What is a relation between hedging and risk of financial distress?

Master Thesis

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Abstract

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Key words: corporate risk management, hedging, speculation, selective hedging, financial distress, oil price shock.

Purpose: To investigate if there is a positive relation between companies' risk of financial distress and the extent to which they hedge under the period of abnormal oil price growth and profit maximization for US based oil and gas companies for the period of time between 2000 and 2008. I also intend to verify their hedging motives of using derivatives

Method: OLS and LSDV multiple regressions will be applied to test the significance of dependence of companies´ hedge ratios on accounted-based Z-Score indicator of bankruptcy.

Theoretical framework: refers to the previous research on financial distress relation to hedging, where Smith and Stulz, 1985; Nance et al, 1993; and Adam, 2006 proved the positive relation between companies´ hedging and probability of financial distress, stating that companies hedge in order to maximize their value by reducing risk of financial distress.

Conclusions: For the sample of companies studied in this thesis the relationship between financial distress and hedging is negative. The considerable evidence of speculation and selective hedging in the chosen sample is found, while hedging motive of using derivatives is rejected. Firms´ leverage, growth opportunities and liquidity determine extent of using derivatives in the studied sample which is in accordance with previous research.

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1. Introduction

In this chapter the reader will be introduced to hedging as one of the aspects of risk management and functions of financial derivatives, as well as its relationship to the companies' probability and vulnerability of financial distress. Furthermore, the problem specification, the purpose of this thesis and hypothesis of inquiry will be presented.

1.1.   Background

The current financial downturn caused by Eurozone crises and other distresses in the global economy during the last decade keep adding pressure on companies and industries of different size and appearance. As an extensive tool against risk exposures, companies around the globe use financial derivatives, which have become increasingly important component of financial market in the last few decades. According to BIS, Bank for International Settlements, the world's oldest international financial organization, amount of the outstanding OTC derivatives notional was equal to $693 trillion at the end of June 2013. This number exceeds the world's gross domestic product that was equal to $75 trillion the same year. The representative figure below demonstrates the development of OTC market over the last decade (BIS, 2013).

Figure 1.1: Global OTC derivatives market.

Triennial and semiannual surveys, notional amounts outstanding, in trillions of US dollars
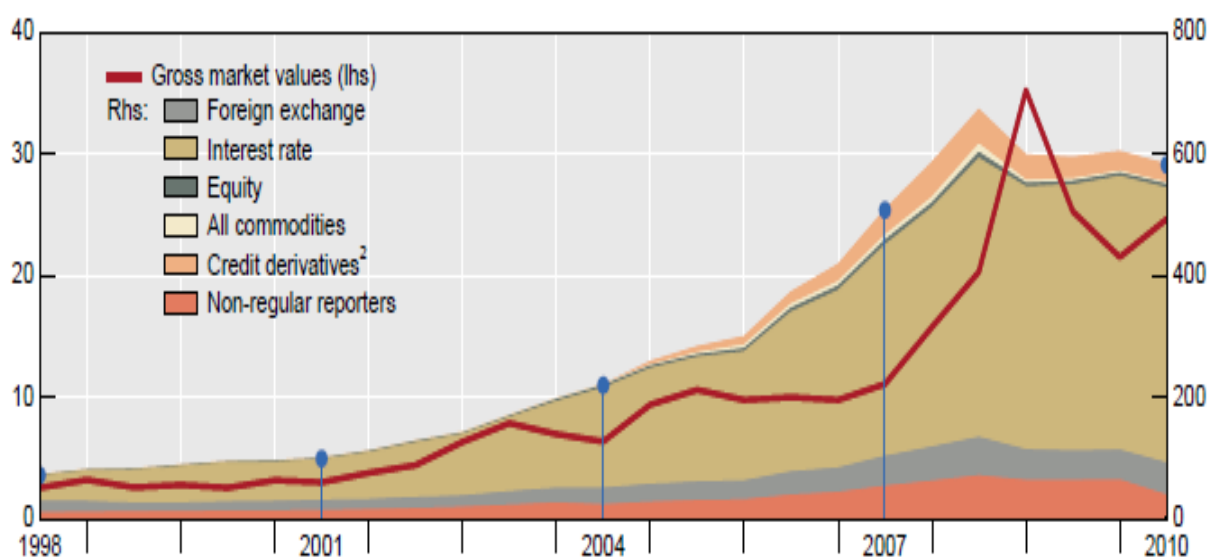
The notional amount represents a proxy for the value of the underlying against which claims are traded in the derivatives markets (Stulz, 2004). Derivatives are financial instruments, whose expected payoffs are derived from the values of other underlying variables, in particular commodities, foreign currencies, equity and debt securities (Hull et al, 2010). Some market players use derivatives to protect themselves against macroeconomic hazards that might undergo their commercial activity in terms of interest rate, inflation, currency rate and variability of commodity prices (Andersen, 2006). Others – use them to speculate on price movements of the underlying assets, having prior intention to make a profit (Gèczy et al, 2007). Hedging is an extensive field of financial derivatives and assumes reduction of exposure to losses that appear in trading and investment activities (Bodie et al, 2000).

Being generally excepted risk management strategy, hedging often hides speculative motives behind it, which affects companies` risk exposure and makes this area of corporate finance attractive to study due to its ambiguous motives and unpredictable outcomes (Stulz, 2004). Moreover hedging is characterized by limited research due to the confidentiality of risk management application and since derivative positions have been off-balance sheet items until recent issuance of FAS 133 regulation (Fang and Lin, 2007; Tufano, 1996). Consequently, corporate behavior on derivative usage is not well understood, giving rise to extensive research on its different strategies and creating subject for this thesis. Hedging as one of the functions of financial derivatives is generally studied on gold mining industry (Tufano, 1996; Fang and Lin, 2007; Adam, 2012) or oil and gas industry, due to the considerable exposure to a hedgeable risk factor, i.e. the gold or oil price, clear variation in hedge ratios and detailed disclosure of hedging activities (Croci and Jankensgård, 2014). Research of this thesis will cover hedging strategies in oil and gas companies.

By using derivatives in the purpose of hedging, companies can maximize their value and reduce risk of financial distress (Stulz and Smith, 1985; Fang and Lin, 2007; Adam, 2012). According to Stulz (1996) and Campbell et al. (1999), financially distressed firms have more incentives to hedge than financially secure firms. Empirical evidence has been contradictory though and question about the relationship between companies' risk of financial distress and level of their hedging activity is still open (Nance, 1993; Tufano, 1996; Mian, 1996).

To test any relationship it is appropriate to place it under the abnormal conditions in order to disclosure hidden effects. The relation between hedging and probability of financial distress has not yet been tested for the oil and gas companies under abnormal market conditions of oil

price shock, which gives rise for foundation of this thesis. Hedging activity of oil and gas companies chosen to be studied in this thesis will be investigated under the time period between 2000 and 2008, which is characterized by extraordinary oil price increase. Tremendous increase of oil price between 2006 and 2008 has exceeded the price rate of the last hundred years, impacting companies` cash flows significantly and thus affecting the risk management view. In 2008 aggregate cash holdings in the oil and gas industry have exceeded with 400% the level they had in the beginning of 2000 (Jankensgård et al., 2013). This gives us a motive and occasion to study the companies' risk management strategy under the unique market circumstances, namely when most of the oil and gas companies have experienced significant growth.

Stulz (1996) argues that hedging increases the value of the firm through reducing cash flow fluctuations and probability of financial distress, as well as the expected costs of bankruptcy. Since cash flow volatility is mainly determined by the cost of financial distress and dividend payments (Fang, Lin), hedging of financial derivatives neutralizes cash flow fluctuation in the company and thus eliminates risk of bankruptcy and financial distress. Consequently, the rise in welfare of oil and gas companies between 2000 and 2008 must result in the low probability of financial distress at these companies and, hence, provide a low incentive to hedge against risks. The figure below represents the development of West Texas Intermediate, a grade of crude oil used as a benchmark in oil pricing, reflecting the dramatic swings over the period (Federal Reserve Bank of St. Louis, 2014), and allowing us to investigate how amount of hedge in oil and gas companies was correlated with oil price development trend.

Figure 1.2: Oil price development between 2000 and 2008
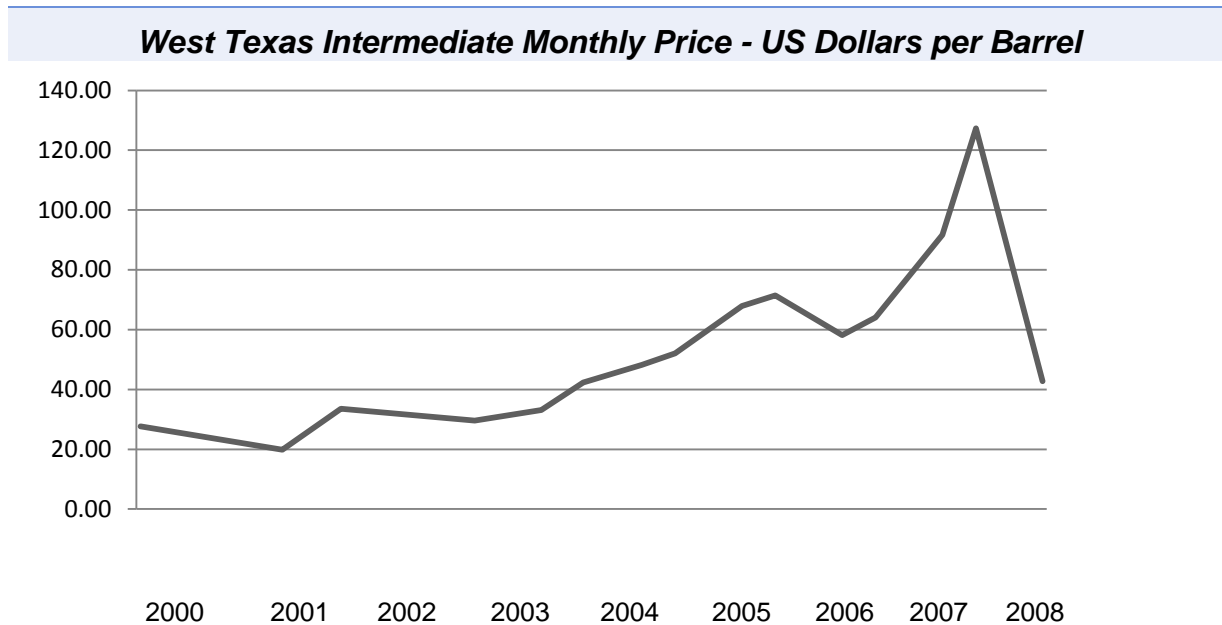
1.2. Problem specification

The roll of financial derivatives has not yet been fully understood: on the one hand we can see constantly growing derivative market and extensive use of financial instruments, on the other hand we can read headlines about scandal losses they have caused (Stulz, 1996). Hedging, as a function of financial derivatives, is a technique that is supposed to neutralize risk exposure and reduce risk of losses, that's why often is used by financially distressed firms in order to increase their value and reduce risk of bankruptcy. Nevertheless, other functions of financial derivatives have been incorporated into companies' hedging programs, prejudicing its' motives and effects, when risk eliminating intentions are being diluted by profit-maximizing motives, turning risk management program into speculation activity with totally different risks levels, when companies instead of reducing risks are bearing extra risks in anticipation of profit (Ghosh, 2003). Selective hedging is another type of financial derivatives' application and is not either so riskless as hedging, due to its inconsistency (Adam, 2006; Stulz, 1996).

Hedging is often mixed up with speculation and selective hedging which can give unpredictable results due to additional risks that companies take. Whether financial derivatives reduce risk or enhance it depends on the nature of the motive of its application (Hirshleifer 1975). Extend of using derivatives is often associated with companies` risk of

financial distress, for instance Dolde (1996) and Love et al. (1997) have found that high leveraged firms, and, thus firms with high probability of default, are more likely to hedge. Adam et al. (2012) have shown a positive relation between companies probability of bankruptcy and how much do they speculate. Campbell et al. (1999) have explained that financially distressed firms have more incentives to speculate than financially secure firms, while Mian (1996) and Nance et al. (1993) have not found any correlation. Stulz (1996) highlighted that in order to be engaged in selective hedging companies need to have a certain level of financial strength and evidenced that financially distressed firms do not hedge. The results about how does the degree of financial distress effect companies hedging activity are therefore contradictive.

The true motivation and understanding of derivatives usage, if it is of speculative, hedging or selective nature, is crucial for the companies, banks and financial institutions, in order to be aware of risks that companies in question undergo and to avoid exposure.

The relationship between the degree of financial distress and the motives of using derivatives lacks evidence and therefore will be tested in this thesis. The time scope is chosen to cover the period of oil price shock, since the abnormal market conditions tend to emphasize the theory or disprove it more obviously. The relationship will be viewed between 2000 and 2008, covering both the period of significant oil price growth between 2006 and 2008 and also period before that, when prices were on the same level or slowly increasing. I believe that these contrasts in oil price development will have a great impact on the companies' financial distress risk and consequently on their hedging strategies during the abovementioned period. Other motives of using derivatives will be under consideration depending on the interpretation of outcome results. The relationship between bankruptcy risk and hedging or other derivatives motives has not been tested before under the special market circumstances.

1.3. Hypothesis and purpose

Based on the conclusions from the underlying theoretical framework, the hypothesis of this master thesis can be formulated in the following way: there is a positive correlation between a company's financial distress risk and the degree of hedging. The purpose of the current thesis is therefore to test this hypothesis using the sample of the 47 US oil and gas firms under the period of tremendous oil price growth and profit maximization for these companies between 2000 and 2008. This gives us the possibility to identify the relationship between hedging and

firms' bankruptcy risk under extraordinary market circumstances, namely to observe different levels of financial distress risk before and during the oil price shock, allowing to detect the motives of derivatives usage and how they change with oil price development under the abnormal market conditions.

1.4. Limitations

The primary limitation of the current study is related to restricted data source in the area of financial derivatives. Since derivative instruments have been allowed to be off-balance sheet item until issuance of FAS 133, Accounting for Derivative Instruments and Hedging Activities, in 1998, and due to the complicated accounting of derivatives afterwards, research on corporate hedging activities is limited (Tufano, 1996; Fang, Lin; 2007). Most of the empirical analyses in this area have been performed relying on the surveys and rather indirect data, creating constraints for efficient and more precise research. The original sample of the companies studied in this thesis consisted of 74 oil and gas companies, but only 53 of them had available information on linear and non-linear derivative positions and only 47 of 53 companies had appropriate information on oil, gas and natural liquid gas production needed for the calculation of independent variable figures. The limited data sample might cause nonnormality of the error terms distribution which can harm the interpretation of the results of this thesis.

1.5. Outline of the paper

Chapter two gives a review on the contradictory results from using financial derivatives and problems connected to the ambiguous motives of their application. Chapter three presents the theoretical framework with the previous research in the field and method specification, including model choice and data collection. Chapter four describes the empirical part where the analyses of regressions are interpreted, while fifth part summarizes the results and conclusions.

2. Should we fear for derivatives?

In this chapter I would like to make an insight on the different motives for using financial derivatives and demonstrate contradictive outcomes that it might result in. True motives for hedging are difficult to identify, because hedging, speculation, and selective hedging can simultaneously be incorporated in risk management programs of the companies.

Researches in the field of risk management and companies` stakeholders are concerned about different outcomes that usage of financial derivatives might result in. The title of this chapter is borrowed from Stulz` article (2004) and it is a very relevant question to ask when dealing with derivative instruments. As Nance (1993) summarizes, the main incentive for a company to hedge is to maximize its value by decreasing tax payments and expected cost of financial distress, as well as reducing agency costs. Stulz (1996) argues that by using derivatives a firm tends to increase its value through reducing cash flow fluctuations. Since cash flow volatility is mainly determined by the cost of financial distress and high dividend payments, using hedging of financial derivatives neutralizes cash flow fluctuation in the company and thus eliminates risk of bankruptcy and financial distress. Despite proven benefits that companies are to receive from hedging its risks, usage of derivatives is ambiguous and can cause serious losses (Stulz, 2004).

Practical examples illustrate that hedging is carrying economic danger and the series of scandalous collapses that accompanies the history of derivatives proof exactly this. For example, the dramatic fall in earnings of the largest Canadian pipeline company Enbridge Inc. has reported a net loss of 300% in the first quarter of 2014 compared to the previous year's profit predominantly due to losses on hedging contracts. Being involved in a long-term hedging program, Enbridge aimed to limit exposure to interest rate volatility and foreign exchange rate, as well as to secure the price on energy commodities by long future and option contracts, whose fair value dropped significantly when prices on underlying fell, resulting in 337$ million losses on unrealized derivatives. [1]

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[1] Thomson Reuters, 2014, http://business.financialpost.com/2014/02/14/enbridges-adjusted-profit-misses-estimate-due-to-hedging-losses/?__lsa=a9f7-0f0

A series of hedging activities put a German conglomerate Metallgesellschaft to nearly collapse in 1993. Futures and swaps positions have been taken to hedge price exposure on forward supply contracts that assumed delivery of gasoline, diesel and heating oil over a period of ten years at fixed prices. When energy prices fell globally with 26%, the company ended up with unrealized losses on derivative positions, which were stretched out by the contango agreement during the whole next year, resulting in 1,3$ billion derivative-related loss (Edwards, 1995).

Historically there are number of other cases when companies found themselves on the wrong side of the hedging positions. The collapse of Barings Bank in 1995, the oldest financial institute in Britain with the royal family among clients, occurred due to the significantly high positions established on Nikkei futures contracts, which crashed down after a gigantic earthquake in Kobe.[2] Procter & Gamble hedged its debt risks from swings in interest rates and currency rates but lost $102 million on leveraged swaps, when American and German interest rates fell significantly in 1994. [3]

Long-Term Capital Management hedge funds' strategy was to make convergence trade through mispricing in securities. By taking long position in the cheap equity and interest rate derivatives and short position in the expensive ones, LTCM managed to expand its frontiers due to dealing with highly correlated offset positions. Despite the up-and-running mechanism that brought LTCM multiple profits, unforeseen interest rate drop due to the East Asian financial crisis in 1997 and Russian government defaulted on its Treasury bonds in 1998, exposed the fund's highly leveraged investments and resulted in nearly collapse of the fund (Dolde, 1996).

The list could be enumerated infinitely, which encourages to the fair question of whether usage of financial derivatives is that risk reductive or not. Does it indeed create value for companies? The contradictory evidence of the impact of derivatives motivates to investigate its true applicability and consequences they can have for the corporations. Whether financial derivatives reduce risk or enhance it depends on the nature of the motive to use them (Hirshleifer 1975).

Derivatives can cause different risk exposure depending on if they are being applied in order to hedge or to speculate (Hirshleifer 1975, Stultz 2004, Tufano 1996, Henstschel 2004).

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[2] Business Week, "The Lesson from Barings' Straits," March 13, 1995, 30.
[3] The NY Times, Procter&Gamble`s Tale of Derivatives Woe, April 1994

Choice of the strategy effects the risk management approach of the company and consequently impacts the company's value creation and possible risks it might undergo. Speculation is often incorporated into the risk management programs of the companies.

Some studies demonstrate that for instance interest rate swaps and floating-rate debts are used mostly in speculative purposes (Chernenko, Faulkender; 2011). According to Gèszy, Minton and Schrand (2007), 40% of the observed companies in their study regularly using interest rate and exchange rate derivatives, are defined as active or non-frequent speculators.

Nevertheless, this contradicts to the traditional financial theory, which suggests that benefits of using derivatives may only be gained in the presence of market imperfections such as taxes and bankruptcy costs, agency costs, financing constraints, undiversified stakeholders and managerial incentives, according to Smith and Stulz 1985; Froot, Scharfstein, and Stein 1993; Bessembinder 1991; Demarzo and Duffie 1995; Stulz 1984, 1990.

Ambiguous conclusions gave a rise to the incentive to study whether there is indeed a correlation between financial distress a company might face and amount of hedging it initiates, as well as if using of derivatives is of hedging nature or there are other motives, for instance, speculative gains.

3. Theoretical Framework

In this chapter, the theories and models, which are designed to analyze the relation between hedging and financial distress of the companies will be presented. Primarily, the definition of hedging and other concepts of financial derivatives will be described, in order to distinguish them in the context. Furthermore, theory of hedging and financial distress will be presented, as well as the data sampling process and selection of variables and regression model will be specified.

3.1. Theory

3.1.1. Functions of financial derivatives

To understand the linear relation between hedging and financial distress I would like to start with determination of the concept of hedging as one of the function of financial derivatives and highlight other overlapping concepts, namely speculation and selective hedging. Derivative instruments are widely used in order to hedge market risk exposures or to speculate on the price fluctuations of the underlying assets (C. Gèczy, 2007). Investigating the intention to hedge among companies and hedging influence on different firm characteristics, researches come across footprints of other than hedging activities that a company is engaged in. Hedging often overlaps speculation both empirically and in the corporate finance literature, when analyzing the risk management strategies, researches get astonished by ambiguity application of financial derivatives. For instance, analyzing significant cash flow gains obtained from derivative transactions of the sample of gold mining firms, Adam (2006) challenges the idea of managers' incentive to hedge could be based on value creation for shareholders by incorporating speculative elements into their hedging programs. Declaring that the major cash flow gains are steaming from the "persistent positive realized risk premia" due to the successful hedging strategy, Adam (2006) highlights the evidence of "excess volatility in the hedge ratios over the time", obviously indicating speculating activity (which though brings small gains to the companies in question). There are

plenty of other works distinguishing the nature of speculation, hedging, and selective hedging, such as: J. Hirshleifer (1975), L. Johnson (1960), G. Brown et al. (2006), Adam et al. (2012), etc. Determining whether usage of financial derivatives is of speculative or hedging character is crucial for the internal and external parties of the companies, banks and other financial institutions, as well as due to achieve compliance of financial regulatory policies.

3.1.1.1. Hedging

To hedge generally means that the derivative position is taken in order to reduce risk. The concept of hedging was presented in a modern way in the beginning of 20th century by John Keynes in *A Treatise on Money*, described as a "normal backwardation", a method of risk transfer, where hedgers were willing to pay a risk premium in order to relieve themselves from the price risk (L. Johnson, 1960).

Smith et al. (1992) confirms hedging as "a process of making an investment in one asset and taking an offsetting position in another asset to reduce the risk of loss". An essential feature of hedging activity is taking position in two markets: one market for the immediate delivery, namely "spot" or "cash" market, while the other is normally the future market (L. Johnson, 1960).

Let us assume, that a hedge activity covers timeline from time t_1 to time t_2, with delivery in future at time t_3. Assets of units x are purchased at time t_1 and sold at t_2. If S_1 and S_2 are spot prices and F_1 and F_2 are future prices at time t_1 and time t_2 respectively, the hedger will receive a gain or loss arising from the price fluctuations between time t_1 and t_2, equal to the value of

$$x[(S_2 - S_1) - (F_2 - F_1)]. \tag{3.1}$$

The position is perfectly hedged, when

$$[(S_2 - S_1) - (F_2 - F_1)] = 0. \tag{3.2}$$

3.1.1.2. Speculation

Speculation, on the other hand, is the "deliberate assumption of the risk in a strong anticipation of profit" (D. Ghosh, 2003). According to Keynes, speculators are willing to enter the future market only if they have the expectation to gain a positive premium, predominately they take long positions in futures (L. Johnson, 1960).

I. Moosa (2010) shows the simple concept of speculation of taking a derivative open position with the planned intention to make a profit or increase risk. Such a position can be created either in the forward or in the spot market.

Let us assume S_e to be the expected spot price on the asset x at time t_{1+1}, while the one-year forward rate on the underlying asset is F. The current spot price on the asset x at time t_{1+1} is S, while risk premia for bearing the risk is r.

If the speculator believes the expected spot price on the underlying asset in one month is going to be higher than the one-year forward rate on this asset, the long position should be taken on the asset in the forward market and therefore a profit of

$$x(Se - F - (1 + r)) \qquad (3.3)$$

is gained. If the assumption is opposite and a speculator believes that the expected spot price on the underlying asset at time t_{1+1} is lower than the one-year forward rate, the short position should be taken on the asset with expected profit of

$$x(F - Se - (1 + r)). \qquad (3.4)$$

3.1.1.3. Selective hedging

Practice of selective hedging as a part of corporate risk management activity was identified by Rene Stulz in 1996 and assumes inconsistent speculative investments within the context of companies' hedging programs, "by varying the size and the timing of the derivative transactions based on the managers' own market views" (T. Adam, 2012). Extensive application of selective hedging by variety of firms has been confirmed by Glaum (2002), Faulkender (2005), Adam and Fernando (2006), Brown et.al (2006), Gèczy et.al (2007),

Adam et al. (2012). Empirical evidence, that companies at least several times have allocated hedging activity based on their own expectations of future interest rates, exchange rates, and commodity prices, have been provided in abovementioned works (T. Adam et al, 2012).

According to Stulz (1996), selective hedging increases shareholders value and reduce probability of financial distress, in accordance with hedging. Nevertheless, it is consistent for the bigger firms, which have access to the superior market information; and firms that have low probability of financial distress and have a sufficient financial strength to take extra risk, which contradicts to the hedging determinants assumption (Stulz, 1996). Firms should not be overconfident though in their market views which might lead to needless risks (Shefrin, 2001), since selective hedging is already a subject to additional risk for companies, due to the fact that not all assets or market exposures are hedged by definition, but just a part of them and just under a limited time (Adam et al, 2012). Accordingly, selective hedging can be identified by measuring the volatility of the companies' hedge ratios over the certain period in time. Total hedge ratio is determined as the sum of portfolio's deltas of all of the firm's long non-linear and linear positions in units of underlying assets, divided by the total production over the same time period in units of the assets in question (T. Adam et al, 2006). Excess volatility in firm's hedge ratios over time indicates that managers incorporate their market expectations into the hedging programs (Bodnar et al, 1998; Adam et al, 2006).

According to Tufano (1996) the extent of derivatives usage can be measured as follows: let LP be non-linear derivative positions, identified in the firm, namely long put options in our case; and L be the linear derivative position, which consist mainly of forward instruments, futures, and swaps; the total firm's production over the year is P; the hedge ratio H for each firm i and time t_x and t_{x+1} will then be:

$$H_i \, t_x = \sum_{i=1}^{N} \frac{(LP+L)t_x}{P \, t_{x+1}}$$

(3.5)

According to Adam et al. (2006) selective hedging SH can be identified as excess volatility of firm's hedge rations over the time, i.e.:

$$SH_i = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(H_{itx} - \mu)^2} \qquad (3.6)$$

3.1.2. Review of derivatives and financial distress

Firms hedge in order to reduce the risk of financial distress and bankruptcy costs (Smith, Stulz, 1985). This approach of explaining the motive for managing financial risks is the starting point in my thesis. Financial distress is determined as a low earning state of the firm, which leads to a non-trivial probability of incapacity of paying its debt obligations (Gordon, 1971). Financial distress "incurs significant cash-flow losses for a firm without being insolvent" (A. Purnanandam, 2003). How can hedging activity affect the probability of facing financial distress for a firm? According to Stulz (1996) through maximizing a firm's value and eliminating the expected bankruptcy costs. Below there will be listed instruments that affect probability of financial distress, identified in the risk management theory, that arise incentive for hedging.

Following Modigliani & Miller's proposition (1983), that the value of a firm is unaffected by its capital structure in the perfect world of no taxes, bankruptcy costs, asymmetric information and agency costs, Stultz and Smith (1985) have responded that if the value of the firm could be affected by financing policy, it must be done in particular through these variables. Stulz (1996) argues that in the efficient market where asymmetric information does not take place, the value creation for a company could only exist due to the real resource enhancement, incurred by reduction in bankruptcy costs, tax payments, underinvestment costs and managerial risk aversion.

Bankruptcy costs

Stulz and Smith (1985) have shown that by hedging companies can save the bankruptcy costs. According to the corporate risk management theory, financial distress is costly and it is mainly evoked by the high volatility of firms earning. Companies that experience noticeable fluctuations of their cash flow are exposed to the higher direct and indirect costs of bankruptcy, as in Minton and Schrand (1999); Froot, Scharfstein, and Stein (1993); Stulz (1990). Direct costs of bankruptcy occur when a firm with high cash flow volatility faces a state when it cannot cover its debt obligations and files for bankruptcy, therefore the costs in terms of payments to lawyers and accountants, court fees, the value of the managerial time spent to administrate bankruptcy and other professional fees are unavoidable. While indirect costs of bankruptcy include lost revenues, wasted investment opportunities, lost customers and other market players, inability to obtain a reasonable credit and difficulty to raise funds.

(J. Warner, 1977). Stulz (1996) has shown that by hedging a firm could eliminate the chance of bankruptcy and consequently reduce the present value of the expected bankruptcy costs as well as to increase a firm's value.

Tax expenses

Stulz and Smith (1985) have also shown that hedging reduces probability of financial distress through reducing tax payments. Companies are exposed to the variability of the earnings generated by their assets due to the market fluctuations. Associated with unpredictability, variability can harm the investments and put under the risk the external financing schedule of the company, which is costly and needs to be neutralized (Froot, 1993). Since more volatile cash inflows implies the higher expected tax payments, by including hedging in the risk management program, the company neutralizes variability of its taxable income and reduces expected tax liabilities, Smith and Stulz (1985).

Leland (1998) and Stulz (1996) describe increased debt capacity as another tax incentive to hedge. Namely, a company might benefit from adding leverage to the extent that does not exceed the sufficient level of probability of distress. By borrowing more the company increases its tax shield deductibility of interest. Empirical evidence conducted by J. Gram and D. Rogers of a significant sample of random firms has shown, that those firms which regularly implemented hedging activity had 3% increased debt ratio and incrementally capitalized value of tax shields, which expanded their debt capacity and increased firms' value by 1,1 (Graham 2001).

Underinvestment costs

Prior research has shown that volatility of cash flow directly affects probability of financial distress of the company, due to the loss of valuable investment opportunities for the firm and due to the increased dependence on external capital market. High value volatility implies that a firm has periods of cash flow shortfall, which result in constrained withdrawing of investments and increased use of external capital market, Stulz (1996). According to Myers (1977), underinvestment costs occur when a firm gives up a positive net present value projects. Therefore, limited investments incur higher contract costs, research and development expenses, production and advertising fees, which reduce company's growth opportunities (Minton, Schrand 1999). According to Myers and Majluf (1984), external source of capital is more costly than using internal capital, due to additional transaction costs,

expensive interest payments, as well as taxes associated with dividend payments to stakeholders.

Bessembinder (1991) argues that corporate hedging increases firms' value by reducing underinvestment costs. It was shown that agency problem leads to underinvestment costs, when a having a risky debt in the capital structure, a significant value gains from companies' investments is distributed mainly to bondholders, while equity holders often miss benefits from increased investments. Therefore shareholders often lack the incentive to invest in new projects that might bring additional positive Net Present Value. Debtholders anticipate the shareholders motive by turning it into the rate of return for issuing debt, while by hedging activities shareholders might bond themselves from such activity. Receiving higher priority, owners gain more benefits from new investment projects, motivating them to extend funds for rising internal capital (Skinner, 2007).

Froot et al. (1993) confirm that firms hedge in order to reduce dependence on external capital by increasing interaction between internal funds and their investments. Due to the cost-based differences in internal and external capital caused by asymmetric information and agency problems, financing costs arise with the level of external capital, as in Froot, Scharfstein and Stein (1993). If a firm with a high volatility of earnings faces a shortfall in cash flow, internal capital could appear to be too scarce to fund a positive Net Present Value investment. More costly externally obtained capital compared to internal one arise incentive for hedging which gives corporations possibility to gain a sufficient internal capital in place in order to take advantage of desirable investment opportunities (Froot, Scharfstein and Stein, 1993).

Other causes of financial distress

Other factors that can reduce a company's value and cause financial distress are important to mention within the theoretical framework of hedging determinants in order to understand the scope of risky factors that can be eliminated by appropriate hedging activities. According to Stulz (1984) managerial risk aversion could be costly for a company and arise an incentive to hedge. Since managerial compensation is related to the volatility of company's cash flows, it is profitable for a company to hedge in order to improve not only own but managerial welfare, resulting in reducing risk premium that managers demand, and hence their compensation (Graham, Rogers; 2001). In case managers own a significant number of shares, the volatility of their welfare becomes affected by the volatility of the share price, which triggers hedging

activity in the company. According to Tufano (1996) there is a positive relation between hedging and shareholdings, which implies that managerial risk aversion determines corporate hedging (Haushalter, 2000).

Haushalter (2000) also associates hedging with the size of a firm, pointing out that hedging can only benefit to the company if obtained gains are larger than direct costs of administrating the hedging activities. Graham et al (2001) confirms that hedging increases with firm's size due to the transaction costs scale economies, since fixed costs in small firms limit hedging activities.

The above theories confirm that financial distress has a value destroying feature. By hedging a company might decrease probability of financial distress and maximize its value, consequently the linear relation between probability of financial distress and amount of hedging is observed. The greater the probability of financial distress is, the more companies hedge. Nevertheless, companies that already find themselves in distress position don't have incentive to hedge, as well as companies in "healthy positions" with long distance to default have a tendency to hedge less (Stulz 1996; Fang and Lin 2007).

3.2. Method

3.2.1. Selection of the model

By using financial derivatives, companies can maximize their value and minimize probability of financial distress (Stulz and Smith, 1985; Fang and Lin, 2007; Adam, 2012). Empirical evidence has been contradictory though and question about the linear relation between firms' financial distress risk and hedging level is still open (Nance, 1993; Tufano, 1996; Mian, 1996). According to Stulz (1996) and Campbell et al. (1999), financially distressed firms have more incentives to hedge than financially secure firms. In order to control this relationship, probability of financial distress will be measured in terms of Altman's Z-score which will be related to the extent of hedging activity in terms of hedge ratio.

The article of Tim Adam, Chitru Fernando and Jesus Salas (2012) was taken as a starting point for my analyzes, where authors investigated firms motives to hedge and speculate by testing derivatives usage strategies on a sample of 92 gold mining firms, through relating outstanding gold derivative positions to various firm characteristics, such as firm size, market-to-book ratio of assets, leverage, liquidity, Altman's (1968) Z-score and Ohlson's (1980) O-score, and dividend policy.

In previous research, influence of probability of financial distress on level and strategies of derivatives usage has been mainly tested leaning on firms leverage ratios, considering leverage to be the determinative variable on distress likelihood, due to the positive relation between debt size and probability of not being able to repay it (Smith, Stulz, 1985; Purnanandam, 2004; Nance, Smith, Smithson, 1993; Graham, Rogers, 2001;). Nevertheless, Altman's Z-score (1968) seem to be more comprehensive measure of predicting the bankruptcy of firms, due to its extensive approach of analyzing a set of important financial ratios, which determine the companies' overall performance. Moreover Altman's Z-score have not been tested much in the contest of corporate hedging strategies, which allows to somehow contribute through this thesis.

3.2.1.1. Predicting financial distress

Default prediction models can be classified according to accounting-based and market-based approach, depending on what kind of data is incorporated in order to predict default events (M. Crouhy, p. 438, 2002). Both approaches will be reviewed below, including most typical models for each kind, but only Altman Z-score model will be described in detail, since it is the one that will be applied in this thesis.

Accounting-based models

 Accounting-based models rely on variety of accounting ratios, weighted on the sample of bankrupt and nonbankrupt firms (Agarwal, Taffler; 2008). First accounting-based prediction of distress model was originally developed by Beaver in 1966, who found that a number of different financial ratios, based on balance sheet and income statement data, could discriminate between paired samples of failed and survived companies with comparable asset size and operating within the same industry, predicting a bankruptcy by being tested according to the univariate approach, meaning one ratio at a time (Altman, 2000). Nevertheless, finding overlap in some ratios when exploring a wide number of them, Beaver suggested a multiratio analysis as a solution to exclude or eliminate the common elements and prevent overlapping (Beaver, 1966). Altman followed the direction and launched the Z-Score model based on the Multiple Discriminant Analysis (MDA) in 1968. According to Altman (1968), the multivariate model has potentially greater statistical significance and provides a simultaneous analysis of entire profile of different financial ratios related to the selected companies. The discriminant function was presented, combining a set of financial ratios for a grouped data set of bankrupt and nonbankrupt firms:

$$Z = V_1X_1 + V_2X_2 + \cdots + V_nX_n \qquad\qquad (3.7)$$

This function transforms the individual variable values into a single discriminant score, Z value, which is then used to classify the object, where $V_1, X_2, \ldots V_n$ are discriminant coefficients and $X_1X_2 \ldots X_n$ are independent variables, representing different financial ratios (Altman 1986).

Altman collected similar to Beaver accounted-based data and combined it into the list of 22 possible financial ratios, from which five were chosen as explanatory variables providing "the best overall prediction of corporate bankruptcy" (Altman, 2000). The final discriminant

function of five financial ratios weighted by the estimated coefficients was presented as the result of Altman's study (1968), but modified later to the Altman (1993), using same variables but different factors:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \qquad (3.8)$$

where X_1 = working capital/total assets,

   X_2 = retained earnings/total assets,

   X_3 = earnings before interest and taxes/total assets,

   X_4 = market value equity/book value of total liabilities,

   X_5 = sales/total assets,

Firms with Z-score output within interval between 1.81 and 2.99 are rated to be not safe and should be considered with attention, indicating "ignorance zone", according to Altman (1968). If the value of Z-score is below the critical value of 1.81, the company is rated as a bankrupt with high probability of default. The Z-score greater than 2.99 indicates solvency and financial health of the company. Since X_1 variable requires stock price data, the model is considered to be applicable just for publicly traded entities (Altman, 2000).

Similar to Z-score, Ohlson's O-score model (1980) represents a statistical bankruptcy indicator generated from a set of balance sheet ratios, with the difference of much wider sample of firms incorporated and ex-ante approach, meaning that investigated financial statements were not necessarily based on the occurred bankruptcy; also probability of bankruptcy is incorporated in the model (Ohlson, 1980).

The ZETA Credit risk model was built in 1977 by Altman et al. as a "second generation model with several enhancements to the original Z-Score approach" (Altman, 2000). It appears to be more accurate, compared to previous methods, in assessing failed companies up to five years prior to bankruptcy with classification of 90% accuracy for the companies within one year and 70% accuracy within five years (Altman et al, 1977).

A number of criticisms about accounting-based models were demonstrated in economic literature, based on the concerns about validity of the accounting statements, which often are considered to be the subject of manipulation by management as well as true asset value may

be very different from book values. Moreover, accounting statements are based on past performance and might not be informative in predicting future (Agarwal et al, 2008).

Market-based models

As a solution to misspecifications and overlapping concerns, as well as lack of the theoretical foundation noticed in the accounting-ratio-based models, contingent claims valuation method for predicting corporate failure was released some years after Beaver and Altman models came. The most widespread are Black and Scholes (1973) and Merton (1974) market-based models, which, in contrast to accounting-based approach, provide strong theoretical ground for predicting firm bankruptcy. They include both accounting and market information assuming market efficiency, without to be influenced by firm's accounting policies. They are also assumed to be more appropriate for prediction purposes due to the market prices reflect future expected cash flows, and are not sample dependent (Agarwai and Taffler, 2008). Black and Sholes (1973) and Merton (1974) measure distance to default and probability of default, assuming that equity is valued as a call option on the market value of the firm's assets. Some assumptions have to be considered: the firm issues only zero-coupon bonds, M&M world without taxes and transaction costs is implied, risk-free interest rate is constant and is the same for borrowing and lending. Thus, by determining if the call option is exercised, shareholders evaluate if the firm faces bankruptcy, which happens in case the bonds mature, due to the assumption that the firm only issues zero-coupon bonds. Distance to default calculation is based on the difference between the expected value of assets and the face value of liabilities, or the default point. Obviously, default occurs when the value of the company's assets fall below the "default point" (Hillegeist et al, 2002).

Being conceptually attractive, market-based models also suffer from misspecification due to the constrains, related to their restrictive assumptions, as well as measurement errors. Accounting-based models predominate in terms of reliability and according to many studies produce significant economic benefits over the market-based approach (Agarwal et al, 2008; Begley et al, 1996; Dichev, 1998). One of the weighty arguments is reliability on the accounting statements, meaning, that firms with good profitability and strong balance sheets normally don't file for bankruptcy, moreover, corporate failure is a process that matures for several years and is therefore necessarily reflected in accounting statements (Agarwal et al, 2008).

Relying on the above-mentioned arguments, I will base my study on the accounting-based Altman Z-Score model, due to its simplicity and widely applicability among publicly traded companies, as well as availability of essential input. The scope of this thesis refers to the publicly traded oil and gas companies, which provide perfectly available accounting information needed for the Z-Score estimation.

3.2.2. Econometrics

3.2.2.1. Panel data estimation

When a data sample represents information about different observations over a certain period of time, it implies a panel of data. The panel data representation can be balanced or unbalanced, combining both time series and cross-sectional units and embodying information across both time and space. The balanced panel dataset implicates that all cross-sectional observations are the same for all periods of time, while in unbalanced panel the observations could be missing or the sample could differ. In this thesis, the sample of companies that will be studied, assumes the same companies from year to year, indicating that balanced panel data approach is appropriate to use here. It allows to study the same sample of units and measure different characteristics as a function of time. It makes this method more advantageous compared to running multiple regressions for several observations at a single point in time or just for one observation over time, or compared to pooled data, which encapsulates the effects of all variables and their characteristics in the same model (Brooks, p. 487-488, 2008). C. Hsiao (2005) emphasizes that panel data provides more effective inference and more accurate econometric estimates by addressing a broader range of issues and solving more complex problems than would be possible with pure time-series or pure cross-sectional data. Moreover, by combining time series and cross-sectional data, one can increase the number of degrees of freedom, and therefore, the power of the test, by employing information on the dynamic behavior of a large number of entities at the same time, which also helps to reduce effects of multicollinearity that arise when time series are modelled individually (Brooks, p 489, 2008; Hsiao, 2005). A general linear model for panel data allows the intercept and slope coefficients to vary both over observations and time, so that

$$y_{it} = \alpha + \beta x_{it} + u_{it}, \qquad t = 1, \dots, T; i = 1, \dots, N \qquad (3.9)$$

Where N number of estimated companies, y_{it} is the dependent variable (hedging ratio), α is the intercept, β is a $k \times 1$ vector of coefficients estimated on the explanatory variables, x_{it} is a vector of observations on the explanatory variables, u_{it} is a disturbance (error) term.

The most straightforward way to deal with panel data would be to estimate a pooled regression, implying estimation of single equation on all data together (Brooks, 2008). According to Wooldridge (p. 128, 2002) "the idea behind pooled cross sections over time is that during each year a new random sample is taken from the relevant population. Since distribution of variables tends to change over time, the identical distribution assumption is not usually valid, but the independence assumption is". While in panel dataset one follows the same group of individuals over time, pooling of cross sections over time assumes no replicability over time (Wooldridge, p. 129, 2002).

In our case 47 companies will be measured over nine years period, consequently panel data representation will be chosen to estimate regression.

3.2.2.2. Fixed and random effects models

According to Brooks (2008), while estimating linear regression with panel data approach, fixed and random effects should be taken into consideration. Fixed effects imply that some of the parameters in the model (intercept and/or coefficients) are fixed in either dimension or in both. For instance, the intercept could differ cross-sectionally but not over the time, while all of the slope estimates are fixed in both dimensions. In order to understand the mechanism of fixed effects model, let us take equation (3.7) and decompose it in terms of the error factor u_{it} into an individual specific effect, μ_i, and the "remainder" effect v_{it} that varies over time and units, capturing everything that is left unexplained about y_{it}, so that

$$y_{it} = \alpha + \beta x_{it} + \mu_{it} + v_{it} \qquad (3.10)$$

According to Woolridge (2002), the main difference between fixed and random effects models is how to deal with the un-observed individual specific effect. It is called a "random effect" when treated as a random variable and a "fixed effect", when treated as a parameter to

be estimated for each observation i. The fixed effect assumption means, that the individual specific effect might correlate with the explanatory variables cross-sectionally but not over time. By leaving out fixed effects that are related to the other independent variables, the coefficients for these variables can be biased, creating omitted variables bias. In our case, fixed effects are applied on the companies, that differ from each other but the difference between them might be related to other independent variables, like distress score, liquidity etc.

Fixed effect model could be estimated with least squares dummy variables (LSDV) approach, which allows heterogeneity or individuality among in our case estimated 47 companies, so that

$$y_{it} = \beta x_{it} + \mu_1 D1_i + \mu_2 D2_i + \mu_3 D3_i + \cdots \mu_N DN_i + v_{it} \qquad (3.11)$$

Where $D1$ is a dummy variable that takes the value 1 for all observations on the first entity in the sample and zero otherwise, $D2$ takes value 1 for all observations on the second entity and zero for all other observations etc. Intercept α is removed from LSDV equation in order to avoid "the dummy variable trap" where perfect multicollinearity between the dummy variables and the intercept appears. The fixed effects model with LSDV approach allows us to test for whether the strict panel structure is necessary for the estimation process or the data can simply be pooled together and OLS regression run (Brooks, p. 491, 2008).

Fixed-effect model can also assume time-fixed effect rather than entity-fixed as discussed above. This approach is applicable when the average value of independent variable varies over time but not across observations at each given point in time. The time-fixed effects model could be presented as follows:

$$y_{it} = \alpha + \beta x_{it} + \delta_i + v_{it} \qquad (3.12)$$

Where δ_i is a time-varying intercept that captures all variables affecting y_{it} that differ across time but not cross-sectionally, i.e. having the same effect on all observations (Brooks, p. 493, 2008).

As for the random effects modes, there are different intercept terms for each unit, which are constant over time, and the relationship between y_{it} and x_{it} is the same over all entities and time. The intercepts for each entity with random effects are based on the common intercept α

and a random variable ϵ_i, which reflects the random deviation of each entity's intercept term from the global intercept α, and is constant over time but changes cross-sectionally, in our case over companies. The random effects panel model can be expressed as:

$$y_{it} = \alpha + \beta x_{it} + \omega_{it}; \;\; \omega = \epsilon_i + v_{it} \qquad (3.13)$$

where the dependent variable x_{it} is still a $1 \times k$ vector of explanatory variables, but unlike the fixed effects approach, there are no dummy variables to measure the variation across entities, instead this occurs based on the random variable ϵ_i. Random effect approach assumes that the new cross-sectional error term ϵ_i has a zero mean value, is independent of the individual observation error term v_{it}, has a constant variance σ_ϵ^2 and is independent of the explanatory variables x_{it} (Brooks, p. 499, 2008).

3.2.2.3. Specification tests

Hausman test

In order to estimate the robustness of the empirical results, several tests have been employed. The Hausman test was proceeded for the regression with lagged variables, presented in Appendix 1 on page 51. According to Woolridge (p. 288, 2002), since fixed effects assume that individual specific term is correlated with independent variables, but random effects is inconsistent in this case, a statistically significant difference between them means evidence against the random effects assumption. In our case the null hypothesis was rejected, which implies that the individual specific effect is not correlated with the explanatory variables for the random model, meaning that the fixed effects approach is more appropriate. The result from the Hausman test is presented in the Appendix 1. As for other regressions estimates, I repeated them for the pooled OLS regression, fixed effects and random effects regressions, in order to avoid the possibility that results might be driven by omitted variables. Fixed effects model was showing the significantly higher R^2 value in all cases, providing the best explanation of the regression.

Endogeneity

In order to avoid endogeneity, which is correlation between the explanatory variables and the error term in the regression, and is thus violation against one of the main assumptions of OLS regression, the lagged variables were implied for all independent variables presented in Table 4.2. on page 38. The result from the implicating of lagged variables does not differ from the one measured for the regression assuming variables in the same period, indicating that the regression does not suffer from endogeneity.

Heteroskedasticity

One of the assumptions underlying the classical linear regression model that have to hold in order to make valid coefficient estimates, is the assumption that the variance of the error terms is constant, also known as homoscedasticity. In case the variance of errors varies over observations, the problem of heteroskedasticity emerges, causing biased standard errors and inefficiency of OLS estimates. To identify the heteroskedasticity, the BPG test is appropriate to carry out, which implies that squared errors are regressed on the independent variables of each model. The null hypothesis means that the sum of coefficients is equal to zero, and in case it is rejected, the heteroskedasticity is identified in the dataset (Brooks, p.132-136, 2008). In our case heteroskedasticity was identified in all regressions but was adjusted for heteroskedasticity and standard errors using White Standard Errors method in Eviews.

Multicollinearity

If multicollinearity appears in the regression it creates possibility of making inadequate inferences of the specification. It appears when explanatory variables are closely related to each other, which violates against an implicit OLS assumption that explanatory variables are not correlated with each other. This creates difficulty in observing individual contribution of each variable to the regression (Brooks, 2008). The correlation test, applied on the independent variables in the model, has shown that multicollinearity does not damage our regression, as it is shown in Appendix 2. Only Quick ratio correlates with Z-score with 54% which implies high correlation coefficient but still not close to 1, as for other variables, they correlate with less than 10% with each other.

3.2.3. Data

3.2.3.1. Data collection

Since derivative instruments have been allowed to be off-balance sheet items until issuance of FAS 133, Accounting for Derivative Instruments and Hedging Activities, in 1998, and due to its complex accounting afterwards, research on corporate hedging activities is restricted with limited data in this area (Tufano, 1996; Fang, Lin; 2007). The sample of the companies studied in this thesis with status on their linear and non-linear derivative positions between year 2000 and 2008, has been granted by my supervisor, from the own research archive. 73 oil and gas US companies have been examined in terms of hedging activity, namely combination of linear and long put contracts, pursued at least under one year within the highlighted time scope. 54 companies have been left after the first selection, which had to be matched with the production data to calculate hedge ratio on.

Total production figure in thousands of barrel of oil equivalent, i.e. Boe, per company and year, extracted from S&P Capital IQ database, includes combination of total production of oil (Mbbls), total production of gas (Mcf), and total production of natural gas liquid NGL (Mbbls), see Figure 3.2. Millions of Barrels (Mmbbls) were converted into the thousands of Barrels (Mbbls) by multiplying it by 1000, while thousand cubic feet of natural gas (Mcf) was converted into Boe by dividing it by a factor of six, since 6 Mcf = 1 Boe is a common industry factor (Wright, p. 191, 2008).

Figure 3.2 Total production

Total Production
Thousand of Boe

- Oil Production (Mbbls)
- Gas Production (Mcf/6)
- Natural Gas Liquid Production (Mbbls)
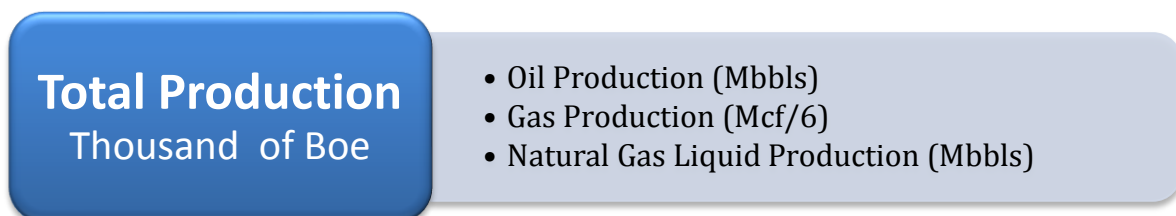
Total production was not available for all companies left from the first selection, therefore firms with incomplete data have been excluded from the sample, resulting in 47 companies between 2000 and 2008 or totally 423 observations balanced data.

Accounting data was collected from Thomson Reuters Datastream and Compustat. Financial ratios, such as Altman Z-Score and Quick ratio were collected from S&P Capital IQ.

3.2.3.2. Selection of variables

Selection of variables and expectation of the linear relation between them is based on the theoretical framework. According to Stulz (1996), Fang and Lin (2007), and Adam (2012), there is a positive linear relationship between degree of financial distress a company faces and amount of hedging it carries out. If this is the case, than extent of hedging activity will be the dependent variable, the slope estimate in the regression will be the relationship between hedging and financial distress, while the independent variable will be an indicator of financial distress.

Extent of hedging activity is, as defined in the theoretical framework, see equation 3.5, a company's hedge ratio, while indicator of financial distress has chosen to be Altman Z-Score, according to the method selection. The relationship between these dependent and independent variables is expected to be negative due to the characteristic of Altman Z-Score. According to the abovementioned theory, the more distressed a company is, the more hedging it pursues. According to Altman (1968), companies with Z-Scores lower than 1.81 are associated with a high probability of financial distress and firms Z-Scores larger than 2.99 considered to be safe, indicating the higher score for more solvent companies. The relationship in our regression will be therefore as follows: the lower Altman Z-Score, the higher hedge ratio is expected to be.

Traditionally, several control variables have been used in the risk management literature, in order to investigate what determines corporate hedging strategies. For instance, Tufano (1996), Adam et al (2006), Fang, Lin (2007), Adam et al (2012) have measured influence of firms size, leverage, managerial ownership, liquidity and firm value on companies' hedging strategies. Taking into consideration the limited amount of observations I have at my disposal, the selection of control variables will be restricted accordingly and most commonly used of abovementioned variables will be included, in order to have appropriate degrees of freedom in the regression specification. The variables are specified as follows:

Dependent variable

Hedge Ratio

Total hedge ratio specifies how much of the company's total production has been hedged over the year and is calculated as a fraction of the firm's production, that is amount of linear derivative contracts plus long puts over the year divided by the firm's total production over the next year. Firms hedge ratio is based on the estimated production for the next year t_{x+1}.

Independent variables

Altman's (1986) Z-Score

Altman's Z-Score is the bankruptcy indicator based on the weighted key accounting-based ratios, combination of which determine the probability of default for a company, namely: $Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$, where X_1 is a working capital (current assets – current liabilities)/total assets; X_2 = retained earnings/total assets; X_3 = earnings before interest and taxes/total assets; X_4 = market value of equity/book value of total debt; and X_5 = sales/total assets (Altman, 1993).

Leverage

Leverage indicates the firm's ability to meet its obligations over the long term (Koller et al, 2010) and is calculated as the book value of the long-term debt divided by the sum of book values of preferred stock, common equity, and long-term debt (Adam, 2012).

Market-to-book ratio

Market-to-book ratio of assets indicates the firm's operating performance and growth of it´s assets, calculated as market value of assets divided by book value of assets. The market value of assets is calculated as the book value of assets minus the book value of common stock plus market value of equity (Adam, 2008).

Liquidity

Liquidity determines the company's ability to meet short-term obligations, such as interest expenses, rental payments, required principal payments (Koller et al, 2010) and is measured as quick ratio in this thesis, defined by the sum of cash, cash equivalents and account receivables, divided by current liabilities (Adam, 2012).

3.2.3.3. Multiple regression

Prediction on the relationship between hedging ratio and Z-Score, as well as influence of other explanatory variables on the hedge ratio, will be estimated with the ordinary least square multiple regression, based on the generalized OLS model with several independent variables:

$$y_t = \beta_1 + \beta_2 x_{2t} + \beta_3 x_{3t} + \ldots + \beta_k x_{kt} + u_t \tag{4.1}$$

where $x_{2t}, x_{3t}, \ldots, x_{kt}$ are a set of $k-1$ explanatory variables, and the coefficient estimates $\beta_1, \beta_2, \ldots, \beta_k$ are the parameters which quantify the effect of each explanatory variables on y (Brooks, p 89, 2008).

- Definitions of variables in the regression are following:

HR_{it} = Dependent variable hedge ratio.

β_0 = The vertical intercept term of the regression.

β_{1-5} = The slope parameter, or coefficient of each independent variable.

X_{it}^{**} = Independent variables (ZS = Altman (1968) Z-Score, LEV = leverage, MTB = market-to-book ratio of assets, LQ = Quick ratio).

ε_{it} = The error term, representing the deviation of the actual observations from the estimation of the regression.

- The following detailed regression represents the model of the thesis:

$$HR_{it} = \beta_0 - \beta_1 x_{it}^{ZS} + \beta_2 x_{it}^{LEV} + \beta_3 x_{it}^{MTB} + \beta_4 x_{it}^{LQ} + \varepsilon_{it} \tag{4.2}$$

4. Empirical Findings

In this chapter the analyses of descriptive statistics and regressions will be highlighted and main results of this work will be discussed.

4.1. Descriptive Statistics

I would like to start the analysis with descriptive statistics that is extracted from Eviews and summarized in Table 4.1. All variables in the model for 47 oil and gas companies between 2000 and 2008 are described with mean, median, and standard deviation. It is interesting to notify that the mean of the Z-Score variable for the sample companies is 1.9, which is higher than the lower border of the "ignorance zone" in the Altman's model (1968), specifying that firms with Z-Score less than 1.81 are associated with the high probability of distress. Mean of 1.91 in our sample identifies that the firms are not distressed on average. This makes sense and is in accordance with the assumption, that most of the oil and gas companies between 2000 and 2008 have maximized their profits because of strong growth in oil price. Adam et al. (2012) describes that selective hedging could be identified with high volatility of hedge ratio. Hedge ratio in our sample is quite volatile with 31% standard deviation, indicating that hedging was not constant over time and that managers in the observed companies incorporated their market views into the companies' hedging programs, indicating selective hedging and speculation that firms were engaged in, according to Adam (2006), Stulz (1996) and Bodnar et al (1998). Companies are leveraged with 40% on average, which implies quite high debt and, thus, indicates considerable risk for financial distress.

Table 4.1 Summary statistics for all variables in the model

	Hedge ratio	LEV	MTB	Quick ratio	Z-Score
Mean	0,25	0,40	1,98	0,80	1,90
Median	0,11	0,27	1,30	0,70	1,72
Maximum	1,73	31,22	23,39	4,90	10,42
Minimum	0,00	-3,67	-3,32	0,00	-1,70
Std. Dev.	0,31	1,58	2,80	0,70	1,47
Skewness	1,30	17,63	4,40	2,79	1,36
Kurtosis	4,55	345,24	26,53	13,96	6,98
Jarque-Bera	160	2071525	11047	2646	406
Probability	0,00	0,00	0,00	0,00	0,00
Sum	104,18	169,26	831,98	337,00	799,04
Sum Sq. Dev.	39,47	1048,03	3281,61	207,26	910,12
Observations	420	420	420	420	420

4.1. Average over Time

To have a brief overview over how variables are related to each other, the schematic relationship between them is presented below in Figure 4.1 as a typical example based on the average over time indicator by calculating the mean of each variable cross-sectionally (measured for all companies) over each year.

Figure 4.1 Interdependence of variables
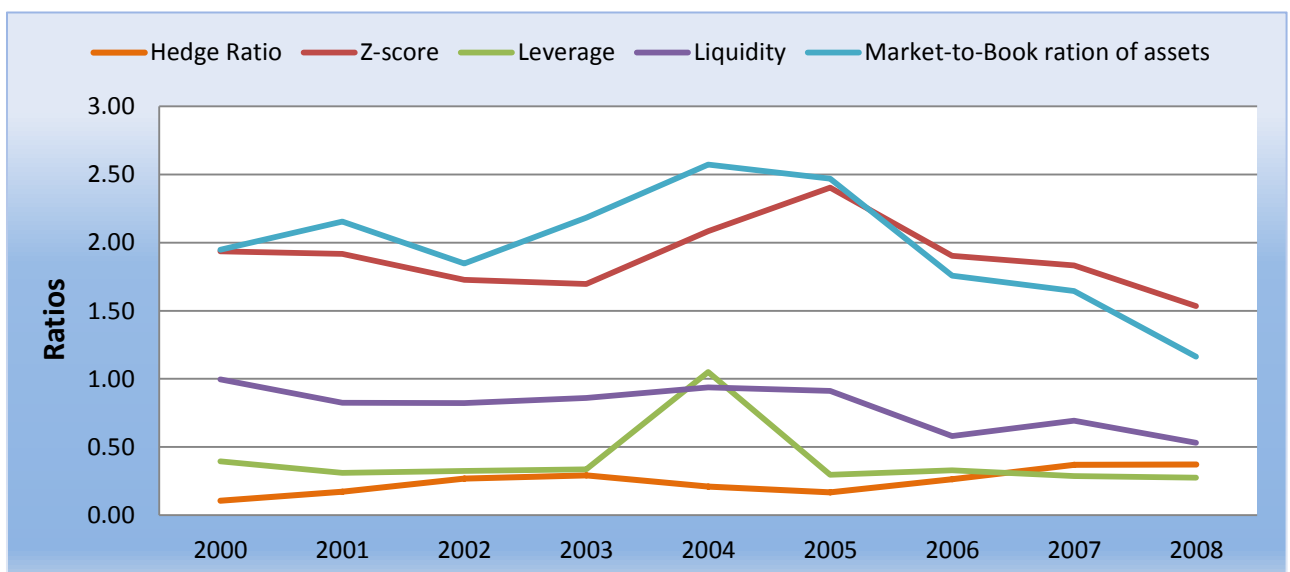
By average over time indicator we can see the inverse relation between Hedge ratio and Z-Score, which corresponds to the theoretical framework and acknowledges the hypothesis at first glance. Hedge ratio is increasing slightly after 2005, when oil prices peak with several hundred percent according to the Figure 1.2 , while probability of default is also increasing during the same time, due to the fact that Z-Score falls. Market-to-book ratio of assets is dropping during the time oil price peaks, indicating high volatility of stock market during the price shock time, and, thus, lower growth of the companies' assets.

4.2. Analyses of regressions

Table 4.2 Panel data analysis of the financial distress effect on hedging

	POOLED	FE	RE
Altman`s Z-Score	0.017785*	0.046426***	0.018922***
	(0.007863)	(0.011372)	0.006592
probability	0.0242	0.0001	0.0043
Leverage	0.008787***	0.004476	0.009564***
	(0.002393)	(0.004176)	(0.002866)
probability	0.0003	0.2846	0.0009
Quick ratio	- 0.054316***	- 0.033987**	- 0.043323*
	(0.015166)	(0.016485)	(0.015266)
probability	0.0004	0.0399	0.0048
Market-to-book ratio of assets	0.000464	- 0.017471**	0.002120
	(0.004332)	(0.007645)	(0.004670)
probability	0.9148	0.0229	0.6501
Number of observations	420	420	420
R-squared	0.012530	0.350881	0.011433

Regressions presented in the tables 4.1, 4.2, and 4.3 are provided with symbols ***, **, and *, denoting statistically significance levels at the 1%, 5%, and 10% respectively. According to the Table 4.2, the results of the pooled OLS regression, fixed effects and random effects regressions, proceeded in Eviews, are presented for all variables, and corrected for the White cross-section standard errors and correlation, which means automatic identification and correction for heteroskedasticity. I have chosen to estimate three regression methods simultaneously due to take into account all possible outcomes and thus reach more complete

and valid results and allow the possibility that some results may be driven by omitted variables when repeat panel regression with fixed effects, random effects and simply pool data. Three of four independent variables in every model are significant in explaining the variation in companies' hedge ratios, for instance, in pooled OLS and in random effect: Z-Score, leverage and quick ratio has an effect on how much companies hedge, while in fixed effect model: Z-Score, quick ratio and market-to-book ratio has this effect. Quick ratio has a negative influence on hedge ratio in all three models, this is consistent with Adams results both in 2006 and in 2012, meaning that companies with high liquidity don't hedge much. Fixed effects model seem to demonstrate the highest effect of chosen independent variables on hedge ratio, its' R^2 suggests that 35% of the variation in hedging is caused by the effect of the companies' bankruptcy risk, liquidity and operating performance, while for other two models the effect of the listed variables is just 1%. Last and most important conclusion to draw on this set of regressions is that probability of financial distress (Z-Score indicator) shows strong significance at the 1% level for the fixed effect model and at the 5% level for the random effects model, indicating hereby an influence on companies' extent of hedging in these two models. The relationship is though positive, which contradicts to the hypothesis and initial theoretical baseline. According to the results in Table 4.1, the companies in the chosen sample hedge more, the less financially distressed they are, because the higher Z-Score is, the more financially strong companies are. This interesting inconsistency with the theory indicates pure speculative motives of the companies in question, who were exploiting growing oil market by "taking derivative positions with the planned intention to make a profit" according to Moosa's (2010) definition, which rejects hedging motives for using derivatives with primary purpose of risk reduction. The strong positive relation between hedge ratio and companies' solvency also confirms the reasoning in Stulz's (1996) and Adam (2012) theory that companies need to have a certain level of financial strength in order to execute hedging. They argue also that companies that are already in financial distress or very close to it are not interested in risk reduction and do not have spare capital to spend on effective risk management programs.

Contradiction to the theory can sometimes be the consequence of simultaneity bias, which occurs when independent variable y and one of the explanatory variables appear in equilibrium so that either x_k causes y or equally y can cause x_k. Simultaneity bias can lead to endogeneity, which is correlation between the explanatory variables and the error term in the regression, and is thus violation against one of the main assumptions of OLS regression,

causing biased and inconsistent regression estimates and leading to unreliable inference (Roberts and Whited, 2011). Measuring hedge ratio and independent variables that might effect the extent to which companies hedge during the same year, might cause ambiguity of the effect and hence simultaneity bias. In order to see what has in fact influenced hedge ratio it is appropriate to study the effect from the previous period on the next period hedge ratio, this excludes simultaneity bias due to the fact that hedging cannot make an effect post factum. To test for simultaneity in the variables of the regression and exclude endogeneity, the estimation was proceeded with lagged values, meaning that independent variables were measured in the previous period $t-1$ and dependent in the current period t (Brooks, p 140, 2008). The result of pooled, fixed effect and random effect regression estimates with lagged explanatory variables is presented below:

Table 4.2 Panel data analysis with lagged values

	POOLED	FE	RE
Altman`s Z-Score (-1)	0.017686	0.056375**	0.039506**
	(0.016351)	(0.018136)	(0.019354)
probability	0.2801	0.0020	0.0419
Leverage (- 1)	0.008859**	0.004091	0.005943
	(0.004063)	(0.003541)	(0.005019)
probability	0.0299	0.2487	0.2372
Quick ratio (- 1)	- 0.034334*	0.002226	-0.016917
	(0.019387)	(0.027581)	(0.025747)
probability	0.0774	0.9357	0.5116
Market-to-book ratio of assets (- 1)	0.001337	- 0.020517***	- 0.010644***
	(0.003491)	(0.005502)	(0.002925)
probability	0.7019	0.0002	0.0003
Number of observations	374	374	374
R-squared	0.007696	0.386460	0.031814

The outcomes of the panel data regression with lagged values in Table 4.2 shows the same effect as measured for the variables in the same period presented in the previous Table 4.1., namely that Z-score has the positive impact on the extent of hedging. The unchanged effect implies that no simultaneous bias has affected the result in the previous regressions set. The difference is though, that fewer variables are significant in the outcome, probably due to the fewer observations in the estimations, since the amount of years is now reduced to eight. For instance the main independent variable Z-Score in pooled least squares regression seems to have no effect on the hedge ratio, i.e. is statistically insignificant. Hausman test, described

before, confirms in this case that fixed effects model is more appropriate for the current model, the result for the test is presented in Appendix 1. All regressions in Table 4.2 are corrected for standard errors robust to heteroskedasticity and with firm serial correlation in Eviews with White cross-section method.

The next regression set presented in Table 4.3 have been estimated with least squares dummy variables (LSDV) approach, including time dummies in order to investigate the effect of the dramatic oil price increase and also the impact on hedging before the oil price shock when oil prices were close to constant. For this purpose time dummies have been added for 2006, 2007 and 2008 years in order to test for the effect of the peaking oil price during this period, as well for 2000, 2001, 2002 and 2003 years to compare with the period when oil price was quite constant and should not have given an impact on corporate hedging. The Hausman test has shown that the best model to use in this context is fixed effects model, that's why other types of estimations are not carried out in this case. The results are very revealing, demonstrating exactly the below mentioned assumption. Namely, positive coefficients and strong statistical significance at the less than 1% level is noticed for time dummy variables during all years when oil price was peaking, namely 2006, 2007 and 2008, while other time dummies are not significant in a single year, and thus do not have any effect on hedging. Altman's Z-Score is not significant in this regression, even after adjusting for standard errors robust to heteroskedasticity and firm serial correlation, meaning that degree of financial distress have no impact on companies' amount of hedging under the period of oil price growth. This confirms the speculative motives of the observed companies, because degree of financial distress was not taken into account, demonstrating therefore that companies' intention to use derivative instruments was not initiated by hedging or risk management motives, but clearly by profit maximization motives or speculation and also by selective hedging. According to the risk management theory described before, financially distressed companies win most on hedging. In our case, companies hedge mostly when their welfare is maximized and when the oil price is showing 400% growth, which has of course nothing to do with "reduction of loss risk" intention as hedging is defined, but is explained instead by "taking offset position with strong anticipation of profit" which is the speculation definition from the theory chapter. Selective hedging motive also explains the current regression result, since it implies "incorporation of management own market views in the company's risk management program" as defined by Adam (2006) and Stulz (1996), which makes sense in the given situation, when, having high expectations on the oil market due to its strong growth,

management of the companies decided to actively use financial derivatives following the oil price increase.

Table 4.3 FE panel data estimate with time dummy variables

		FE
Altman`s Z-Score		-0.044461
		(0.057108)
	probability	0.4436
Leverage		1.874923**
		(0.815728)
	probability	0.0314
Quick ratio		-0.177205
		(0.120761)
	probability	0.1564
Market-to-book ratio of assets		0.132646**
		(0.069207)
	probability	0.0684
Dummy 2006		0.205880***
		(0.009714)
	probability	0.0000
Dummy 2007		0.674199***
		0.013957
	probability	0.0000
Dummy 2008		0.465444***
		(0.025817)
	probability	0.0000
Dummy 2000		-0.032212
		(0.055968)
	probability	0.5701
Dummy2001		-0.176973
		(0.069725)
	probability	0.1599
Dummy2002		-0.097439
		(0.061456)
	probability	0.1254
Dummy2003		0.105755
		(0.113105)
	probability	0.3599
Number of observations		38
R-squared		0.763341

5. Summary and conclusions

This section summaries research performed in this master thesis, including the study motivation, main theories which were reviewed, the choice of method and execution of regressions to prove the hypothesis. Conclusions of the results are presented and further studies in the field are suggested.

5.1. Summary

The purpose of this paper is to investigate how does the risk of financial distress effect extent to which companies' hedge and to study this relationship under the abnormal market conditions of tremendous oil price increase. A number of scandalous collapses caused by operations with derivative instruments and at the same time extensive growth of derivatives market awakes interest of studying the fundamental principles of hedging, as one of the main functions of derivatives use. The theory of risk management says, that by hedging companies can maximize their value and reduce risk of financial distress, therefore the more financially distressed firms are the more incentive to hedge they have (Stulz and Smith, 1985; Fang and Lin, 2007; Adam, 2012, Campbell et al, 1999). However, the empirical evidence of this theory is ambiguous and there are studies disproving the positive relationship between degree of financial distress and extent of hedging. For instance, Tufano (1996) has not found value-maximizing motives for hedging and thus has not confirmed that financially distressed firms hedge more in order to increase their value. Stulz (1996) argues that financially distressed companies do not hedge a lot, because firms need to have sufficient financial strength to take additional risks that has to do with using financial derivatives without jeopardizing their core business.

The main objective of this master thesis is to make attempt to prove the existence of relationship between degree of financial distress and hedging by studying 47 US oil and gas companies under the period of oil price shock. Moreover, the hedging motive of using derivative instruments at the observed sample of companies are questioned in this study, since

hedging is often mixed up with other strategies of derivative instruments, namely speculation and selective hedging are often incorporated in companies' risk management programs. It is important to distinguish between these strategies and understand which of them to imply in order to take efficient decisions and be aware of possible risks they can cause. There are no clear boundaries of these strategies defined in the risk management literature, indicating what consequences one or another might have. In this master thesis the fundamental definition of these concepts is presented and motives for using one or another in the observed sample of companies are extracted.

Proxy for testing the relationship between financial distress and hedging was based on Altman's Z-Score and hedge ratio indicators, relying on the previous research in this area. Altman's Z-Score is an accounting-based model for predicting firms´ bankruptcy, based on the weighted set of financial ratios calculated for a sample of failed and nonfailed firms, combination of which determines the probability of default for a company. It is widely applicable measure of bankruptcy for publicly listed companies, remarkable for its validity and simplicity to apply. Extent of hedging is measured as a fraction of the firm's estimated production, computed as the amount of linear derivative contracts plus long puts over the year divided by the firm's total production over the next year.

A number of control variables have been included in analysis in order to support to identify what more determines the extent of hedging. Relying on previous studies, the variation in the amount of hedging could be explained by the firms´ leverage, market-to-book ratio of assets, and liquidity. The OLS multiple regression was run with random and fixed effects to investigate the relationship allowing an un-observed individual effect correlate with explanatory variables for each company and also be independent from them, in order to avoid the results of the regression to be driven by omitted variables.

Lagged explanatory variables were used in order to avoid endogeneity in the regression and detect how independent variables impact hedging in advance, as well as to verify if simultaneity bias exists in the regression. Endogeneity was not identified in the regression and lagged variables have not affected the result. The impact of the oil price shock on the companies´ hedging strategy and on its´ probability of financial distress have been measured with least squares dummy variables regression, where dummy variables have been created for the period of oil price increase and for the period before that, to stress the contrast of different market conditions and identify its` impact on corporate hedging. In order to secure for the

valid estimation results and to draw correct inferences, multicollinearity analysis have been performed in the interest of checking that the independent variables are not correlated with each other. Heteroskedasticity was excluded by White Standard Errors method in Eviews, which adjusts for standard errors robust to heteroskedasticity and firm serial correlation.

5.2. Conclusions

The results from six of seven regressions computed within this thesis have shown the stable positive relation between Z-Score indicator and amount of hedging, meaning that the more financially strong firms are the more they hedge. This empirical finding contradicts to the main accepted theoretical baseline, which states that companies prefer to hedge in order to maximize their value by reducing probability of financially distress (Smith and Stulz, 1985; Nance et al, 1993; Adam, 2006) and therefore rejects the hypothesis that there is a positive relationship between the probability of financial distress and amount of hedging. The Z-Score indicator shows positive significance at least at 5% level in all regressions except the LSDV regression, indicating that variation in companies´ bankruptcy risk indeed effects extent of hedging, but in the opposite from the prediction way. Two explanations are appropriate for the achieved results, the first one is that the primary motive of using derivative instruments in the observed sample of companies was speculation and selective hedging, but not hedging itself, since, by definition, with hedging activity companies intend to reduce risk of financial distress and relieve themselves from the loss exposure (L. Johnson, 1960). As for the companies in the examined sample, they are not financially distressed according to the descriptive statistics, as Z-Score indicator is showing 1,9 on average, but do use derivatives intensively. Moreover, companies in the chosen sample appear to have a tendency to hedge more, the more solvent they are, indicating pure speculative motives by exploiting growing oil market and "taking derivative positions with the planned intention to make a profit" according to Moosa's (2010) definition. Another conclusion to draw is that the positive relation between hedge ratio and companies' solvency confirms the reasoning in Stulz's (1996) and Adam's (2012) theory, that companies need to have a certain level of financial strength as a backup in order to use derivatives and take additional risks without jeopardizing their core business. The result also confirms Stulz´s (1996) argumentation that companies, finding themselves in

financial distress or very close to it, are not interested in risk reduction and do not have spare capital to spend on expensive risk management programs.

I also found that abnormal oil price increase between 2006 and 2008 has a strong positive effect on companies` extent of using derivatives. The relation is obvious and has a very high statistically significance of less than 1% level as shown in the Table 4.3. This result also contradicts against the theory, which implies that companies should hedge more the more financially distressed they are, expecting less hedging under the environment of strong market growth and companies´ value maximization. While companies in our case are on the contrary showing high hedge ratio, when the oil price are growing with 400% and their welfare is maximized, indicating that companies were speculating, or taking derivative positions with strong anticipation of profit between 2006 and 2008.

Period between 2000 and 2005, characterized by constant oil price or slightly increase in oil price, does not show significance in explaining change in companies´ hedge ratio in a single year. This strongly indicates practice of selective hedging, because it is consistent with selectivity of timing and amount of using derivatives and with "incorporation of management own market views in the company's risk management program" as defined by Adam (2006) and Stulz (1996). Companies do not hedge a lot when the market is calm, but do hedge intensively when the market is showing growth opportunities under the oil price shock period.

Altman's Z-Score is not significant in this regression, even after adjusting for standard errors robust to heteroskedasticity and firm serial correlation, meaning that degree of financial distress has no impact on companies' amount of hedging under the period of abnormal oil price growth. This confirms the speculative motives of the observed companies, because degree of financial distress was not taken into account, demonstrating therefore that companies' intention to use derivative instruments was not initiated by hedging or risk management motives.

Leverage is showing positive significance in explaining extent of hedging in four out of seven regressions, which confirms evidence found by Dolde (1996) and Love et al (1997) about high leveraged firms hedge more, and contradicts to the findings of Mian (1996) and Nance (1993) who found no evidence on the relationship and rejects the capital structure motive of hedging.

I found a negative relation between market-to-book ratio of assets and extent of derivatives usage in three out of seven regressions, which is consistent with the finding of Mian (1996) and Adam et al (2012). Market-to-book ratio indicates firms´ growth opportunities, therefore in the oil and gas industry companies with fewer growth opportunities appear to have more developed mines involved in operation and thus larger exposure to oil price changes, impacting in more hedging need (Adam, 2012).

I also found that quick ratio, indicating companies´ ability to meet long-term obligations, has a negative relation to the extent of hedging in four out of seven regressions. This is consistent with earlier studies on this relationship, since liquidity is considered to be a substitute for hedging, explaining the negative correlation between these two alternatives.

The current study suggests therefore that for the chosen sample of companies in the specific industry, oil and gas sector, examined between 2000 and 2008 in US, the theory of hedging determinants suggested by Smith and Stulz in 1985 is not confirmed when it comes to the positive relation of financial distress on hedging. Instead, I find a negative relation between firms´ probability of financial distress and extent to which they use financial derivatives. The primary motive of using derivatives for the observed companies was speculation between 2006 and 2008 and selective hedging during the whole observed period between 2000 and 2008. The result of my research confirms that firm´s leverage, growth opportunities and liquidity determines degree of hedging as it is shown in previous studies.

Further research in this area could be unlimited. Bigger samples of companies and other mining industries could be examined to confirm the relationship between financial distress and hedging, as well as examine true motives of using derivatives and what determines hedging strategies.

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Appendixes

Appendix 1 Hausman test

Correlated Random Effects - Hausman Test
Equation: Untitled
Test period random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	19.326887	4	0.0007

** WARNING: estimated period random effects variance is zero.

Period random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
Z(-1)	0.014530	0.017686	0.000005	0.1729
LEV(-1)	0.012197	0.008859	0.000002	0.0151
MB(-1)	0.003215	0.001337	0.000000	0.0010
QR(-1)	-0.015104	-0.034334	0.000029	0.0004

Period random effects test equation:
Dependent Variable: HR
Method: Panel Least Squares
Date: 05/25/14   Time: 14:13
Sample (adjusted): 2001 2008
Periods included: 8
Cross-sections included: 47
Total panel (unbalanced) observations: 374

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.235858	0.030814	7.654145	0.0000
Z(-1)	0.014530	0.013353	1.088153	0.2773
LEV(-1)	0.012197	0.009751	1.250857	0.2118
MB(-1)	0.003215	0.005527	0.581773	0.5611
QR(-1)	-0.015104	0.026951	-0.560449	0.5755

Appendix 2: Correlation matrix of independent variables

	ZS	LEV	MTB	QR
ZS	1,00	-0,02	-0,02	0,54
LEV	-0,02	1,00	0,07	0,05
MTB	-0,02	0,07	1,00	0,03
QR	0,54	0,05	0,03	1,00