DETERMINANTS OF COMMODITY HEDGING BEHAVIOR OF NORTH AMERICAN INDEPENDENT OIL AND GAS PRODUCTION COMPANIES

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ABSTRACT

The thesis analyzes the patterns of commodity hedging behavior among publically listed North American independent oil and gas producers during the shale revolution boom period between 2005 and 2014. The main aim is to identify company and market specific characteristics of some companies in the sector hedging a larger fraction of their annual production while others let prices impact their revenues and bottom lines more intensively. The database consists of 49 publically listed independent oil and gas producers from the U.S. and Canada and investigates the relationship six explanatory variables and commodity hedging. The thesis finds that the operationally and financially most stable companies in the sample tend to hedge a larger fraction of their production than their less healthy competitors. This stability is implied by the firms' higher market valuation, larger reserves portfolio, lower leverage and higher liquidity. However the analysis fails to identify any significant statistical relationship between commodity hedging in the sample and single continuous variables of firm size and liquidity and also the shape of the crude oil forward curve. The result that commodity hedging is most important for the less stable corporations in the oil and gas industry has some policy implications for North American regulators aiming to limit the risk taking behavior of major investment banks. Regulatory actors need to take into consideration the indirect effects of their actions on risk management clients of financial institutions as well.

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CHAPTER 1 - INTRODUCTION

Commodity producing companies use production hedging techniques to decrease the losses suffered in case of a rapid and large downfall of commodity prices and therefore minimize the probability of their default. One such price movement is the recent plunge in global crude oil and natural gas prices beginning in mid-2014 which resulted in nearly 50 percent lower Brent, WTI and Henry Hub indices by early 2015. The rapid emergence of the situation has given and is still giving several North-American exploration and production companies a hard time in securing liquidity for the fiscal year of 2015. As many firms face serious financial pressure, significant cuts in capital spending and operational cost reductions were focal points of companies' press releases during the fourth quarter of 2014 and the first quarter of 2015. (Patel, 2015; Timiraos, 2015)

Having a decent derivative commodity hedging portfolio for the fiscal year of 2015 could ease this liquidity pressure significantly. The low hydrocarbon price environment has put banks and other financial institutions on the losing side of these derivative contracts, which means substantial cash inflows for upstream firms. (Loder & Campbell, 2015; Alexander & Loder, 2015) Also, companies with a healthy fraction of their production hedged for 2015 experienced smaller fallbacks in earnings and EBITDA figures and therefore could more easily maintain their credit ratings. Protecting earnings and EBITDA proved to be crucial since plunging share prices left debt issuance as the only option for firms when turning towards external financing.

Given these recent developments of the industry, the North American oil and gas sector from 2005 to 2014 is a particularly interesting environment to investigate commodity hedging patterns. During these ten years the industry has gone through the so called shale revolution when due to technological advances the amount of profitably extractable sources of hydrocarbon

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increased dramatically in the continent and the whole sector experienced a significant boom environment. As a consequence, the market saw a significant increase in the number of independent oil and gas producers and also the surging production volumes of already existing firms. New entrants had to establish their commodity hedging policies and growing incumbents potentially optimized their hedging behavior to the changing industrial environment.

Financial academic literature has also increasingly turned towards the issue of commodity hedging in recent decades. With the development of financial markets derivative hedging has become a more and more integral part of firm risk management portfolios and therefore researchers aimed to find explanatory patterns behind hedging decisions of executives and define optimal hedging ratios of companies. The mixed results of earlier studies, shown later in this thesis, prove that the understanding of this complex risk management tool still needs to deepen in the coming years.

In this thesis my goal is to analyze the commodity hedging patterns of Northern American independent oil and gas producers during the shale revolution period from 2005 to 2014. Specifically I would like to identify company and market specific characteristics of some companies in the sector hedging a larger fraction of their annual production while others let prices impact their revenues and bottom lines more intensively. My interest towards the topic mainly comes from a half year long internship spent at the Budapest office of Morgan Stanley where I was part of the credit risk team focusing on the North American energy sector. Also, to my knowledge only very few academic studies have so far aimed to investigate commodity hedging patterns specifically in the North American oil and gas industry and no paper has covered the time interval of the shale revolution from a commodity hedging aspect.

The database I use for my thesis consists of 49 publically listed North American independent oil and gas producing companies. To construct my sample I collect annual data over the time period between 2005 and 2014 from firms' annual reports and the Standard and Poor's CapitalIQ database. In my analysis I investigate the relationship between the yearly fraction of production hedged by corporations and the companies' size, credit rating, liquidity, financial leverage and geographic diversity as well as the shape of the crude oil forward curve. I find that within my sample operationally and financially more stable companies tend to hedge a larger fraction of their production than their less healthy competitors. Stability in this sense refers to a higher enterprise value, a larger portfolio of proved hydrocarbon reserves, lower levels of financial leverage and a stronger liquidity position. The relationship proves to be rather weak but tends to be stable over the time interval investigated.

The structure of my thesis is as follows: in the second chapter I summarize the academic literatures's findings in the area focusing on factors that incentivize and those that disincentivise firms to enter into commodity hedging contracts and also company characteristics that explain hedging behavior. This is followed by the derivation of my hypotheses based on the literature's findings and also my in-depth interview with a Morgan Stanley credit professional whose field of expertise is the North American oil and gas exploration and production segment. The fourth chapter presents the database I use in my analysis and shows descriptive statistics of particular variables. In the fifth part I explain the process and details of my quantitative analysis and results gained from the analysis. The thesis ends with the conclusions drawn from the results.

CHAPTER 2 - LITERATURE REVIEW

2.1 A short description of commodity future derivatives

In the following paragraphs I give a brief summary of how commodity future derivatives work as financial assets.

A commodity futures contract is an agreement to buy/sell a specified quantity of a commodity at a future date, at a price fixed when setting up the contract. Entering into the contract does not result in any immediate cash transfers between the contractual partners, which means that the value of the derivative is zero when the agreement takes place. Companies do not enter into commodity futures to raise funds for investing, these assets are risk management tools used as insurance for the future selling price of the firms' outputs. Since the contracts are bets on the expected future spot price, they don't create exposures to the actual products. (Gorton & Rouwenhorst, 2005)

Since the 2000s financial institutions and portfolio investors emerged as active players in energy trading since they consider commodities and energy in particular an asset class that shows little correlation with traditional equity and fixed-income investments. (Simkins & Simkins, 2013) Commodity futures as an asset class do differ from stocks, bonds, and other conventional assets by several factors, including the following: (1) commodity futures are derivative securities; they are not claims on tangible or intangible assets of corporations; (2) they are usually short (less than one year-long) maturity claims; (3) the commodity prices that are subjects of these contracts show seasonality in price levels and volatilities. (Gorton & Rouwenhorst, 2005)

Investing in commodity futures will not generate gains or losses based on expected but on actual movements in spot prices until maturity of the contract. Investors into these kinds of contracts will benefit if the spot price at maturity is higher than it was expected when entering into the contract and will lose when the spot price at maturity is lower than the expected spot price. Obviously, the commodity producing firm will generate gains or losses opposite to the investor. (Gorton & Rouwenhorst, 2005)

There are basically two major price indices that dominate price discovery in the oil market. These are the West Texas Intermediate traded on NYMEX and the Brent traded on ICE Futures. For natural gas, the most important price index is the Henry Hub traded on NYMEX. (Simkins & Simkins, 2013) The shape of the commodity forward curves can fall into two categories. In situations when the futures price exceeds the current spot price are said to be contango-shaped, while commodity futures with a positive basis (spot price is higher when signing the contract than the available future price) are referred to as being in backwardation. There is a theory of Keynes formulated in 1930 commonly discussed in academic articles claiming that the futures price of a commodity is less than the expected future spot price, and that the futures price should increase over time so that it equals the expected spot price at the expiration date of the contract. (Kolb, 1992) It is important to note that a positive basis is different from normal backwardation, commodity forward curves can be in contango and at the same time be in normal backwardation. (Gorton & Rouwenhorst, 2005)

Contango shaped curves occur when supply being higher than demand today rationalizes storing a commodity and backwardation happens when there is a relative shortage of a commodity today. (Downey, 2009) Crude oil has historically been in backwardation in approximately two-thirds of the trading days between 1983 and 2007. Usually curves are

contango-shaped when spot prices experienced low periods. (Simkins & Simkins, 2013) Contangos are not persistent since they can be arbitraged by simply building storage facilities and finance these constructions by selling forward contracts. (Downey, 2009)

Knowledge of trends and behavior of commodity spot and futures prices is essential in designing optimal commodity hedging and trading portfolios for market players. Commodity price changes tend not to be independent but rather to be characterized by volatile periods as variances change over time. (Baillie & Myers, 1991) Another important feature of commodity price movements is asymmetric dynamics in the volatility. This means that positive shocks to commodity returns result in greater jumps in volatility than negative shocks. Storage values are also crucial for commodity price changes, as low inventory figures tend to lead to increased volatility, while high inventories reported by companies usually result in low volatilities. (Carpantier & Samkharadze, 2013)

2.2 Incentives for using commodity hedges

Although derivatives have been in existence for a long time, their use has only gained increasing attention in the last several years, parallel to dramatic jump in the use of derivative instruments for corporate risk management. (Panaretou, Shackleton & Taylor, 2013) Surging demand for over-the-counter derivative securities is mostly driven by demand coming from companies willing to hedge specific risks like commodity price, interest or currency risk. (DeMarzo & Duffie, 1995) Literature on hedging with derivatives mostly addresses the issue of why firms enter into costly derivative contracts when the individual agreements' effects on overall risk at the company level can be questionable. (Smistad & Pustylnick, 2012)

Increased use of and interest in commodity hedging may result from market players observing increased volatility in commodity markets in the last decades. Cashin and McDermott (2002) find that trends in real commodity prices are highly and increasingly volatile over time. As an example, annual price changes of less than 20 percent characterized the market before 1913, however during the period following 1913, price changes larger than 20 percent happened more than 13 times. Volatility grew even further since the 1970s. They also find that short-run movements in real commodity prices are highly unpredictable as a result of these emerging market phenomena.

The question can emerge that in case of a huge shock to the oil price, how lasting it is expected to be. Cashin, Liang and McDermott (2000) cite the results of Deaton and Laroque (1992) and Deaton (1992) who find, that commodity price cycles tend to be characterized by temporary booms, rapid downfalls and long periods of flat prices. Also, shocks to commodity prices often prove to be permanent. For most of the commodity products it typically takes more than five years for the impact of the initial shock to halve. The authors also find that in case of crude oil, the duration is the highest among the investigated commodities. Natural gas is among the commodities in case of which the duration is rather short.

Price volatility in itself would not give a sufficient rationale for hedging. Based on Modigliani and Miller's results under perfect market conditions, hedging does not affect firm value no matter how volatile commodity prices are. (Graham & Rogers, 2002) However corporate risk-management theory identifies several market imperfections that can make volatility costly and therefore rationalize hedging through derivatives. A list of these imperfections can be set as the following: (1) costly external financing; (2) taxes; (3) costs of managerial risk aversion; (4) financial distress costs. (Guay & Kothari, 2003)

Literature on corporate risk-management points to at least three risk exposures in case of commodity-producing companies resulting from volatility in market prices: (1) volatility of cash-flows; (2) volatility of income; (3) volatility of firm value. (Guay & Kothari, 2003) Reducing volatility in these financial figures can have the following beneficial effects: (1) larger debt capacity through alleviating financial contracting costs; (2) tax advantages resulting from increased debt usage; (3) being able to better exploit investment opportunities; (4) reducing informational asymmetries between management and shareholders; (5) creating incentives for superior management performance in those firms where management holds significant amount of shares. To sum up, by transferring the risk of business processes that firms do not have any insight into or control over, a firm is able to concentrate its efforts on those competencies that they are best at, increasing the overall effectiveness and efficiency of the firm. (Simkins & Simkins, 2013) Therefore more accurate planning, budgeting and earnings forecasting is available for the company. (Downey, 2009) In the following paragraphs I will briefly summarize some results published on the potential beneficial effects of corporate hedging through derivatives.

Graham and Rogers (2002) in their study address the issue of how hedging decreases the probability of financial distress at firms and therefore increases their debt capacity and resulting tax advantages. They note that beyond tax advantages a larger debt capacity can have beneficial effects through unused credit facilities as well. These unused capacities result in lower expected default rates and decreased financial distress costs. Findings of the article show that leverage of companies investigated is associated positively with hedging through derivatives. Graham and Rogers also find that the debt-hedging relationship is reverse: a larger hedging portfolio of a firm

leads to increased debt capacity. They argue that derivatives-induced debt capacity increases firm value by 1.1%, on average.

If a company makes significant amount of capital expenditures on an annual basis, smoothing revenues and cash flows can ensure that the firm will have the necessary funds to finance its capex program each year. Volatile cash flows in this case will probably result in foregone future revenues due to the lack of crucial investments today. (Stulz, 1996)

Beneficial effects of hedging through reduced informational asymmetries between management and shareholders was studied among others by Dadalt, Gay and Nam (2002). In their paper the authors hypothesize that by reducing volatility in earnings and cash-flows, management can decrease the asymmetries in information between the firm and shareholders/debt holders. This happens by eliminating some part of the noise in the company's performance where noise refers to factors contributing to earnings that are believed to be outside of managerial control. As a result analysts covering the company and external financers can more precisely assess the firm's true earnings capacity and the quality of its managers. Their findings show a robust inverse relationship between a firm's derivatives use and measures of information asymmetry.

Potential motivations behind increasing firm value by decreasing information asymmetries through hedging are realized by DeMarzo and Duffie (1995) as the following: (1) improved information received by shareholders will increase their willingness to support investment projects run by the company and (2) reputational effects will increase future wages of managers. This theory has also been validated by surveying CFOs of non-financial companies, as they responded that by delivering less noisy information companies can help shareholders to

distinguish superior managerial performance from the effects of luck. (Servaes, Tamayo & Tufano, 2009)

In the case of risk-averse managers holding a sizeable portion of the company's shares, the expected utility of the managers is severely reduced by volatility in the firm's expected earnings. Therefore a positive relationship is expected between the proportion of managerial shareholding and risk management through derivative hedging. (Smith & Stulz, 1985) Results are controversial in this area of incentives as Tufano (1996) and Schrand and Unal (1998) find evidence that companies with higher managerial ownership tend to hedge more, on the other hand Géczy, Minton and Schrand (1997) and Haushalter (2000) find no such relationship.

Some findings suggest that hedging policies not only decrease volatility in cash flows and earnings but result in higher profitability as well. Bartram, Brown and Conrad (2011) find that within their sample from 47 countries firms that use derivatives to hedge risks significantly outperform those that do not use this measure as part of their risk management program. Regardless of whether they measure performance in earnings, cash-flow or return on assets, results are consistently higher in case of companies that hedge than in case of those that do not.

2.3 Costs and other disadvantages of commodity hedges

Although hedging through derivatives can seriously decrease the cash-flow risk a company faces, it is not at all obvious that a firm will use this opportunity as part of its risk management program. If trying to make economically optimal decisions, firms will use derivatives only if the benefits of the contracts exceed the costs. This may explain the findings published that show economically small magnitudes of derivative hedging programs relative to their entity-level risk exposures. (Guay & Kothari, 2003) Also limiting factors to company

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hedging found by Brown (2001) are that firms use derivatives to fine-tune an overall risk-management program that includes other means of hedging (e.g., operational hedges) as well and that firms make decentralized decisions on derivatives use and therefore only those divisions enter into derivative contracts that find earnings volatility crucial to their performance.

Based on survey answers from CFOs Servaes, Tamayo and Tufano (2009) report that in case of commodity prices, the typical firm behavior is partial rather than complete hedging. They consider this phenomenon completely consistent with the view that shareholders can more efficiently manage idiosyncratic risk than firms by simply holding diversified portfolios. Therefore companies will mostly hedge to avoid catastrophic outcomes like financial distress and failure to carry out their business plan resulting from rapid changes in commodity prices.

It is important to note that by reducing volatility a companies can not only give away the downside risk but also they can lose the upside rewards. These foregone financial gains can be considered costly for the company if they have to raise new capital or debt to fund their important investment programs. (Servaes, Tamayo & Tufano, 2009) This consideration is reported to be common among company executives since the basic rationale behind risk management with derivative hedging seems not to be well understood by company top managements and boards. This is suggested by the results that besides direct costs of making derivative contractual agreements, managements and boards are most concerned about opportunity costs of hedging (foregone gains if prices move in favor of the firm's operations). (Servaes, Tamayo & Tufano, 2009) Whaley (2006) also points out that most of the major problems arising as a result of derivative hedging have been caused by inadequate oversight and lack of knowledge by management. Further increasing this effect, media and investors often

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punish companies for hedging positions that result in cash outflows when commodity prices move upwards, and therefore disincentivize managers to hedge. (Downey, 2009)

2.4 Firm characteristics determining the usage of commodity hedges

Literature aims to find the features along which firms that tend to hedge more can be differentiated from companies that tend to hedge less. Results show that the following factors are usual determinants of hedging: (1) company size, (2) geographical diversification of operations, (3) dividend policy, (4) investment opportunities, (5) access to external financing and (6) leverage. It is important to note however, that evidence found by the articles is often weak, and considering a larger sum of papers gives mixed results on the relationship between these factors and hedging strategies. In the following paragraphs I briefly summarize the results published.

Guay and Kothari (2003) find some not strong evidence that firms that are larger by asset size use more derivative hedging as part of their risk management activities. Bartram, Brown and Conrad (2011) report that on average companies using derivatives as part of their risk management programs tend to be more mature firms. Their results show that the unadjusted Tobin's Q of the average hedging corporation is 17% lower than that of the average competitor without derivative usage. Mian (1996) also finds strong evidence that hedging activities exhibit economies of scale.

Geographical diversification increases the number of sources of company cash flows and therefore diverse firms are expected to use more derivative hedging to handle various cash flow risks. Guay and Kothari (2003) find that geographical diversification are one of the two most significant factors when it comes to firm hedging behaviour.

Companies that are committed to stable and smooth dividend payments policies over time will favor volatility to be removed from the source of these dividend payouts, namely cash flows. Nance, Smith and Smithson (1993), Tufano (1996) and Géczy, Minton and Schrand (1997) all find that companies that are committed to specific dividend payment policies tend to use more derivative hedging over time.

Some research (Stulz, 1996, Myers, 1977, Myers & Majluf, 1984) have so far found solid evidence that companies with larger opportunities and needs to invest will use more derivative hedges that companies without. Guay and Kothari (2003) find that investing opportunities are one of the two most significant factors when it comes to firm hedging. Mian (1996) on the other hand finds no evidence of companies with derivative risk management practices having more investment options relative to assets.

Cash flow volatility is most painful for companies when potential to develop business is high however both internal and especially external sources of funds are scarce. (Haushalter, 2000) Géczy, Minton and Schrand (1997) find that companies with high growth opportunities and limited access to internal and external financing are the most likely to hedge the volatility in their earnings and cash-flow. Haushalter (2000) also reveals a positive relationship between the extent of hedging and external financing costs and therefore that firms that have a credit rating tend to hedge more.

A most common interest of studies dealing with company hedging is the relationship between derivatives use and firm leverage. As Guay and Kothari (2003) report, there is mixed evidence on the relationship between debt issued relative to earnings and assets and company

hedging. From the six articles they cite three includes findings on significant association between the two factors while the other three fails to identify any relationship.

2.5 Usage of commodity hedges among oil and gas companies

Relatively few empirical research aims to understand hedging motives and strategies within the sector of Oil & Gas E&P companies. This is surprising, since as Haushalter (2000) discusses, oil and gas producing companies provide an ideal environment to analyse commodity hedging strategies, since (1) volatility of oil and gas prices has a substantial impact on cash flow variability; (2) opportunities to hedge commodity price risk are widely available for companies both at mercantile exchange platforms and over-the-counter markets; and (3) a huge variability is observable among firms regarding annual production hedged.

North-American E&P companies in the oil and gas industry tend to deal with risk issues at a high professional level. Smistad and Pustylnick (2012) investigate Canadian O&G companies' hedging behavior and find that all 12 firms in their scope employ derivatives to handle commodity price risk. The most common contracts the companies entered into were swaps and collars. Also they find that almost with no exception O&G firms use commodity futures with the aim of reducing price risk and do not enter into derivative contracts with speculative intentions.

Haushalter (2000), in line with its intuition, finds a wide variation in hedging policies among oil and gas producers. He also finds a positive relationship between the fraction of production hedged and differences in financial leverage, and the relationship is greater in case of firms that have little financial flexibility. He also finds that the extent of hedging is positively related to financing costs, measured by credit ratings.

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CHAPTER 3 - HYPOTHESES

I formulated my hypotheses based on empirical findings of the literature focusing on commodity hedging strategies of companies and also on an in-depth interview made with Péter Galambos, Associate member of the Risk Management Department in Morgan Stanley's Budapest office. Mr. Galambos's field of expertise is credit risk assessment of North-American oil and gas companies. In the following paragraphs I discuss in detail my hypotheses tested through quantitative analysis in later stages of my thesis.

Literature often uses hypotheses that derivative hedging shows positive relationship with company size (and age) since hedging activities exhibit economies of scale. (Guay & Kothari 2003; Bartram, Brown & Conrad 2011; Mian 1996) However based on my in-depth interview with the previously mentioned oil and gas credit professional I got the insight that small oil and gas companies hedge more relative to their production, as a rapid and significant decline in hydrocarbon prices would endanger their financial health much more. Therefore my first hypothesis is the following:

Hypothesis I: *Within my sample, company size shows a negative relationship with commodity hedging, and therefore larger firms (measured by the combination of enterprise value and the amount of proved reserves) tend to hedge a smaller fraction of their production that smaller firms.*

Access to external financing is usually assumed to be in negative relationship with hedging as companies that can only issue new debt or shares with high costs should be the most eager to protect their cash flows. (Haushalter 2000; Géczy, Minton & Schrand 1997) This assumption was also verified by my in-depth interview. The most common proxy to capture costs of external financing is whether the firm is rated by one or more of the major rating

agencies. Since my database for this thesis entirely consists of companies rated by Standard&Poor's I will measure costs of external financing by whether the firms belong to the investment grade or the non-investment grade category according to their credit rating. These two categories are commonly used and relevant features in international financial markets, as for example some equity or hedge funds are restricted from investing into securities of non-investment grade firms. Therefore my second hypothesis is the following:

Hypothesis II: *Within my sample, access to external debt financing and financial contracting costs show a negative relationship with commodity hedging, and therefore firms whose credit rating issued by Standard & Poor's is equal to or higher than BBB- (investment grade category) tend to hedge a smaller fraction of their production than non-investment grade companies.*

Geographical diversity is usually assumed to be in positive relationship with hedging as more potential sources of cash flow volatility lead to more intensive risk-management activities. (Guay & Kothari 2003) This factor is absolutely relevant for internationally active North American oil and gas companies as hydrocarbons are marketed based on different price indices in different continents. The two most relevant indices are WTI in the U.S. and Brent in Europe. These indices are usually strongly positively correlated but spreads between them can experience rapid changes in extreme cases of geographically limited external shocks. Therefore my third hypothesis is the following:

Hypothesis III: *Within my sample, geographical diversity shows a positive relationship with commodity hedging, and therefore firms that have producing international assets in a particular year tend to hedge a larger fraction of their production than those companies that only have assets in North-America.*

Financial leverage (amount of debt outstanding relative to cash generating ability) is usually assumed to be in positive relationship with hedging. (Guay & Kothari 2003) Based on insights from my in-depth interview the oil and gas industry is extremely capital intensive, and firms often issue high amounts of debt to finance exploration and drilling activities. Since outstanding debt results in continuous cash outflows through interest payments and debt repayments, companies that are pressured by a low commodity price environment can easily default on their obligations. Therefore my fourth hypothesis is the following:

Hypothesis IV: *Within my sample, financial leverage shows a positive relationship with commodity hedging, and therefore firms that have higher Total Debt/EBITDA ratios tend to hedge a larger fraction of their production than those companies that have lower Total Debt/EBITDA ratios.*

From my in-depth interview I gained the insight that liquidity position of oil and gas companies is also a potential motive behind commodity hedging decisions. In case of financial pressure put on firms by falling hydrocarbon prices cash in hand is the fastest, easiest and cheap source of meeting external obligations. Underperformance in cash flow generation will hit firms with low levels of cash and marketable securities most severely. Therefore my fifth hypothesis is the following:

Hypothesis V: *Within my sample, financial liquidity shows a negative relationship with commodity hedging, and therefore firms that have higher amounts of cash and marketable securities on their balance sheets tend to hedge smaller fraction of their production than those companies that have lower amounts of cash and marketable securities on their balance sheets.*

My last hypothesis is solely based on insights gained from my in-depth interview and aims to identify companies' motivation to use more derivative hedging when forward curves are contango-shaped. This potential motivation is the consequence of the financial costs of entering into commodity hedging contracts, which depend on the difference between the spot and the future prices of hydrocarbon commodities. In cases when the future price exceeds the spot price, the transaction costs of derivative hedging contracts are much lower than in cases when the spot price exceeds the future price. Therefore my sixth hypothesis is the following:

Hypothesis VI: *Within my sample, the difference between spot and forward WTI crude oil prices shows a positive relationship with commodity hedging, and therefore in years when the forward curve is Contango-shaped companies will hedge a larger fraction of their production than in years when the forward curve is in Backwardation.*

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CHAPTER 4 - DATABASE

To analyze the commodity hedging behavior of oil and gas producers, I constructed a database of 49 publically listed (on the NYSE or the TSX) U.S. and Canadian independent E&P companies rated by Standard&Poor's. I gathered data on their operations between 2005 and 2014. The main rationale behind selecting this sample of companies was the following:

(1) Publically listed companies: due to strict disclosure requirements, publically listed companies are obliged to publish detailed and audited data regarding their operations annually, in contrast to privately held firms. Data to construct all variables necessary for testing my hypotheses could not have been collected through internet sources for privately held companies.

(2) Independent, U.S. and Canadian E&P companies: firms in the oil and gas industry that are mostly exposed to commodity price volatility are independent producers. This kind of companies is typical in the U.S. and Canada, while other continents' oil and gas industries are dominated by large, integrated companies.

(3) Companies rated by Standard&Poor's: by selecting firms whose debt profile had been rated by one of the major rating agencies I was able to construct a variable of access to external debt financing. Also, Standard&Poor's CapitalIQ database made data for several variables easily accessible. Credit ratings issued by Standard&Poor's are used in research on hedging behavior of oil and gas companies (Haushalter, 2000) and are considered as most trustworthy by the Risk Management department of Morgan Stanley.

In setting up the database and selecting appropriate measures to construct variables I used insights both from academic studies and from previously mentioned in-depth interview with an oil and gas credit professional. In the following paragraphs I discuss in detail the metrics used as variables for quantitative analysis.

4.1 Dependent variable

In their annual reports companies disclose both commodity production volumes for the particular financial year and commodity hedging derivative contracts in place at 31st December of the particular financial year. For derivative contracts both fair values expressed in dollars and hedged volumes are reported therefore hedged fractions of future production can be calculated. To calculate this fraction I considered hedged volumes for the next 12 months ($YEAR_{t+1}$) and divided them by produced volumes during the past financial year ($YEAR_t$). The reason behind calculating hedging fractions in the described way is the following: production estimations for the year coming ($YEAR_{t+1}$) is only rarely disclosed in annual reports. Therefore the available data that was most relevant in making hedging decisions for the next year is the production volume of the past year ($YEAR_t$).

4.2 Independent variables

A continuous variable is used to indicate the size of the companies in the sample. This variable consists of two components: (1) enterprise value on 31st December of the particular year (the sum of total market capitalization and total outstanding debt) and (2) total proved oil and gas reserves data on 31st December of the particular year. From the numerous reserve categories that oil and gas firms report, proved reserve base was chosen since this amount is the one that investors and creditors consider the most relevant. Enterprise value data was accessed through the Capital IQ database of Standard & Poor's and reserves data was collected from the annual reports of the companies. Finally, to construct the variable I took the arithmetic mean of the logarithms of both enterprise value and reserves data.

Company credit rating issued by Standard&Poor's is included in the regressions as a dummy variable proxy for access to external debt financing. Data on credit ratings was gathered from the CapitalIQ database of Standard&Poor's. The rating values within the sample have a considerable level of variance as they range from CCC+ to A-. To construct a dummy variable I transformed these rating values into two categories. All ratings that are equal to or higher than BBB- are categorized as 'Investment Grade' ratings and those equal to or lower than BB+ are categorized as 'Non-Investment Grade' ratings.

A binary variable is used to indicate whether the company had any international assets during the particular financial year. As international assets I consider producing fields outside of North America. Data about asset portfolios was gathered from company websites. In the sample, altogether 11 companies had international assets and all of these assets were producing during the full 10-year long period.

Another dummy variable indicates the dominant shape of the one year ahead WTI crude oil forward curve during the particular year. This shows whether crude oil future prices one year ahead were mostly higher or lower than spot prices during the particular financial year. Data for WTI prices was gathered from the U.S. Energy Information Administration's website and shows that during the investigated time period forward curves were for 7 years Contango-shaped and spent 3 years in Backwardation.

Financial leverage of the companies is measured as the ratio of total debt outstanding on 31st December of the particular financial year and EBITDA (earnings before interest, taxes, depreciation and amortization) generated by the firm during the particular financial year. Both financial measures were collected from annual reports of companies in the sample.

Debt/EBITDA is one of the most commonly used metrics to assess firm leverage by financial institutions and investment firms. The ratio is usually in the range of 0 to 10 for most of non-financial companies and only exceeds this interval in extreme cases (e.g. leveraged buyout).

To measure companies' liquidity position, the following proxy was constructed. I used the amount of cash and marketable securities on the firms' balance sheet at the end of each particular year between 2005 and 2014. Since this nominal amount is largely positively correlated with firm size, I divided it by the size indicator previously shown to measure company size. Finally, in the regressions I will use the logarithm of this variable.

4.3 Data Characteristics

4.3.1 Dependent Variable

In line with Haushalter (2000), in my database I find significant level of variation of commodity hedging among oil and gas companies. The distribution for the entire sample broken down by firm years is shown in Figure 1 and also broken down by mean values for firms is shown in Figure 2.

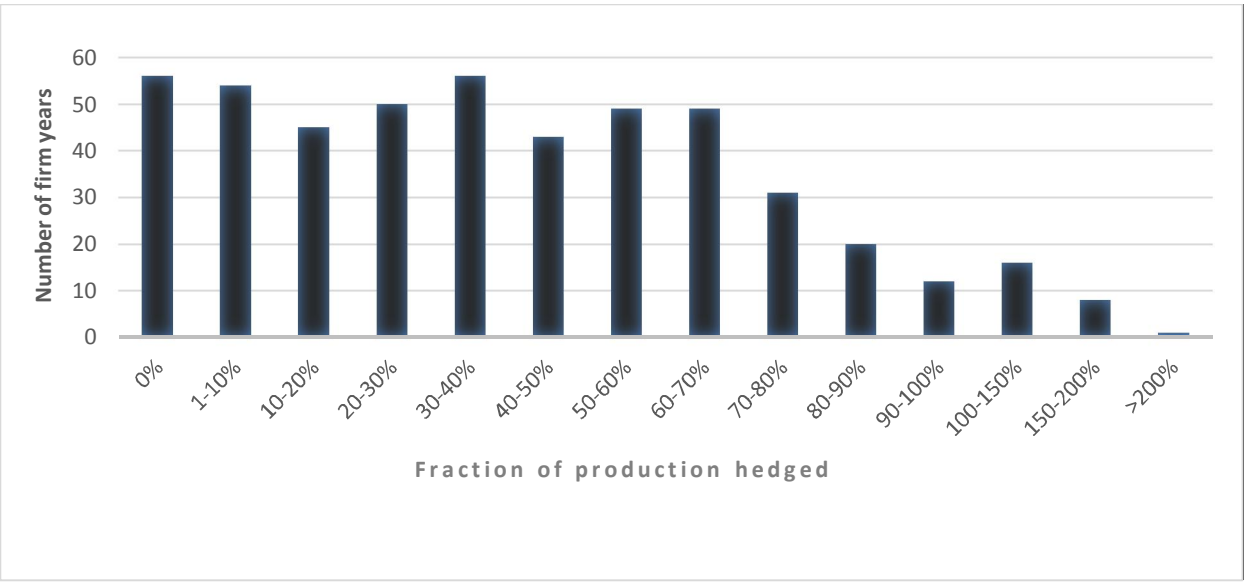

Figure 1 Fraction of annual production hedged by oil and gas producers in the sample 2005 to 2014

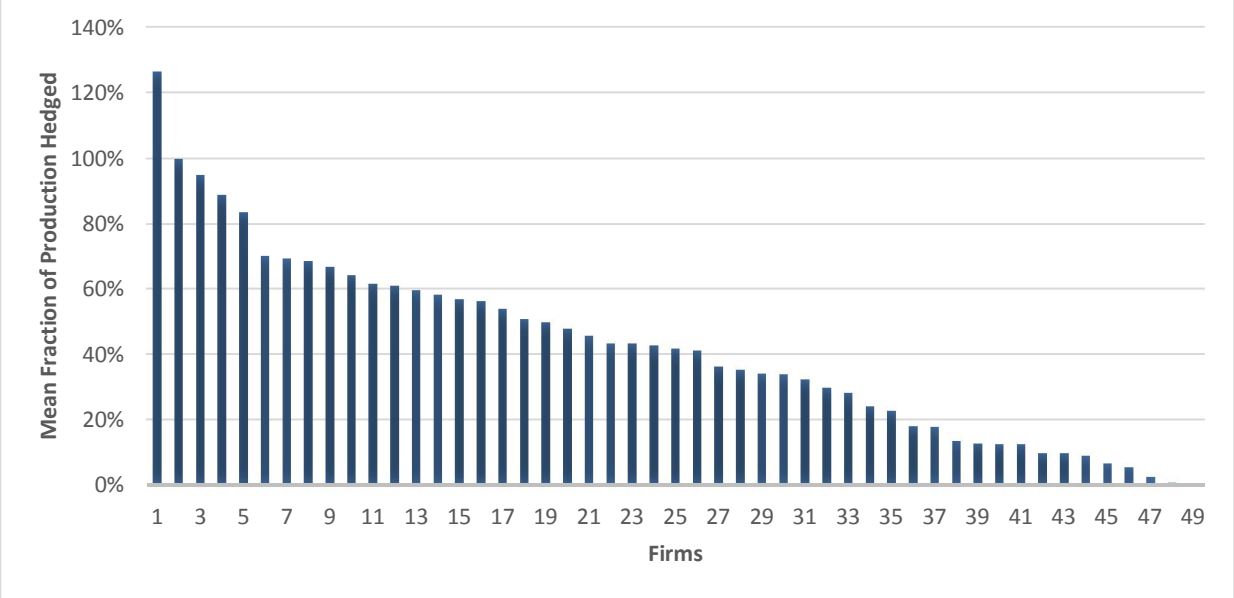

Figure 2 Ranked plot of mean fraction of production hedged by each firm respectively in the sample 2005 to 2014

Trends of production hedging over time within the sample can be seen in Table 1. As we can see fraction of production hedged is relatively stable over time in the sample and does not show any clear increasing or decreasing trends. In 9 out of 10 years the mean of production

hedged by all companies is in the 35-44% range and standard deviation of the median over time is also below 10%. Number of firms that do not enter into commodity hedge contracts in a particular year seems to be somewhat lower after 2008, however the years of 2012 and 2014 are exceptions. In years when number of firms with no commodity hedges are very low, mean and median values tend to be higher.

Mean and median figures in this sample are considerably higher and proportions of companies with no hedging are considerably lower than Haushalter's (2000) values for his sample of 100 independent oil and gas producers between 1992 and 1994. Haushalter finds that companies with no hedging are in the range of 43 - 54 percent within the sample and among firms that do use hedging, mean values are between 28 and 32 percent and median values are between 23 and 25 percent. The same findings hold when comparing my results with other surveys cited by Haushalter, e.g the "Wharton Survey of Derivative Usage among U.S. Non-Financial Firms". These differences are in line with other studies' claims that in recent decades hedging has become a more and more common element of firm risk-management policies.

TABLE 1
Fraction of Production Hedged by Year

	MEAN	MEDIAN	FRIMS WITH NO HEDGE
2005	43%	33%	14%
2006	43%	27%	16%
2007	42%	27%	12%
2008	39%	36%	16%
2009	44%	45%	6%
2010	43%	41%	6%
2011	40%	33%	4%
2012	40%	37%	12%
2013	51%	51%	4%
2014	35%	35%	24%

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4.3.2 Independent variables

Features of the binary independent variables are the following:

(1) The variable of international assets is constant over time for respective firms in the sample. 11 companies have producing international assets within the sample and for each firm the overseas assets had producing status for each year between 2005 and 2014.

(2) The variable of credit rating is also relatively constant over time for respective firms. There are only 4 companies in the sample that belong to the investment grade category in some years and to the non-investment grade category in others. From the remaining 45 firms, 30 is non-investment grade category in each year in the sample and 15 is constantly investment grade category.

(3) The variable showing the shape of the one year ahead WTI forward curve is obviously constant for the respective firms over time. For the years 2007, 2013 and 2014 its value is zero, meaning that the forward curve was in backwardation. In the remaining seven years the forward curve had a contango shape and therefore the value of the variable is one.

Features of the continuous independent variables are summarized in Table 2. The size of companies in the sample tends to grow over time as suggested by the increasing trend in mean, median and minimum figures, however the maximum value of firm size is rather constant over time. The decomposition of the size variable shown in Table 3 tells that enterprise value showed and increasing trend over time but suffered a one-time significant setback in 2008 due to the recent financial crisis. Reserves data clearly shows a linearly increasing trend as a result of the shale boom in the U.S. during the years investigated. Mean, median and maximum values for firm leverage tend to be highest in the sample during years between 2011 and 2013 that can be a

logical consequence of increased confidence in the industry as a result of historically very high hydrocarbon prices.

Cash and marketable securities on the firms' balance sheet does not seem to follow any increasing or decreasing trends between 2005 and 2014. Lowest maximum values for liquidity positions tend to appear around the most severe years of the recent financial crisis between 2007 and 2009, a logical consequence of the financial pressure put on oil and gas companies by frozen capital and debt markets and falling commodity prices.

TABLE 2

Characteristics of Independent Variables by Years

	SIZE				DEBT/EBITDA				CASH			
	MEAN	MEDIAN	MIN	MAX	MEAN	MEDIAN	MIN	MAX	MEAN	MEDIAN	MIN	MAX
2005	2.93	2.82	1.81	4.47	1.67	1.05	0.00	10.00	1,098	60	0	4,213
2006	2.99	2.86	1.84	4.61	1.50	1.20	0.26	4.67	168	19	0	2,585
2007	3.08	3.02	1.99	4.62	1.79	1.24	0.39	10.00	229	34	0	1,736
2008	2.98	2.92	1.80	4.50	2.24	1.05	0.29	10.19	287	43	0	2,360
2009	3.07	3.04	1.88	4.53	2.70	1.76	0.48	10.88	422	38	0	4,275
2010	3.15	3.19	1.96	4.50	2.14	1.39	0.29	15.68	607	63	0	9,454
2011	3.18	3.18	1.91	4.50	2.28	1.54	0.01	12.78	527	53	0	7,088
2012	3.17	3.20	1.93	4.46	3.09	2.07	0.19	28.84	518	53	0	7,003
2013	3.25	3.30	2.01	4.49	2.61	2.01	0.67	16.80	666	54	0	6,246
2014	3.23	3.27	2.28	4.48	2.75	1.89	0.50	10.00	690	28	0	7,369

TABLE 3
Characteristics of Components of Size Index by Years

	ENTERPRISE VAUE				PROVED RESERVES			
	MEAN	MEDIAN	MIN	MAX	MEAN	MEDIAN	MIN	MAX
2005	9,536	2,700	383	92,655	686	138	8	9,366
2006	11,600	3,416	457	146,745	777	174	10	11,169
2007	15,171	4,523	534	162,918	790	245	18	10,560
2008	9,764	3,302	183	99,335	790	250	19	9,975
2009	12,670	5,005	282	112,004	831	257	18	10,326
2010	14,146	7,701	393	118,527	892	314	22	8,310
2011	13,107	6,683	300	118,888	950	345	19	8,387
2012	13,023	5,821	290	94,483	926	379	14	8,642
2013	15,451	7,195	315	107,768	992	439	34	8,921
2014	13,529	6,180	547	100,799	1,045	548	40	8,906

4.3.3 Correlations

The correlation matrix for all variables used in the quantitative analysis can be seen in Table 4. The hedged fraction's correlation with four independent variables, namely Credit Rating, Firm Size, Leverage and Cash Liquidity is in line with my hypotheses. For the International Asset and Forward Curve variables the direction of the relationship suggested by correlations is just the opposite as assumed earlier.

It is important to note that we can see strong positive correlation values among the variables Credit Rating, Firm Size and International Asset. Strong positive correlation between Credit Rating and Firm Size variables is driven by company size being one of the most important factors in the determination of default probability. The rationale behind this is that large corporations have much more means to avoid financial distress in case of negative shocks. The relationship between variables International Asset and Firm Size suggests that larger companies in the sample have producing fields overseas with a higher probability. In line with this, the four largest companies in the sample, namely ConocoPhillips, Canadian Natural Resources, Anadarko

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Petroleum and Apache Corp. all had international assets between 2005 and 2014. This is supported by the following considerations:

(1) Oil and gas operations outside North America often include offshore drilling activities that mean significantly more sources of risk, higher capital requirements and stricter regulatory environment - factors smaller E&P companies usually cannot handle.

(2) The shale hydrocarbon boom in the U.S. mostly happened during the last ten years and offered numerous onshore drilling opportunities for E&P companies in North America. Therefore companies that did not have international assets before the mid-2000s and also those that already had could easily expand their asset portfolios within the basins of the U.S. and Canada.

To shed some light on the strong positive correlation between the credit rating and international asset variables we have to consider the following: both variables seem to act like an index of the overall operational and financial stability of the companies in the sample. This is very straightforward in case of the credit rating variable, as credit ratings are issued based on an analytical process that assesses the operational and financial health of the firms investigated. However the binary variable of whether a company has international assets in a particular year seems to contain a very similar set of information about firm stability within this sample. This is to be shown in Tables 5 and 6. Graphical representation of the tables can be seen in the Appendix from Figure 1 to Figure 6.

Table 5 and Figures 1 to 3 in the Appendix show the outcome of dividing my sample into two subsamples along the binary variable of credit rating. Results show that the subgroup of companies with an investment grade credit rating tends to contain the majority of firms which

are largest by size, have lowest values of financial leverage, have most financial liquidity and own international assets. Table 6 and Figures 4 to 6 in the Appendix show the outcome of dividing my sample into two subsamples along the binary variable of credit rating. Results show that the subgroup of companies with international assets tends to contain the majority of firms which are largest by size, have lowest values of financial leverage, have most financial liquidity and have investment grade credit rating. Therefore it seems that within this sample both the credit rating and the international asset variables are relatively good proxies for the companies' overall operational and financial stability.

TABLE 4

Correlation Coefficients

	Fraction Hedged	Credit Rating	Size	International Asset	Fwd Curve	Leverage	Liquidity
Fraction Hedged	1	-0.226	-0.127	-0.349	-0.017	0.119	-0,072
Credit Rating		1	0.734	0.642	-0.024	-0.205	0,101
Size			1	0.57	-0.087	-0.188	0,104
International Asset				1	0	-0.171	0,094
Fwd Curve					1	-0.027	0.011
Leverage						1	-0.044
Liquidity							1

TABLE 5

Characteristics of Particular Variables along Companies' Credit Rating Category in the Sample

		MEAN	MEDIAN	MIN	MAX	Q1	Q3
SIZE	Investment Grade (17 companies)	3.7	3.8	3.1	4.5	3.5	4.0
	Non-investment Grade (32 companies)	2.8	2.7	2.1	3.9	2.5	3.1
LEVERAGE	Investment Grade (17 companies)	1.5	1.4	0.8	2.9	1.1	1.9
	Non-investment Grade (32 companies)	2.6	2.3	0.6	8.9	1.3	3.2
LIQUIDITY	Investment Grade (17 companies)	1047	783	22	3594	319	1255
	Non-investment Grade (32 companies)	245	68	11	4217	32	103
INTERNATIONAL ASSET	Investment Grade (17 companies)	0.6	1	0	1	0	1
	Non-investment Grade (32 companies)	0	0	0	1	0	0

TABLE 6
Characteristics of Particular Variables along International Assets in the Sample

		MEAN	MEDIAN	MIN	MAX	Q1	Q3
SIZE	International Asset (11 companies)	3.8	3.8	2.7	4.5	3.6	4.0
	No International Asset (38 companies)	2.9	2.9	2.1	4.0	2.6	3.3
LEVERAGE	International Asset (11 companies)	1.5	1.3	0.8	2.9	0.9	1.7
	No International Asset (38 companies)	2.5	2.1	0.5	8.9	1.4	3.0
LIQUIDITY	International Asset (11 companies)	1169	787	22	3594	549	1377
	No International Asset (38 companies)	334	75	11	4217	36	200
CREDIT RATING	International Asset (11 companies)	0.9	1	0	1	1	1
	No International Asset (38 companies)	0.2	0	0	1	0	0

CHAPTER 5 - QUANTITATIVE ANALYSIS

5.1 Univariate Analysis

Table 7 contains results of six pooled OLS regressions with the fraction of production hedged as a dependent variable and with a different single independent variable in each model. Coefficient and standard error figures show that for three of the independent variables, the size indicator, the credit rating and financial leverage, the direction of the relationship with the dependent variable is in line with my hypotheses. For two independent variables the direction is the opposite of what was assumed earlier, these are the international asset and the forward curve variables. The liquidity variable seems to show no quantifiable relationship with the fraction of production hedged by companies. The international asset variable is significant at the 1 percent confidence level with an R squared value above 0.1. The credit rating and the financial leverage variables are significant at the 5 percent confidence level and have R squared values around 0.05. Based on the results shown in Table 7 no significant statistical conclusion can be reached for the Size, Liquidity and Forward Curve variables.

Although I assumed in my hypotheses earlier that geographical diversity shows a positive relationship with commodity hedging, the international asset variable has a negative coefficient value. As we could see earlier, companies in the sample that own international assets are on average operationally and financially more stable compared to firms whose production is limited to North America. Therefore the negative coefficient of the international asset variable most probably supports the intuition that operationally and financially more stable companies hedge a smaller fraction of their production compared to less healthy firms. This way, the negative relationship between the international asset variable and the fraction of production hedged is in

line with the four hypotheses that company size shows a positive, credit rating a negative, leverage a positive and liquidity a negative relationship with commodity hedging.

TABLE 7

Results of Univariate Pooled OLS Regression Models

	SIZE	CREDIT RATING	INTERNATIONAL ASSET	LEVERAGE	LIQUIDITY	FWD CURVE
Fraction Hedged	-0.073	-0.169**	-0.297***	0.197**	0.000	-0.013
Std. Error	0.049	0.074	0.059	0.083	0.000	0.019
R squared	0.016	0.051	0.122	0.049	0.005	0.000

***,** and * indicate significant at the 1 percent, 5 percent and 10 percent levels respectively

5.2 Multivariate Analysis

In Table 8 I disclose the results of three pooled OLS regression models with more independent variables. The results further support that company size, company liquidity and the shape of the crude oil forward curve are not in significant relationships with the fraction of production hedged in this sample. In Model 1 the credit rating and the financial leverage variables show the same direction of relationship as well as similar levels of significance and coefficient values than in the univariate regression models earlier. When adding the size variable in Model 8, it clearly distorts the credit rating variable's significance but does not affect the significance and the coefficient value of the leverage variable. This is in line with correlation coefficients seen earlier in Table 4. It is also important to note that compared to the results of the regressions in Table 7, the size variable's direction has turned, indicating an opposite relationship than assumed in the hypotheses. This also suggests a distorting impact of the strong positive correlation between the size and the credit rating variables. Compared to Model 1, the explanatory power of Model 2 is unchanged.

Adding the international asset variable in Model 3 further distorts the credit rating variable's significance and nearly completely eliminates its coefficient value. The financial leverage variable's significance level and coefficient value is also impacted. The international asset variable is strongly significant in Model 3 and its coefficient's magnitude is the same as in the univariate regression. Compared to Model 1 and Model 2 the explanatory power of Model 3 is clearly higher.

TABLE 8

Results of Multivariate Pooled OLS Regression Models

	Model 1			Model 2			Model 3		
	Coefficient	Std. Error	R squared	Coefficient	Std. Error	R squared	Coefficient	Std. Error	R squared
CONSTANT	0.439***	0.052		0.299	0.201		0.191	0.171	
CREDIT RATING	-0.140**	0.069		-0.186*	0.109		-0.064	0.109	
LEVERAGE	0.163**	0.081		0.163**	0.081		0.137*	0.078	
LIQUIDITY	-0.000	0.000		-0.000	0.000		-0.000	0.000	
FWD CURVE	0.002	0.022		0.007	0.022		0.012	0.022	
SIZE				0.049	0.070		0.093	0.059	
INTERNATIONAL ASSET							-0.298***	0.080	
			0.086			0.089			0.158

***;** and * indicate significant at the 1 percent, 5 percent and 10 percent levels respectively

Results suggest that within the sample companies that are among the operationally and financially most stable ones tend to hedge a significantly smaller fraction of their production than those firms that are less healthy in this aspect. This is most clearly shown by the coefficient value of the international asset variable, but also supported by the credit rating's coefficient value in Model 2 and Model 3. Earlier we could see that the international asset binary variable divides the

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sample into two subsamples and the group characterized by the ownership of international assets contains the majority of the most stable firms. Model 3 suggests that these companies tend to hedge on average nearly 30 percentage points less of their production than firms without international assets and which are less operationally and financially stable. The lower significance and coefficient value of the credit rating variable compared to the international asset variable is most likely the result of the investment grade subsample containing around 50 more firm years than the international asset subsample and therefore dividing the entire sample less sharply.

From the variables that are factors of company operational and financial stability only the leverage variable shows significant relationship with commodity hedging in the regression models. Both the size and the liquidity variables are insignificant and their coefficient values are small or even zero in magnitude. This suggests that the relationship between firm stability and commodity hedging within the sample is only strong enough to be captured by binary variables and cannot be captured by continuous variables.

In Table 9 we can see the results of adding yearly dummies to the pooled OLS regression models seen earlier in Table 7 (the reference year is 2014). Coefficient values and significance levels for the company-specific variables and the forward curve variable are nearly unchanged compared to Models in Table 8. Therefore the relationship between firm stability and commodity hedging seems to persist over time from 2005 to 2014 and does not tend to be subject to one-time yearly effects.

In my database I could not find any unambiguous explanations for the strong significance of Year 2013 in models 4 to 6. Based on my in-depth interview with the previously mentioned

Morgan Stanley credit professional the high average volumes of hedging in 2013 are most probably related to the market structure of hydrocarbon prices in that particular year – the values of spot and future crude oil prices and the difference between them determining the transaction costs of entering into derivative hedging contracts.

TABLE 9

Results of Multivariate Pooled OLS Regression Models with Year Dummies

	Model 4			Model 5			Model 6		
	Coefficient	Std. Error	R squared	Coefficient	Std. Error	R squared	Coefficient	Std. Error	R squared
CONSTANT	0.348***	0.061		0.178	0.221		0.063	0.197	
CREDIT RATING	-0.136**	0.068		-0.191*	0.110		-0.070	0.110	
LEVERAGE	0.178**	0.087		0.181**	0.086		0.155*	0.084	
LIQUIDITY	-0.000	0.000		-0.000	0.000		-0.000	0.000	
FWD CURVE	0.045	0.036		0.048	0.036		0.050	0.036	
SIZE				0.059	0.073		0.104	0.063	
INTERNATIONAL ASSET							-0.299***	0.081	
YR2005	0.103	0.063		0.116*	0.068		0.122*	0.068	
YR2006	0.066	0.057		0.075	0.061		0.082	0.062	
YR2007	0.095	0.068		0.102	0.071		0.109	0.071	
YR2008	0.024	0.047		0.033	0.050		0.042	0.049	
YR2009	0.042	0.037		0.046	0.038		0.055	0.037	
YR2010	0.052	0.034		0.051	0.034		0.053	0.034	
YR2011	0.031	0.038		0.030	0.040		0.028	0.038	
YR2012	0.027	0.041		0.032	0.043		0.037	0.042	
YR2013	0.163***	0.023		0.163***	0.024		0.159***	0.023	
			0.101			0.106			0.175

***;** and * indicate significant at the 1 percent, 5 percent and 10 percent levels respectively

To check the robustness of the results so far shown by the regression models I divide the sample into two subsamples along the credit rating variable into the investment grade and non-

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investment grade categories. Within the two subsamples I consider only the companies that are in the same category for all the ten years. By this, the investment grade subsample consists of 15 firms and the non-investment grade subsample consists of 30 corporations.

Results in Table 10 show that for the investment grade subsample the relationships shown earlier are considerably stable. The leverage variable has the same level of significance and the coefficient value is similar as earlier. The international asset variable's decreased significance is most probably the result of much smaller sample size, since within the investment grade subsample ten companies own international assets and there are only five that don't.

In the non-investment grade subsample none of the earlier shown relationships are present. The international asset variable was not included in the regression, as only one company in the subsample has international assets between 2005 and 2014. The leverage variable's significance disappears and its coefficient value also decreases. The only significant relationship is shown by the size variable, however it shows the opposite direction than previously assumed in the hypotheses, suggesting that larger companies in the subsample tend to hedge larger fraction of their production than smaller firms.

TABLE 10

Results of Multivariate Pooled OLS Regression Models on Subsamples Designed along Companies' Credit Rating

	Investment Grade			Non-Investment Grade		
	Coefficient	Std. Error	R squared	Coefficient	Std. Error	R squared
CONSTANT	0.671	0.516		-0.036	0.213	
LEVERAGE	0.215**	0.092		0.127	0.075	
LIQUIDITY	-0.000	0.000		-0.000	0.000	
FWD CURVE	0.006	0.025		0.028	0.034	
SIZE	-0.077	0.124		0.170**	0.075	
INTERNATIONAL ASSET	-0.176*	0.097				
			0.246			0.058

***;** and * indicate significant at the 1 percent, 5 percent and 10 percent levels respectively

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CHAPTER 6 – CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Conclusions

In my thesis I investigated the patterns of commodity hedging behavior of North American independent oil and gas producers between 2005 and 2014. My database consisted of 49 companies from this sector. Based on the academic literature's previous findings and my in-depth interview with a Morgan Stanley credit professional I hypothesized that the fraction of annual production hedged shows a positive relationship with financial leverage and geographic diversity and that hedging is in a negative relationship with company size, access to external financing and liquidity. I also assumed that firms hedge a larger fraction of their production when the crude oil forward curve is contango-shaped compared to years when the curve is in backwardation.

Results show that the operationally and financially most stable companies in the sample tend to hedge a smaller fraction of their production than the less stable firms. Within this sample stability means larger size regarding market valuation and reserves portfolio, lower financial leverage and better liquidity position. The relationship is shown by three variables, namely the international asset, the credit rating and the financial leverage factors. The relationship seems to be stable over time within the sample as including time fixed effects did not impact neither the coefficient values nor the significance level of the variables.

However there are results which suggest that the identified relationship is rather weak. Firstly, two continuous variables, the size index and the financial liquidity are both unable to capture this relationship even in the univariate models. Moreover, when dividing the sample into

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two subsamples along the companies' credit rating, this relationship cannot be identified among the non-investment grade firms.

Potential reasons behind the weak results may be the following:

(1) Earlier summarized literature already finds mixed results on commodity hedging. As more papers reveal, executives' motivations on hedging are heterogenous as they weigh the potential benefits and losses differently. Therefore actual decisions on hedging do not necessarily follow the patterns described by hypotheses usually listed by academic studies and also include factors not easily described by available data.

(2) The construction of the sample for this thesis was constrained by data availability issues. In North American countries audited and trusted data is available for publically listed companies which limited the scope of companies to consider in database design. Omitting privately held firms from the sample decreased the sample size as well as variance within the sample.

Findings of this thesis are mostly in line with previous results of academic studies. As seen earlier, papers show that financial leverage is in a positive relationship (Guay & Kothari, 2003) and access to external financing captured by the companies' credit ratings is in a negative relationship (Haushalter, 2000; Géczy, Minton & Schrand, 1997) with commodity production hedging. Studies also include conclusions that operationally and financially more stable firms hedge a smaller fraction of their production than their less healthy competitors (Bartram, Brown & Conrad, 2011; Mian, 1996). However my analysis fails to identify any relationship between commodity hedging and company characteristics like liquidity or size. These issues could be addressed in a more widespread study by a larger database also including privately held, very small oil and gas producers.

In the future my research could be extended by adding privately held companies to the database. This could be most easily carried out by collecting data through questionnaires directly sent out to firm managements. By including private companies not only the sample size would improve considerably but variance regarding firm size could be increased as well. Moreover, access to external financing could not only be proxied by the categories of investment grade and non-investment grade but also a division could be made between a company being rated by the large credit rating agencies or not. An interesting aggravation of the scope of investigated firm characteristics could be including a proxy for investment and capital spending opportunities faced by corporations.

6.2 Policy Implications

Since commodity derivative contracts are agreements between two business entities, they have limited policy relations. However it is worth considering that one of the contracting partners is usually a financial institution, in North America often one of the largest investment banks, including JP Morgan, Morgan Stanley or Goldman Sachs. These firms have been under increased regulatory supervision since the recent financial crisis, which has resulted in huge fines for questionable past business practices and also much stricter capital and operational requirements.

As a result, financial institutions have severely decreased the scope of their commodity trading businesses, both for reasons of falling profitability and also because of regulatory actions tightening investment banks' risk taking opportunities. (Arnold, 2015) While keeping major investment banks' risk appetite between barriers may be beneficial for the economy, it is important to note that commodity hedging agreements include two parties. Although derivative

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contracts may create risks at one side of the agreement, in this case for the buying financial institutions, at the same time they significantly cut down on the probability of default for the commodity producing firms. Moreover, as results of previous academic studies and this thesis show it is especially the smaller and less stable producers who turn to derivative contracts as risk management tools.

It is important to note, that financial institutions are not the only type of entities that can enter on the buying side into commodity hedging contracts. Major hydrocarbon producing companies, like Exxon, BP or Chevron are continuously expanding their commodity trading businesses and stealing smaller oil and gas firms as clients from investment banks. However these corporations cannot yet entirely take the place of Wall Street in commodity hedging and banks are still needed as counterparties of commodity producing firms in derivative contracts. (Leff, 2013)

What this implies is the following: regulatory actions in the U.S. that aim to directly decrease risk levels in the financial services industry may indirectly create a shortage of available risk management tools for the less stable commodity producing companies. This can either be a result of restricting investment banks from pursuing particular business activities or increasing their capital requirements that leads to the closure of the least profitable business lines. (Sharma, 2014; Sanderson, 2015) Therefore regulators aiming to control risk appetite of Wall Street need to take into account indirect effects on related industries as well and try to avoid tightening the available risk management toolkit for commodity producing companies.

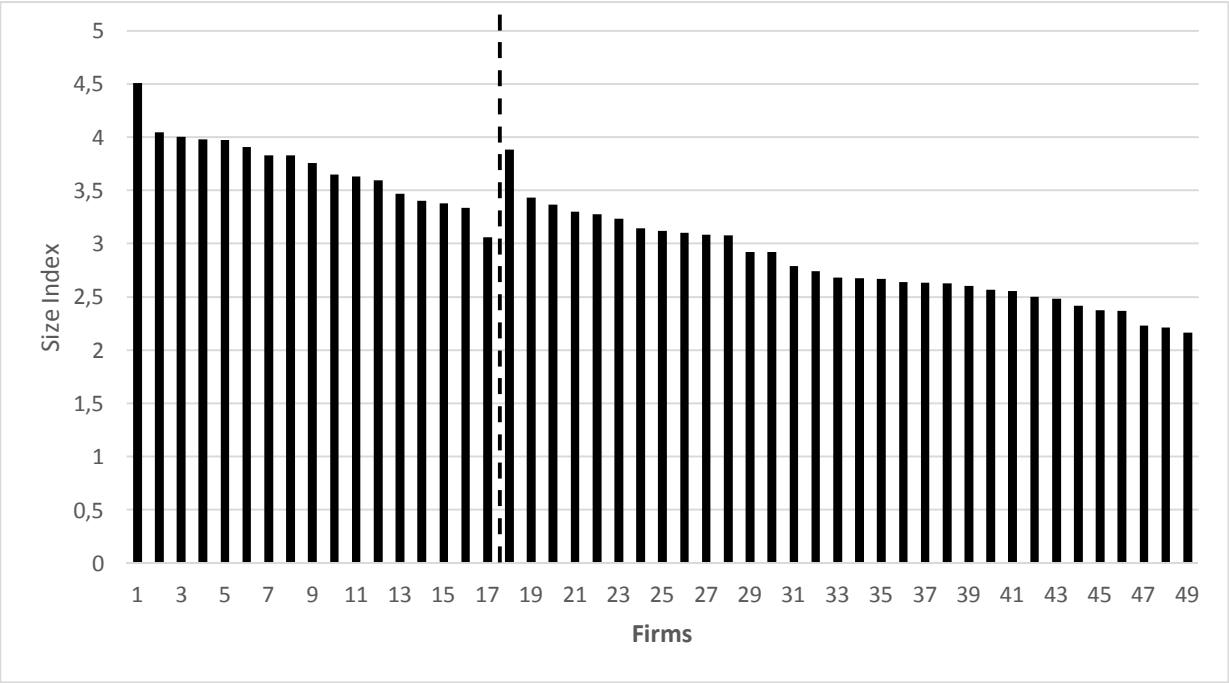

Figure 1. Distribution of the Size variable along Credit Rating categories - dotted line indicates the division between Investment Grade (on the left) and Non-Investment Grade (on the right) companies

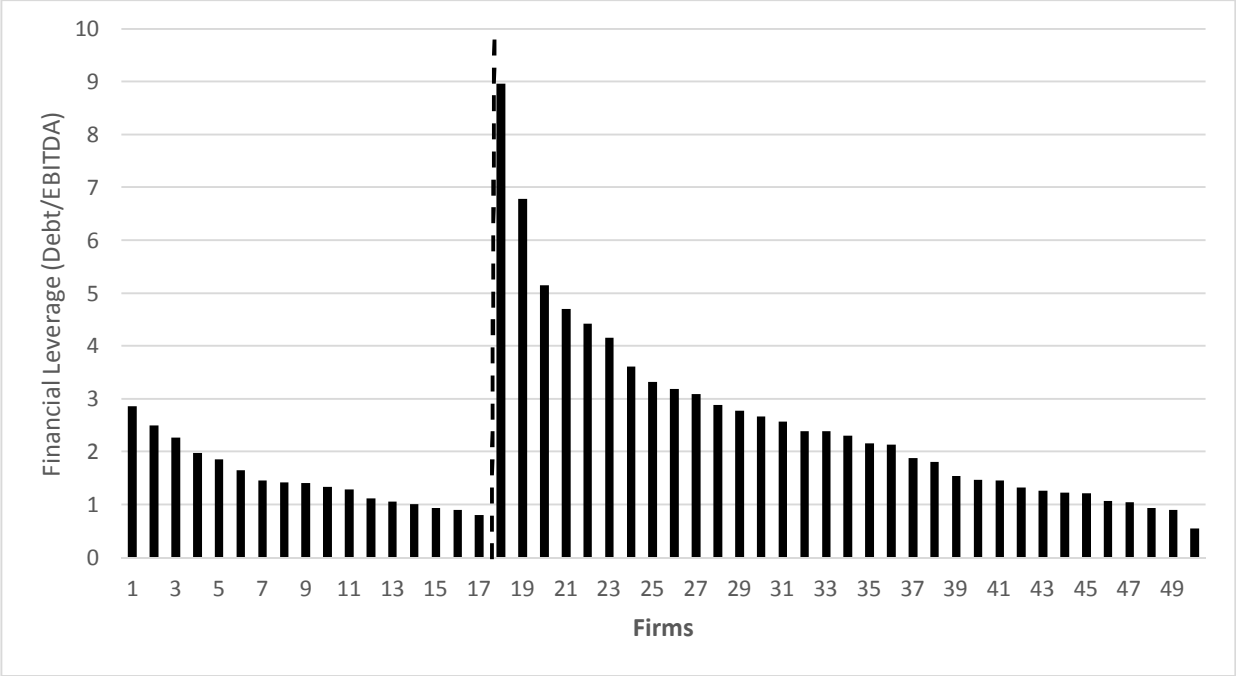

Figure 2. Distribution of the Leverage variable along Credit Rating categories - dotted line indicates the division between Investment Grade (on the left) and Non-Investment Grade (on the right) companies

APPENDIX

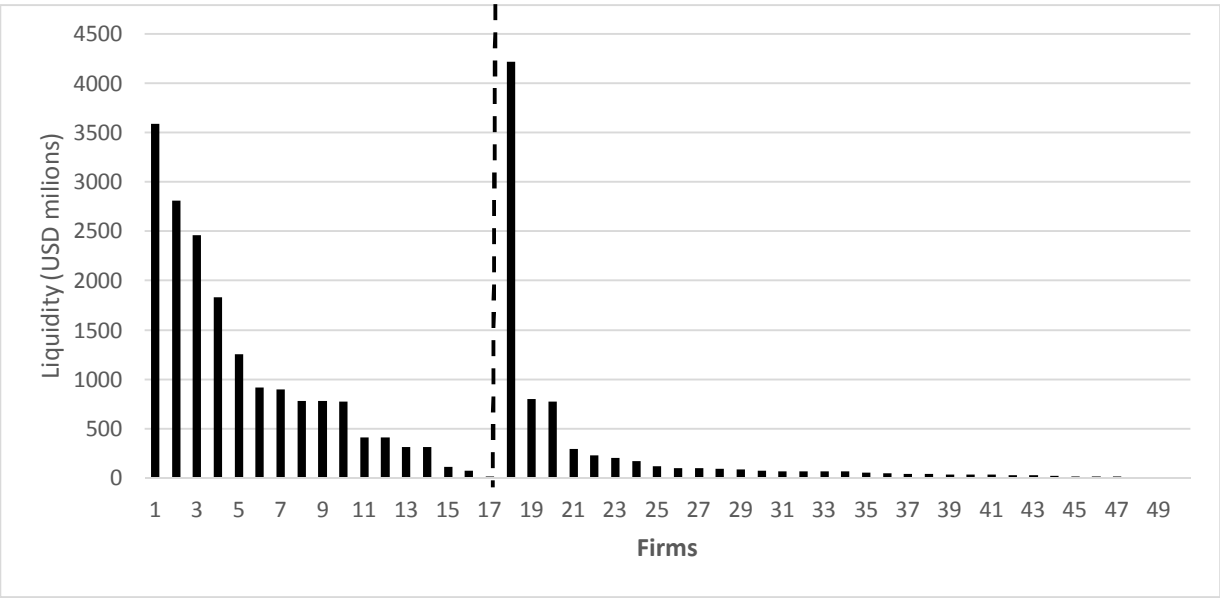

Figure 3. Distribution of the Liquidity variable along Credit Rating categories - dotted line indicates the division between Investment Grade (on the left) and Non-Investment Grade (on the right) companies

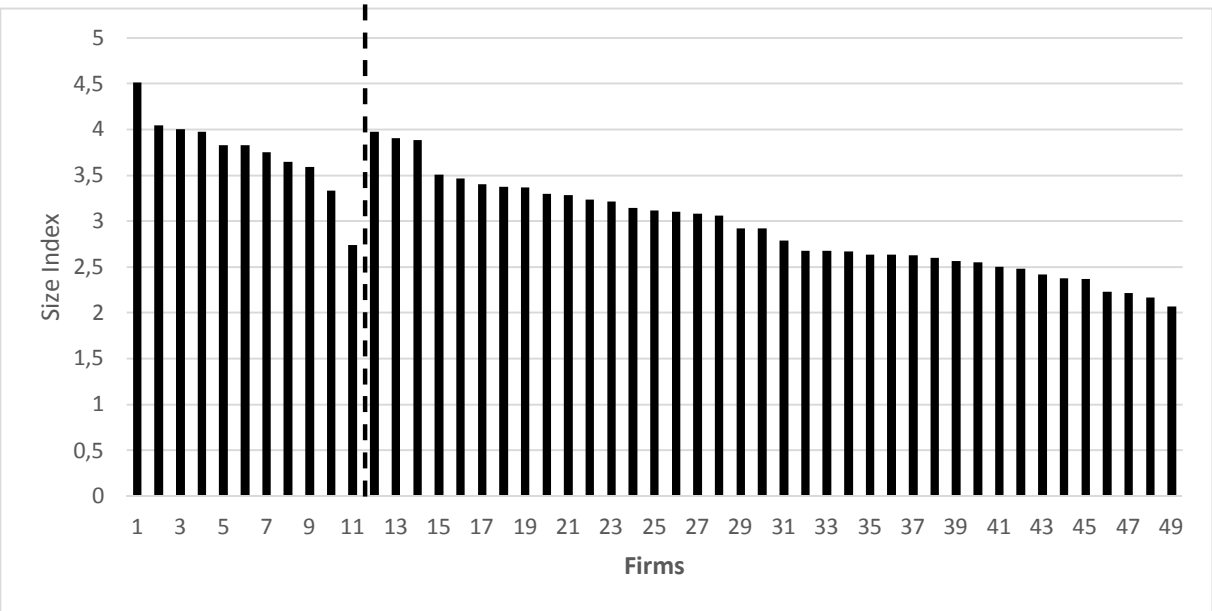

Figure 4. Distribution of the Size variable along International Asset categories - dotted line indicates the division between firms with international assets (on the left) and firms that do not have international assets (on the right)

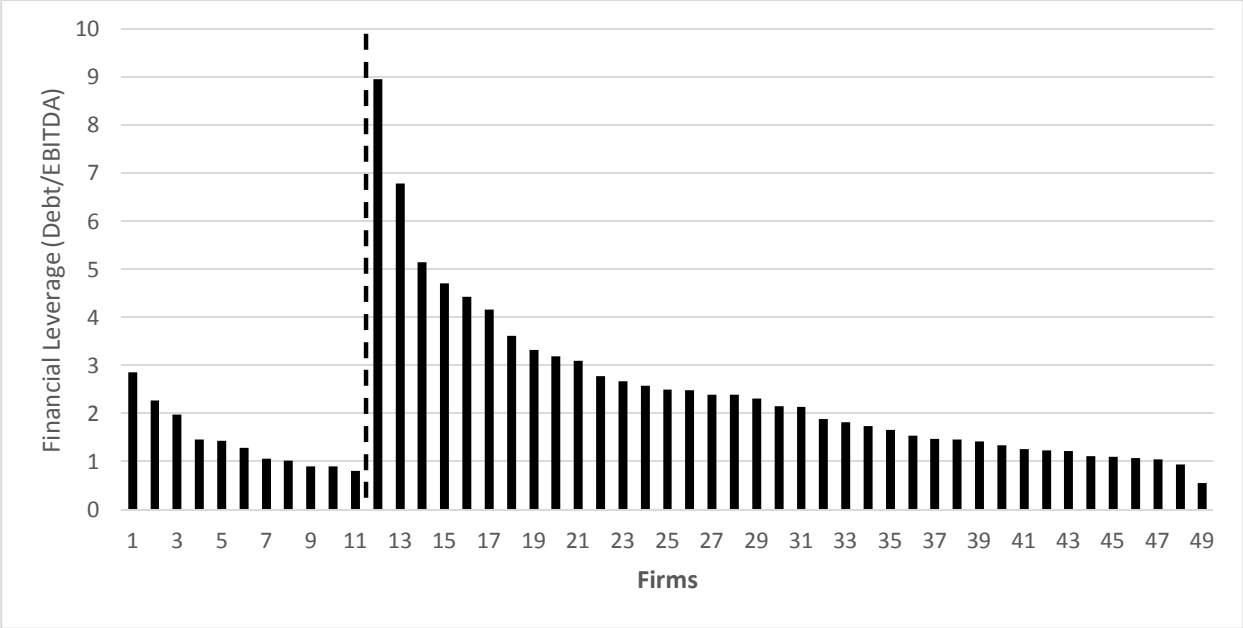

Figure 5. Distribution of the Leverage variable along International Asset categories - dotted line indicates the division between firms with international assets (on the left) and firms that do not have international assets (on the right)

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