price sensitivity during a commodity price downturn. My dependent variable throughout all regression models is the firm specific equity price return. The independent variables change throughout the various regression models to analyze the effects of the different variables and financial ratios analyzed.

### *Regression Models 1-3*

The dependent variable for these three models, as stated above, is the firm specific equity price decline. The independent variables are: 1) Firm specific commodity return, 2) Leverage ratio, 3) Net derivative position on balance sheet – total assets, 4) Net derivative gain (loss) – total revenue, 5) Interest expense ratio, 6) Firm beta. The key difference between each regression model in this set is the time period. Model 1 is FY 2014, Model 2 is Q1 2015 – Q3 2015, and Model 3 is the total period (2014 – Q3 2015). The following table summarizes the results of regression models 1-3. Leverage has a negative coefficient throughout all three models, and has a statistically significant effect on the equity price return. This means the higher leverage ratio a firm has, the larger decline in stock price a given firm will experience. In regards to the two derivative ratios, only one shows a statistically significant relationship to equity price return. Net derivative to total assets has a statistically significant relationship to equity price decline with a negative coefficient, but only in Model 1. Possible explanations for this can be attributed to the uncertainty on the future of commodity prices, as Model 1 only shows the financial position of the sample companies at the onset of the commodity price downturn. The market is unsure on where commodity prices were headed, and could potentially have doubts on the effectiveness of the open derivative contracts companies had on their balance sheet. Interest expense to revenue, as discussed earlier, is positively correlated to leverage. This can explain the negative coefficients for the interest expense ratio. While interest expense was only statistically significant in Model 1, it plays a similar role to leverage in predicting the equity price sensitivity to declining commodity prices, as it can be used as another metric to analyze the leverage a given firm has.

| Regression Output | MODEL 1 | MODEL 2 | MODEL 3 |
|---|---|---|---|
| **INTERCEPT** | 0.18 | -0.38 | -0.24 |
| T-STAT | 0.66 | 0.43 | -1.22 |
| **FIRM SPECIFIC COMMODITY PRICE RETURN** | 0.19 | -16.57 | -0.62 |
| T-STAT | 0.31 | -1.66 | -0.61 |
| **LEVERAGE RATIO** | -0.37 | -0.49 | -0.73 |
| T-STAT | -2.02** | -3.40* | -2.80* |
| **NET DERIVATIVE POSITION - TOTAL ASSETS** | -2.85 | 1.43 | -0.40 |
| T-STAT | -2.24** | 1.31 | -0.16 |
| **INTEREST EXPENSE - REVENUE** | -1.70 | -0.32 | -0.87 |
| T-STAT | -3.80* | -1.33 | -1.73 |
| **PRODUCTION COSTS - REVENUE** | -0.22 | -0.19 | -0.41 |
| T-STAT | -0.86 | -1.14 | -1.12 |
| **DERIVATIVE GAIN/(LOSS) - REVENUE** | 0.51 | -0.16 | 0.27 |
| T-STAT | 1.68 | -0.62 | 0.46 |
| **BETA** | -0.02 | -0.33 | -0.02 |
| T-STAT | -0.44 | -3.10* | -0.15 |
| **REGRESSION F STATISTIC** | 8.53* | 10.20* | 4.66* |
| **ADJUSTRED R SQUARED** | 0.52 | 0.57 | 0.34 |
| **NUMBER OF OBSERVATIONS** | 50 | 50 | 50 |

* p-values below 5%

** p-values below 1%

*Regression Models 7-9*

As discussed earlier, every company in the sample produces the same two commodities. Regression models 1-3 showed no statistically significant relationship between firm specific commodity return and equity price return. To further analyze the first three regression models, I eliminated the firm specific commodity return. The elimination of firm specific commodity return showed no significant differences between models 1-3 and models 7-9 as shown in the following table. Once again, leverage was the most significant factor, as portrayed in models 1-3.

| Regression Output | MODEL 7 | MODEL 8 | MODEL 9 |
|---|---|---|---|
| **INTERCEPT** | 0.10 | 0.38 | 0.04 |
| T-STAT | 0.93 | 2.92 | 0.20 |
| **FIRM SPECIFIC COMMODITY PRICE RETURN** | | | |
| T-STAT | | | |
| **LEVERAGE RATIO** | -0.37 | -0.54 | -0.75 |
| T-STAT | -2.02** | -3.78* | -2.93* |
| **NET DERIVATIVE POSITION - TOTAL ASSETS** | -2.74 | 1.35 | -0.75 |
| T-STAT | -2.27** | 1.22 | -0.32 |
| **INTEREST EXPENSE - REVENUE** | -1.69 | -0.36 | -0.90 |
| T-STAT | -3.83* | -1.44 | -1.81 |
| **PRODUCTION COSTS - REVENUE** | -0.22 | -0.21 | -0.41 |
| T-STAT | -0.88 | -1.20 | -1.14 |
| **DERIVATIVE GAIN/(LOSS) - REVENUE** | 0.49 | -0.19 | 0.34 |
| T-STAT | 1.67 | -0.74 | 0.58 |
| **BETA** | -0.03 | -0.28 | 0.01 |
| T-STAT | -0.60 | -2.67* | 0.10 |
| **REGRESSION F STATISTIC** | 10.15 | 11.00 | 5.45 |
| **ADJUSTRED R SQUARED** | 0.53 | 0.55 | 0.35 |
| **NUMBER OF OBSERVATIONS** | 50.00 | 50.00 | 50.00 |

* p-values below 5%
** p-values below 1%

*Regression Model 4*

Regression Model 4 sought to analyze whether the financial position of a given firm prior to the commodity price downturn had any significant effect on the stock price performance during the commodity price downturn. The dependent variable in this regression was the equity price return during the commodity price downturn. The independent variables are: 1) Firm specific commodity return, 2) Leverage ratio, 3) Net derivative position on balance sheet – total assets. The independent variables are figures as of FYE 2013 to portray the financial position prior to the commodity price downturn. As the table below portrays the regression results, it is important to note the only statistically significant variable is leverage, once again with a negative coefficient. This continues to signify the effect of increasing levels of leverage and its negative effect on equity price returns during a period of declining commodity prices.

| **Regression Output** | **MODEL 4** |
|---|---|
| **INTERCEPT** | -0.36 |
| T-STAT | -0.66 |
| | |
| **FIRM SPECIFIC COMMODITY PRICE RETURN** | -0.44 |
| T-STAT | -0.42 |
| | |
| **LEVERAGE RATIO** | -0.64 |
| T-STAT | -2.52** |
| | |
| **NET DERIVATIVE POSITION - TOTAL ASSETS** | -2.02 |
| T-STAT | -1.20 |
| **REGRESSION F STATISTIC** | 2.81** |
| **ADJUSTED R SQUARED** | 0.10 |
| **NUMBER OF OBSERVATIONS** | 50.00 |

* p-values below 5%

** p-values below 1%

*Regression Model 6*

Regression model 6 analyzed the relationship between stock market betas for each sample company for FY 2014, and Q1- Q3 2015, and equity price decline. The dependent variable remained constant in this regression model as the equity price decline for each company. The independent variables are the firm specific commodity price return for the whole period (2014 – Q3 2015), and stock market betas for FYE 2014, and Q3 2015. This regression model showed only one statistically significant variable, 2015 market betas. This relationship has a negative coefficient. This means that the larger a beta a given company has, the larger the equity price decline that given company will experience. One possible explanation for these results can be the period of time commodity prices have remained low. At this point in the commodity price downturn, companies have begun to declare bankruptcy. Companies with larger equity price declines have most likely become more risky investments as companies' battle with the low commodity prices. The table below shows the results of regression model 6.

| Regression Output | MODEL 6 |
|---|---|
| **INTERCEPT** | -0.55 |
| T-STAT | -1.25 |
| | |
| **FIRM SPECIFIC COMMODITY PRICE RETURN** | -1.76 |
| T-STAT | -1.88 |
| | |
| **BETA 2014** | 0.05 |
| T-STAT | 0.78 |
| | |
| **BETA 2015** | -0.68 |
| T-STAT | -4.91* |
| | |
| **REGRESSION F STATISTIC** | 8.67* |
| **ADJUSTRED R SQUARED** | 0.32 |
| **NUMBER OF OBSERVATIONS** | 50.00 |

## DISCUSSION AND CONCLUSION

As prior research showed earlier in this paper, the decision for a given company to hedge their O&G price exposure using derivative instruments can be based on many different factors. After analyzing the companies in this sample, it was clear that every company hedged using derivative instruments. As mentioned above, this study focused on the relationship between the use of derivative instruments and stock price sensitivity during a period of declining commodity prices. I also brought in other variables that could explain equity price declines aside from the use of derivative instruments.

The regression models showed that the use of derivative instruments has no real statistically significant effect on stock price sensitivity, but the use of leverage in a given firm's capital structure has a statistically significant effect throughout all of the regression models. Leverage was the only variable that continually had the same effect on a given firm's equity price declines. The regression models that included leverage as an independent variable clearly showed that as a firm increases the amount of debt in their capital structure, the equity returns will continually decline more during period of declining commodity prices.

To further improve this study, I can take each company's specific derivative instruments used, and analyze whether or not there are any differences in stock price sensitivity based on the type of derivative instruments used, and amount of derivative instruments used. This study did not have the time and ability to analyze the specific derivative positions used by each sample company. Taking this detailed information would allow for further analysis and possibly, a more definitive answer on how derivative instruments affect a firm's stock price sensitivity during a period of declining commodity prices.

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