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Determinants of Hedging Maturity

An empirical study in oil and gas companies

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Abstract

This study analyzes hedging maturity structure and examines the relation between the maturity structure of corporate hedging and debt characteristics. The purpose of the study is to provide new insights in what determines the hedging maturity and discover new aspects of companies hedging positions, which still is an unexplored area of modern risk management theory. The objective of the paper is to look into possible variables that may explain maturity of financial instruments used in hedging and if the theory behind debt maturity is relevant and applicable in determining the maturity of hedging positions. A dataset containing quarterly information about a pool of American oil and gas companies hedging behavior and their financial performance between the years of 2012 and 2016 were used. In addition, financial ratios previously determined to be significant for hedge ratio were added. Overall, our findings indicate there is no evidence for a relationship between long-term debt and hedging maturity.

Key words**:** hedging, maturity, debt, long-term, determinant

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1 Introduction

1.1 Background

During the past 50 years industries has experienced and gone through globalization. This has led to an increase in macro effects having an impact on the individual company's operations. Due to globalization certain events such as a country's political climate and economic state are now of concern to many companies operating on an international stage. The increase of uncertainty impacting a company's business has led to an increase of awareness and countermeasures to mitigate these potential unwanted outcomes from operating on e.g. a global market. Companies try to plan for the future and protect themselves by engaging in risk management.

The future is always "present" in our society and offers opportunities which companies may capitalize on (Giddens, 1999; Bernstein, 1996). While Giddens and Pierson (1998) argue that we live in a "risk society" Beck (1992) argues that it is modernization itself which have introduced and given birth to our society's awareness and handling of uncertainties. They argue how the risk we are exposed to today is a result of modernization and therefore the assessment of risk is possible (Beck, 1992; Giddens & Pierson, 1998). This change in our society has given us "corporate governance" which basically enforces companies to be good citizens. As a result, the use of management control systems has increased in the form of internal control, risk management programs, auditability and responsibility. The firm should not be exposed to any risk it is not supposed to be exposed to and it should only be exposed to "wanted" risk (Culp, 2002). This has led to companies engaging in risk mitigation where e.g. risk transfer is a big part of a company's risk assessment. A common risk transfer used among businesses is the usage of hedging where uncertain or unwanted price development in commodities is controlled by taking on or structuring contracts.

Whilst it may be popular to use hedging its effectiveness has been questioned to the cost surrounding hedging strategies (Mello & Parsons, 1999; Rampini et al., 2014). Although hedging may indeed have potential in mitigating price fluctuations these findings suggest that the more a company is in need of having stabilized cash flows, the costlier it will be (Ibid). However, despite the level of inconsistency in gains from hedging, companies may still benefit from setting up hedging positions to reduce expected cost of bankruptcy (Smith & Stulz, 1985). Furthermore, hedging has also been proven to reduce underinvestment by coordinating investment and financing which otherwise is a common agency problem arising between shareholders and debt holders (Froot et al., 1993). Mello and Parsons (1999) emphasize the need for collateral and cash buffers if a company chooses to engage in hedging in order to cover unrealized losses. Their findings suggest that the companies best suited to engage in hedging are the ones with large cash assets or excessive cash flows. This may be an indication of larger firms being more suitable for hedging, but although larger firms do hedge more, they do it for reason unrelated to financial constraints (Stulz, 1996). In addition, previous research has examined how larger firms try to time market prices (selective hedging), thereby alternating the length of the hedging positions to increase value (Haushalter et al., 2006). However, no significant result for economic gains has been found. Due to the empirical evidence of firms trying to time the length of its hedging positions, but while the reason behind it is debatable, we find it is reasonable to conduct further studies on the determinants for the length of hedging positions, e.g. hedging maturity.

1.2 Research Problem and Purpose

According to classical theories in risk management leverage increase the hedge ratio of a firm while hedging also reduces underinvestment and expected costs of bankruptcy (Smith and Stulz, 1985; Froot et al., 1993; Tufano 1996). However, more recent theories emphasize on the costs associated with executing risk management (Mello & Parsons, 1999; Rampini et al., 2014). Hence, theories make opposite predictions where Froot et al. (1993) implies that financially constrained firms hedge more while the theory of Rampini et al. (2014) claim that financially constrained firms hedge less. The determinants of hedging maturity and its influence in a firm’s risk management strategy is still an unexplored area of modern risk management theories. There is a time dimension to hedging when firms use it to speculate. Studies conducted on speculative hedging suggest that firms with information advantage are more likely to use hedging programs for speculation (Stulz, 1996; Adam et al., 2017; Jankensgård, 2015).

While there is a large portion of literature, theory and empirics on debt maturity trying to explain why for instance firms choose long versus short maturities the maturity dimension of hedging positions is close to non-existent. Previous studies have analyzed the correlation between asymmetric information and the choice of risky debt maturity (Flannery, 1986), the debt maturity structure and liquidity risk (Diamond, 1991) and the empirical determinants of debt maturity (Stohs & Mauer, 1996). In a more recent study Brick and Liao (2017) have examined the joint choices of cash holdings and debt maturity while Khaw and Lee (2016) examine how firms use debt maturity as a tool to mitigate underinvestment problem. Moreover, studies have been pursued in the association between tax aggressiveness and corporate debt maturity where evidence show that shorter debt maturity is more prevalent for tax aggressive firms (Kubick & Lockhart, 2017). Managerial incentives and how they affect the maturity structure of corporate public debt has also been examined by Tanaka (2016) who found that firms with higher managerial ownership issue shorter maturity bonds. Furthermore, Lasfer (1999) present evidence for larger firms holding higher levels of long-term debt while smaller firms hold short-term debt. In addition, Barclay and Smith (1995) agued how large firms with few growth options tend to hold a higher level of long-term debt. Despite the rich empirical literature in debt maturity explanations of the determinants of hedging maturity is still not touched upon. Traditional risk management theory has put its attention on the volume aspect of hedging and the area of debt maturity is well-researched. Although hedging maturity is a relatively uncharted part of risk management research some empirical studies indicate that hedging effectiveness increase with maturity (Ederington, 1979; Hill & Schneeweis, 1982; Geppert, 1995; Lien & Shrestha, 2007; Ghoddusi & Emamzadehfard, 2017). In addition, several studies have investigated if there is a relationship between derivative usage and firm value (Carter et al., 2006; Jin & Jorion, 2006; Allayannis & Weston, 2001; Khediri & Folus, 2010; Bessembinder, 1991; Lookman, 2004).

The focus on this study lies in trying to discover new aspects of hedging by empirically evaluate the factors and determinants of hedging maturity. Due to the fact that this area of research is still in an immature and primary phase make studying the hedging behavior of firms from a maturity perspective an interesting topic worth researching in. Therefore, the aim of this study will emphasize on the determinants of hedging maturity with a focus on the relationship to the companies' chosen debt maturity to observe whether the characteristics of a firm's debt determine the length of firms hedging positions. Moreover, this study takes a firm perspective and examines if the theory behind debt maturity is relevant and applicable in determining the maturity of hedging positions.

Based on the existing theory indicating that larger firms hold higher levels of long-term debt and hedge to a higher extent than smaller firms, we derive in the following research question: Is long-term debt a determinant for hedging maturity?

1.3 Contribution to Existing Research

The paper's contribution relative existing research is mainly the new insights it adds to a still unexplored area in modern risk management theory. In contrast to the volume aspect of hedging we shed light on to which degree the features of a firm's debt have an influence on the maturity on firms hedging positions and derivative usage. Previous research has only been done on the determinants of a firm's debt maturity and while theoretically the same logic applies, our study investigates the specific differences and implications of these theories. The study puts a new perspective on the hedging dimension and opens up an area that gives plenty of room to conduct additional future research on. Moreover, the study contributes to the existing research in that we combine and test both classical and recent theories. Furthermore, our study provides new empirical results by associating a new proxy for corporate hedging, supplementary to the traditional hedge ratio, as a dependent variable in our regression model and linking it to a set of different independent variables.

1.4 Research Limitations

The original sample of the companies studied in this paper consisted of 214 oil and gas companies. However, the observations for the companies in the original dataset without any reported numbers related to our independent variables were excluded. Our results are industry and country specific to the American oil and gas industry which diminish the probability of receiving a generalized result of corporate hedging practice. Moreover, the range of the time period researched in this study (Q4 2012 – Q2 2016) can be discussed as it includes a noteworthy drop in oil prices which has an influence on our result.

1.5 Outline of the Study

Chapter one provides the background regarding the relevance of the research topic and specifies the study's particular research problem together with the paper's purpose and contribution to existing theoretical knowledge. Chapter two contains the theoretical framework of the research field relevant to the research problem and purpose followed by the hypothesis development. Chapter three describes the methods chosen and the logic behind the methodological design together with the data used. Chapter four demonstrate the empirical results and analysis based upon the theoretical approach and empirical data. Chapter five present the conclusion of the study and suggestions for future research.

2 Theoretical Review

2.1 Modigliani & Miller

Modigliani and Miller (1958) proposed that under ideal market conditions the market value of the firm is independent of the financing structure while the firm's financing decision is of no consequence to its claimholders. Hence, the market value of the firm is always the value implied by its optimal capital structure, irrespective of the actual choice of capital structure by the firm. Modigliani and Millers propositions are based on the assumptions that there are perfect capital markets where all market participants share homogenous expectations and atomistic competition. Furthermore, they assume that a firm's investment program and financing is known and fixed. According to Fama (1978) these assumptions are enough to prove that value is independent of financing. On key implication of the ideal capital market assumptions was proposed already by Fisher (1930) in the Fisher separation theorem which says that in an ideal capital market value is maximized for all owners if the firm undertakes all investments with positive net present value. Moreover, it says that the investment decision is independent of the financing decision and of the preferences of the owner.

Another implication of Modigliani and Millers propositions is that if there is an optimal capital structure, the firm will always be as if it were optimally financed. According to Froot et al. (1993) there is nothing a risk management program can do to improve the underlying bad economics of low prices. When the Modigliani-Miller assumption hold, investors will be able to replicate any risk management decision themselves through portfolio diversification and at similar cost. The equilibrium price of any asset reflects the systematic risk of that asset under an ideal capital market, free from unexploited arbitrage opportunities. This means that in a Modigliani-Miller world hedging using fairly priced derivatives will not influence the net present value of any project and all corporate risk management becomes irrelevant. It just affects how value is divided among different investors, not the total value. Risk management should be value adding under risk neutrality due to managers incapability to manage systematic risk. Instead, managers should focus on managing unsystematic risk due to the firm's owners' knowledge in their own risk preferences. However, the owners are risk neutral relative unsystematic risk and are not willing to pay to reduce exposure to unsystematic risk. This implies that if risk management should be value adding to a firm there has to be market imperfections in which hedging will affect and be beneficial to the firm (Smith & Stulz, 1985).

2.2 Risk Management

Any firm is subject to both systematic and idiosyncratic risk and risk management is about identifying and evaluating risk which a company is exposed to and how to prepare or deal with the outcome of a future event. The concept of risk could be referred to as the magnitude and likelihood of unanticipated changes that have an impact on a firm's cash flow, value or profitability where risk is the measure of the unforeseen changes (Oxelheim & Wihlborg, 2008). Risk comes from various sources but in finance it is usually sprung from uncertainty. Within corporate risk management the use of hedging is often discussed, and risk exposure is often reduced through buying and selling forward and future contracts (Bystrom, 2007). There are various situations and scenarios where hedging can be beneficial or valuable for a firm. Smith and Stulz (1985) argue how hedging could reduce expected costs of bankruptcy and Froot et al. (1993) showed how hedging could reduce underinvestment. They argued how volatile cash flows and costly external financing could be stabilized (coordinated) with the hedge strategies, thus reducing the level of underinvestment. However, others argue whether or not hedging really stabilizes cash flows and emphasizes the costs of risk management (Mello & Parsons, 1999; Rampini et al., 2014). Although risk management is supposed to save corporate resources the same authors present a paradox surrounding risk management. According to the authors, the cost of risk management increases as a firm becomes more financially weak which poses a complex problem from a risk manager's point of view. Whilst the authors may agree on the paradox their view of collateral constraints differ. Mello and Parsons (1999) argue that hedging requires collateral in the form of cash buffers and credit lines in order to cover unrealized losses on hedging contracts. In contrast Rampini et al. (2014) makes the case of financially constrained firms' preference of financing over hedging. When it comes to whether or not financially constrained firms hedge more or less the community is divided (Froot et al., 1993; Rampini, 2014), but we do know larger firms hedge more (Stulz, 1996). Furthermore, other authors argue how the hedge ratio is affected by leverage (increases) and cash flow (decreases) (Tufano, 1996; Disatnik et al., 2014) which points to a relation between financial flexibility and hedging.

2.3 Determinants of Hedging

According to theory, risk management with hedging strategies has the potential to reduce the cost of financial distress (Nance et. al., 1993). Firms can use hedging as a strategy to reduce the cost of bankruptcy and there is evidence for the extent of hedging to be related to a firm's financing cost (Smith & Stultz, 1985; Haushalter, 2000). In addition to the risk reducing benefits of hedging there is also the aspect of selective hedging where firms adjust the size and timing of their hedging programs based on their market views (Jankensgård, 2015; Adam, et al., 2015). The existing theory suggests that financially distressed firms speculate more in an attempt to overcome financial distress (Campbell & Kracaw, 1999; Stulz, 1996). According to Adam et al. (2015) managers hedge more selectively if they have experienced gains in the past. Jankensgård (2015) further enhance this argument and highlights the fact that there is more selective hedging in firms with high inside ownership where overconfidence makes managers increase the selective hedging.

The result from studies regarding speculative hedging in relation to firm size is not coherent. Adam et. al (2015) present evidence implying smaller firms speculate more than larger firms. However, the authors also find evidence, in the same sample, for larger firms speculating more due to an information advantage compared to smaller firms. Whilst the authors argue whether or not firm size is related to speculation they find evidence for a negative relationship between speculative hedging and the probability of distress. Stulz (1996) argue there are two conditions necessary for selective hedging to be value creating. The first condition is that the firm has an information advantage over other market actors that it can take advantage of. When a firm has the perception of having information advantage it motivates them to extend their derivative operations to include active trading based on a market view (Geczy et al., 2007).

2.4 Financial Distress

Financial distress is a state where a company fails to meet its financial obligations to its creditors. The increased risk of bankruptcy may lead to increased cost of financing and give birth to opportunity cost related to projects. According to Ogden et al. (2003) the cost of falling into financial distress is a function of the probability of falling into distress and the cost of bankruptcy. In addition, financial distress is seen as costly and its possibility is important in determining the optimal level of leverage (Opler & Titman, 1994). Whilst higher levels of leverage typically increase the possibility of financial distress, firms with a too low level of leverage do not utilize the potential value increase of adding debt to the company's capital structure. Furthermore, previously conducted research has proven that there is a positive relation between a firm's financial condition and its performance in downturns (Opler & Titman, 1994). The authors found that high leveraged firms struggle more than its counterparts during downturns which may force companies to seek out methods (e.g. hedging) to reduce the cost of financial distress. Two common ways for a company to reduce its financial distress cost is to reduce the expected cost of bankruptcy or the probability of financial distress (Ogden et al., 2003).

Cost arising from financial distress may be loss of competitiveness where a firm is forced to pass up valuable projects or forced to sell assets in order to increase liquidity. This fact is supported by Opler and Titman's (1994) findings of how leveraged firms experience larger drops in equity value and lower operating income. However, Andrade and Kaplan (1998) argue the importance of distinguishing between financial and economic distress. Economic distress relates to a negative operating income whilst financial distress relates to failure of meeting legal obligations (debt payment). In their research they showed how distress arised due to high level of leverage and not economic distress. To mitigate the risk of a firm from entering financial distress it is possible to reduce the volatility in the firm's cash flow by engaging in hedging (Stulz, 1996). Although authors agree upon the potential benefits of hedging their belief of who the majority user is differ. Whilst Froot et al. (1993) argues financially constrained firms hedge more, Rampini et al. (2014) argue that financially constrained firms hedge less.

Haushalter (2000) found evidence supporting the theory of firms with higher leverage engaging in hedging to a larger extent than firms with lower levels of leverage. The link found by Haushalter (2000) is consistent with the argument by Froot et al. (1993) that hedging can reduce financing costs while it also supports the notion by Stulz (1996) who argues that corporate hedging can be viewed as a technique that allows managers to substitute debt for equity. As a result, Haushalter's (2000) evidence suggest that hedging and financing policies should be made jointly in order to not miss the relation between capital structure and the determinants of the costs of financing. However, although firms facing financial constraints hedge more extensively, this relation does not imply that it increases shareholder value but instead it can lead to overinvestment (Tufano, 1998).

To determine how much of a corporates capital which stems from debt the measurement leverage ratio is used. The most common one is debt to equity ratio and it is used as an indication of how aggressive a company is while at the same time signaling the level of risk involved in investing in the specific company. The riskiness of both equity and debt increases with leverage and principal agent theories both affect and are affected by leverage (Ogden et al., 2003). As a company increases its leverage it increases the possibility of entering financial distress where the first sign is negative cash flows and reduced earnings. Moreover, an increase in leverage ratio for a firm makes debt harder to pay off as a whole and thus affects the firm's investment decisions (Culp, 2002). If the issue is not resolved the firm runs the risk of having to lay off employees, close factories and failure of meeting payments to suppliers and creditors. If any of the actions does not solve the problem the company will enter the last stage, bankruptcy. Hence, one way to reduce this cost is if the firm hedges.

There are several theories explaining why risk management can be viewed as a substitute for equity capital or alternatively increase a firm's debt capacity. In Myers (1977) under-investment model, risk management had the role of reducing a firm's exposure that can eat through equity values and increase the relative proportion of debt in the capital structure and thus aimed at hedging value. In other words, risk management can be used by equity to expropriate debt. According to Froot et al. (1993) and their cash flow model, risk management should instead focus on reducing the firm's dependence on leverage to fund certain investments and thus aim at hedging cash flows. Mayers and Smith (1982) and Smith and Stulz (1985) were among the first to provide arguments that hedging reduces the probability that a firm encounters financial distress by reducing the variance of firm value. Furthermore, a firm can reduce bankruptcy costs by holding a hedge portfolio that pays positive amounts when the firm would be bankrupt without hedging (Smith & Stulz, 1985). Despite previous mentioned concerns there are proven benefits related to the use of leverage (e.g. tax-shield) which makes it a common practice within corporate financial management. In addition, whilst the use of debt to equity varies between firms it has been proved to have significance to the use of hedging strategies. This is in line with the studies showing how hedging can reduce the risk of bankruptcy while at the same time increase firm value, thus making it reasonable for firms with high leverage to hedge (Stulz, 1996). Furthermore, Haushalter (2000) argued the existence of a positive relation between financial leverage and hedging by proving how higher leveraged companies engaged in more hedging.

2.5 Debt Maturity

The choice of debt maturity is one of several decisions that comprise corporate financial theory. For instance, this includes the choice between debt and equity or whether to issue public or private debt. When a firm decides to finance its operations and growth opportunities with debt, the firm has to decide on the maturity of debt where different debt maturity has different advantages and shortcomings. According to traditional theory firms should match the maturity of their debt to that of their assets i.e. debt maturity is measured relative to the timing of the cash flows. Stohs and Mauer (1996) findings support this theory and indicate that asset maturity is an important factor in explaining both cross-sectional and time-series variation in debt maturity structure. Their results suggest that larger, less risky firms with longer-term asset maturities use longer-term debt. Another aspect of the maturity dimension is looked into by Flannery (1986) who evaluates the extent to which a firm's choice of risky debt maturity can signal insiders' information about firm quality. Whilst Myers (1977) concludes that a firm's value will be maximized by issuing debt whose maturity corresponds to the life of the investment projects being undertaken Flannery (1986) offers a reason why some firms would prefer to issue short debt to finance longer maturity investment projects. Such behavior credibly signals insiders' optimistic evaluation of the firm's prospects. For instance, if bond market investors cannot distinguish between "good" or "bad" firms, good ones will consider their long-term debt to be relatively underpriced, and will, therefore, issue short debt (Ibid).

Corporate debt is divided into short and long-term debt where the label of the obligations is determined by its due date. Myers (1977) found that firms with more growth options have less long-term debt in their capital structure. This is consistent with the findings made by Barclay and Smith (1995) where large firms with few growth options had more long-term debt in their capital structure. They also found evidence for firms with larger potential information asymmetries issued more short-term debt. Furthermore, firms with high or low bond ratings have debt with shorter average maturity (Stohs & Mauer, 1996). Companies with a high probability of lacking funds to settle long-term financial obligations while at the same time having a low credit rating have no other choice than short maturity loans (Ibid). However, firms with small liquidity risk have no incentive to ignore short-term debt and the authors found that as a firm's leverage goes up so does its liquidity risk, thus making it more common for high leverage firms to have long-term debt (Ibid). This is aligned with Diamond's (1991) findings that borrowers with high credit rating prefer short-term due to their willingness to bear the liquidity risk of refinancing short maturity debt, and those with some-what lower ratings prefer long-term debt.

Another aspect to take under consideration in the choice of debt maturity is to which degree tax planning is conducted in a firm. Kubick and Lockhart (2017) argue that tax planning has a meaningful influence on debt contracting and suggest that shorter debt maturity is more prevalent for tax aggressive firms. Their results suggest that lenders view this as a risky activity and therefore restrict the maturity structure of debt to provide a monitoring mechanism for the contracts. According to Culp (2002) a firm whose objective is to maximize post-tax firm value can benefit from risk management if the Modigliani and Miller assumption of frictionless capital is violated. When focusing on the role of investor, Tanaka (2016) found that firms with higher managerial ownership have lower credit ratings, showing preferences for more risk-taking activities and issue shorter maturity bonds. These findings support the view that bondholders are concerned about wealth transfer from bondholders to shareholders through managers engaging in risk-taking activities and thus require these firms to issue shorter maturity bonds. Hence, the evidence is consistent with the idea that investor demand in the corporate bond markets plays an important role in determining the maturity structure of corporate bonds.

The choice of debt maturity can also be used as a tool to mitigate underinvestment problem. Brick and Liao (2017) shed light on the debate on cash holdings and debt maturity. They argue that firms that face financial constraints would borrow long-term debt to build up the firm's cash reserves and thus find that there is a positive relation between debt maturity and cash holdings. Lasfer (1999) present evidence for larger firms holding higher levels of long-term debt while smaller firms hold short-term debt. In addition, Barclay and Smith (1995) agued how large firms with few growth options tend to hold a higher level of long-term debt.

This leads us to the hypothesis: There is positive relationship between long-term debt and hedging maturity.

2.6 Reviews of Derivatives

Derivatives are financial securities whose value depends on the value of an underlying asset (Bystrom, 2007). The underlying asset can be almost anything and the limitless possibilities have given rise to a large and fast growing derivative market. From a risk management point of view this has increased the need for technical expertise in derivatives and they are characterized as linear and non-linear. Linear derivatives (futures & forwards) are securities where the payoff is a linear function of the movement in the underlying asset and the payoff for non-linear (options) derivative changes with time and space (Ibid). The use of derivatives (hedging) has been proven to reduce cash flow volatility and thereby reducing the risk of a company becoming financially distressed (Fang & Lin, 2007; Stulz, 1996). The focus of this study is the determinants of both linear and non-linear hedging maturity and therefore the focus of the next sections will be on futures, forwards and options.

2.6.1 Futures and Forwards

Futures and forwards are financial instrument used to purchase something today with delivery tomorrow (Bystrom, 2007). A risk manager who takes on a future contract will be obligated to buy or sell something in the future and do not have the option to buy or sell as one would if they used non-linear derivatives (e.g. options). The price at which the exchange will take place is called forward price and the time is called maturity date. Although the securities are similar there are differences in future and forward contracts. Forwards are non-standardized contracts where each contract is tailor-made, bilateral, they are traded over the counter and the underlying asset is usually delivered at the maturity date (Sundaram & Das, 2011). Futures are standardized contracts, traded on organized future exchange and the underlying asset is settled in cash at the maturity date of the future contract. The buyer is said to be in a *long* position and the seller is said to have a *short* position (Sundaram & Das, 2011). Furthermore, a forward contract has a onetime transaction of cash which takes place at the maturity date of the contract whilst a future contract is valued mark-to-market (Bystrom, 2007). This means the contract is revaluated on a daily basis in relation to its spot price and small transaction between the parties occurs every day as a result of the price fluctuations. The price of the contract is set by using arbitrage principle and it follows the *law of one price*.

2.6.2 Hedging with Futures and Forwards

Although futures and forwards are possible to use for speculative purposes they are best used as tools in risk management (Bystrom, 2007). Futures and forwards enable investors to hedge exposures related to market commitments (Sundaram & Das, 2011). The advantage of hedging with forwards and futures is the knowledge of a future price for an asset bought today which gives the risk manager an opportunity to stabilize future cash flows or in other words, eliminating cash flow uncertainty (Sundaram & Das, 2011). However, there is a possible risk in hedging with futures which the academics refer to as *basis risk*. The *basis* refers to the difference between futures and spot prices in a futures contract and it may fail to be riskless due to *commodity basis risk* or *delivery basis risk* (Sundaram & Das, 2011). *Commodity basis risk* occurs when the future price deviates from the underlying assets spot price at maturity. This is due to deviating grades between the asset being hedge and underlying asset of the future contract. *Delivery basis risk* occurs when the contracts expirations date differs from the expiration date of the position being hedged. By acknowledging basis risk, one must accept that hedging cannot entirely eliminate the risk (variance) related cash flows. To mitigate the variance in cash flow Sundaram and Das (2011) suggest one should choose the contract with the highest correlation (absolute value) between its price changes and the changes of the spot price of the asset being hedged. Due to the superiority of the mentioned correlation, the authors argue how the length of hedging positions does not have a significant impact on the variance of cash flows. However, the determinants of the contracts length are not proven.

2.6.3 Options

Non-linear derivative instruments are option contracts and contracts with embedded options. Option-based derivatives have values that are not linear in the underlying price and thus cash flows on option-based contracts can change by more or less than the underlying changes (Culp, 2002). Options function more as classical insurance and unlike forwards and futures, which are binding contracts for both sides, options give the holder the right to, but not the obligation, to buy (call) or sell (put) an asset at a pre-determined price (strike or exercise price) on a specified future date (European) or on or before a specified future date (American) The privilege of having the option of walking away has a price in terms of a premium that the holder pays and one of the most well-known option pricing models was developed by Black and Scholes (1973). Options can have a variety of assets, indexes or reference rates underlying them and the basic plain vanilla option is either negotiated Over-the-counter (OTC) or listed on an exchange. Obvious examples are options based on common stock, commodities and foreign exchange in which the value is based on (Culp, 2002). Moreover, OTC interest rate options based on market determinations of LIBOR called caps, collars and floor have during the past decade caught increasing attention.

Like forward contracts, option contracts are also zero net sum assets, however, unlike forward contracts the "price" of an option is equal to the premium paid by the long to the short. There are also examples of non-traded financial options such as employee stock options often used for incentive reasons. They are contracts in which employees or managers or a firm are compensated with an option-like equity component that allows them to buy some number of shares on or before some specified date at an agreed price. In addition to financial options any option in which managerial flexibility to make decisions conveys value on the firm is called a real option.

2.6.4 Hedging with Options

A core purpose of options is to allow firms to turn view about future into profits (Gottesman, 2016). Options can be used to control risk and one of its most important applications is as a hedging vehicle (Kolb & Overdahl, 2003). Although options are usually regarded as risky instruments, it is possible to create option positions that have substantially lower risk than an outright position in an option. Options can protect a firm from the financial consequences of unfavorable changes in market prices and the four basic naked option strategies are long call, long put, short call and short put (Sundaram & Das, 2011). Hence, the main difference between derivative instruments such as futures and forward contracts is that for the holder of an option the downside risk is limited (Eales & Choudhry, 2003).

From a risk management standpoint, options are not only used to hedge against (or bet on) a market view, typically about price views, but uniquely also on market volatility views. The choice of option position embodies if a firm is bullish or bearish on the market direction and volatility. If the market moves the opposite direction the maximum loss will be the premium paid for the position multiplied with the number of contracts bought. Option contracts can be used both to speculate and to hedge portfolio risks and a combination of options can create new payoff profiles. There are plenty of strategies through which a firm can monetize a volatility or price view such as “straddles” and “strangles”. However, this paper will not dive further into detail on advanced option strategies.

3 Methodology

3.1 Theoretical Method

The focus of this study will be on the determinants of hedging maturity and the different factors determining the length of an investment or speculation. Furthermore, we will look into possible variables that may explain the length/ maturity of financial instruments used in hedging and if the theory regarding debt maturity is applicable for hedging. In order to answer these questions, we used secondary data containing quarterly information about a pool of American oil and gas companies hedging behavior and their financial performance over a span of 15 quarters (Q4 2012 – Q2 2016). In addition to the dataset provided by Lund University we added financial ratios previously determined to be significant for hedge ratio. The research conducted in this paper may be viewed as a time series study due to the way we conduct our analysis. By looking at various variables relevant to hedging maturity over a period of time and how or if they change we try to find the determinants of maturity. Whilst qualitative studies may bring valuable insights, a quantitative method is more suitable for the purpose of our study. The goal of our study is to discover explainable variables for our dependent variable hedging maturity. The most suitable method when researching relationships between financial historical variables is a quantitative study where we quantify data and run correlation and regression analysis. The quantitative method provides a more accurate precision in its analysis compared to a qualitative study. However, a qualitative study usually ventures deeper and is more open for discussion whilst a quantitative study explains a phenomenon (Denscombe, 2009).

3.1.1 Research Approach

We used a deductive method, the most common view, as we try to view the relationship between theory and research where we search for explanation and prediction (Bryman & Bell, 2011). To answer our research question, we have constructed and based our hypothesis with well-established theories within the area of corporate finance and risk management. In this paper we used statistical calculation methods to test our hypothesis. We calculated the statistical significance for our hypothesis and the results have been achieved in a correct way (Palsson, 2001). Our research uses the philosophical system of positivism where metaphysics and theism are rejected and only that which can be scientifically verified is valid (Bryman &

Bell, 2011; Depoy & Gitlin, 1999). The data used in this paper is free from interpretation and the conclusion drawn is based on accurate calculations.

3.1.2 Ethics

There are certain rules and guidelines of how one should behave and act towards participants while conducting research. Denscombe (2009) points out the importance of transparency and how the author should document and communicate the work process. In addition to being transparent the research should not in any way be harmful to any participants or equivalents (Bell & Bryman, 2011). According to the AoM *Code of ethical conduct* the responsibility of any potential harm to individuals lie with the researchers (Ibid). Furthermore, the MRS *Code of conduct* emphasizes the need for researchers to take all possible precaution to ensure no participants are harmed during or as a result of the conducted research.

3.2 Data Description

3.2.1 Secondary Data

The secondary data for this study consist of documented and reported actions related to the usage of derivatives among American oil and gas companies. The dataset was provided by Lund University and span over a period of 15 quarters (Q4 2012 - Q2 2016). To answer our hypothesis, we gathered company specific data from Thomson Reuters Datastream Economics database regarding information and data related to the company's total debt, market value, total assets, share equity and number of employees. Scientific publications, books and other articles were used to broaden and provide depth to this papers area of interest, risk management. These scientific sources provided us with information and a foundation to think of and research an unexplored area within the subject of risk management. Finally, by using public accessible secondary data we have increased the credibility of the study making it possible for others to repeat it (Denscombe, 2009; Befring & Andersson 1994).

3.2.2 Data and Critique

When one is conducting empirical research, it is of utmost importance to treat data carefully and it should not be tampered with (Denscombe, 2009). Furthermore, when we are dealing with statistical data one should be cautious of who has gathered the data and why they have gathered it (Dahmstrom, 2011). Moreover, due to random samplings inability to completely represent the population as a whole there is a risk in basing decision on incomplete information. We have been careful in our handling of the data used in this study, especially when we have been forced to do small adjustment and calculations in the dataset. The data used in our research is originally gathered and made public for purposes other than research but is widely used among academics. Due to this we feel comfortable in using data provided by Thomson Reuters Datastream Economics.

3.2.3 Selection of Companies and Time Period

Companies in the original dataset without any reported numbers related to our independent variables were excluded. Due to our data containing cross section observation over time, we ran our test on an unbalanced panel data spanning over a period of 15 quarters (Q4 2012 - Q2 2016).

3.3 Empirical Method

3.3.1 Selection of Model

The model used in this paper will be an OLS regression in a panel setting. This choice is based on previous studies where the determinants for hedging have been examined and the reasoning behind the included variables will be argued for in the section below (Haushalter, 2000; Haushalter et al., 2006; Adam et al., 2008).

3.3.2 Dependent Variable

Hedging Maturity

Due to derivatives potentially having a significant impact on a company's profits this study looks at the determinants of hedging maturity. We examine whether the level of long-term debt and/or leverage is a determinant of the length of a company's derivative contracts and thus our dependent variable is hedging maturity. We find maturity a qualified measure to use as a proxy for assessing a firm's hedging policy. It differs from a firm's hedge ratio in the way that maturity shows the strategic planning of horizon of management while the hedge ratio represents the amount of the hedged position on an annual basis. Previous studies in this area has analyzed the optimal hedge ratio and concluded that hedging effectiveness increase as the hedge horizon becomes longer i.e. using longer maturity contracts may improve the hedging effectiveness (Ederington, 1979; Hill & Schneeweis, 1982; Geppert, 1995; Lien & Shrestha, 2007; Ghoddusi & Emamzadehfard, 2017). Using hedging maturity instead of hedge ratio as a dependent variable will enable us to examine new dimensions of the hedging positions conducted by the companies in our dataset and shed light on aspects that is still not explored.

3.3.3 Independent variable

Long-term Debt

We use a long-term debt ratio as a measurement to determine our companies financial leverage and borrowing capacity. Moreover, the long-term debt ratio is used a proxy for expected financial distress. The variable involves the companies' portions of debt issued with an original maturity greater than one year and it is the ratio of the company's book value of long-term debt to its total assets. We find it to provide a reliable measure of our companies long-term financial positions and their ability to meet financial requirements. Traditional risk management theory claims that the higher a company's long-term debt ratio is, the more likely the firm is to use derivatives. Furthermore, hedging is believed to reduce the probability of a company falling into distress trough the reduction of the variability in companies cash flows (Mian, 1996; Géczy et el., 1997; Smith & Stulz, 1985; Nance et al., 1993).

3.3.4 Control Variables

It is important to ensure the coefficient of the independent variable of interest does not suffer from omitted variable bias and by adding control variables to the regression we can try to eliminate omitted variable bias (Sheather, 2009). If we incorrectly leave out a relevant variable in our regression we have omitted variable bias. Control variables are usually correlated with both the dependent and the independent variable of interest and they are treated the same way as the independent variables but are interpreted differently. We are not interested in the control variable itself but rather the relation and effect it has on the dependent variable.

Firm Size

Firm size is a commonly used proxy in various studies and becomes a standards independent variable in models. The size of the companies in our dataset is measured as the log of total assets.

Hedge Ratio

Hedge ratio is a traditional measure of a firms hedging activity and is usually used as the proxy for hedging intensity. In our study we use a binary variable based on the hedge rollover for the firms in our dataset.

Dividend Payout Ratio

We include the dividend payout ratio for the companies in our dataset as a proxy for their dividend policy. One assumption concerning this ratio is that companies facing liquidity constraints pay small or no dividends. We define the variable like Haushalter (2000) as annual dividends paid to common stockholders as a fraction of income before extraordinary items, adjusted for common stock equivalents.

Financial Leverage

Haushalter's (2000) study confirms a positive relation between hedging and financial leverage. Our definition of financial leverage is in line with Haushalter's (2000) as the ratio of the companies' book value of short-term and long-term debt to the market value of assets.

3.3.5 Reliability and Validity

Reliability and validity define a research study's trustworthiness. Reliability refers to the precision and stability of the measurements in a study (Befring, 1994). High-reliability research can be repeated without the results being different (Ibid). The validity and reliability of a regression model rests on the model being correctly specified. As we have used recognized computational methods and models in our study, and that the study's data is publicly available, possible to repeat, our study has met the requirements for reliability. Validity is defined as how well the study measures what it intends to measure according to the formulated research problem (Befring, 1994).

3.3.6 Normality

Due to the large skewness and kurtosis among our independent variable we conducted a test for normality called Bera-Jarque which states that the distribution is set by the mean and the variance (Brooks, 2014). If the sample contains skewness below or above 0 then the residuals are not normally distributed around its mean. Furthermore, if the level of kurtosis deviates from the level of 3, the data is determined to be non-normally distributed. The Bera-Jarque test statistic is given by:

$$W = \mathrm{T} \times \left[\frac{b_1^2}{6} + \frac{(b_2 - 3)^2}{24}\right]$$

Where T is the sample size (Brooks, 2014). The result from the Bera-Jarque normality test indicates that the variables in the sample are non-normally distributed (Appendix A). There are some extreme outliers or extreme residuals which cause a rejection of the normality assumption, but this is common in financial modelling (Brooks, 2014). As a result, we tried to mitigate the impact of extreme outliers in our analysis by winsorizing all the independent variables in the dataset. All the independent variables were winsorized at 1^{th} and 99^{th} percentile which reduced the skewness for our sample (Appendix A). Although this particular method introduces statistical bias it was still the preferred method. In addition, to mitigate the effect of extreme residuals the researcher may try a log transformation to "normalize" the distribution. The use of a log transformation reduces the skewness and makes the data more suitable for testing and regression running (Appendix A). Although the data is still non-normally distributed, the level of skewness and kurtosis almost resemble a normally distribution. There is no perfect method to deal with non-normality but due the OLS well researched behavior it is safe to continue using the method. In addition to OLS we can rely on the central limit theorem which more or less states that if the sample is large enough it is considered to be normally distributed (Brooks, 2014).

It is important to note the drawbacks of using winsorizing in order to force a normal distribution. By using winsorizing one introduces statistical bias which can lead to an undervaluation but the opposite, including the outlier in the analysis can lead to overvaluation (Ghosh & Vogt, 2012).

3.3.7 Heteroskedacity

Heteroskedacity is an occurrence where the variances of the errors are not constant. Although heteroskedacity may have a significant impact on a variable it can be hard to detect. By logging the variables, we can rescale the data, making the variance more constant and as a result deal with heteroskedacity (Brooks, 2014).

3.3.8 Endogeneity

Roberts and Whited (2012) argue that endogeneity it the most important and pervasive issue confronting studies in empirical corporate finance. A key assumption of our regression analysis is that the independent variables are not endogenous. Brooks (2014) defines an endogenous variable as a variable whose value is determined within the system of equations under study. Hence, endogeneity can be considered a model misspecification where an error term is correlated with its explanatory variable. Endogeneity threatens the viability of models that make causal claims regarding the relationship between an independent variable and a dependent variable and masks the casual effect of interest. If the variables in the economic model are endogenous their values are to be determined in the model whereas exogenous variables are considered to be determined outside the model (Treviño, 2008). For instance, the reason that OLS cannot be used directly on structural equations is that endogenous variables are correlated with errors which will lead to biased coefficient estimates. In addition, OLS estimates are also inconsistent and do not converge to their true values as the sample tends towards infinity. Consequently, random effects cannot be used if an error term is correlated with any of the variables and the easiest way of dealing with endogeneity is to use fixed effects. In order to reduce possible endogeneity, we lagged the dependent variable and applied fixed effect. The choice of using lagged variables is based on the dynamics of econometric models and the search for possible causality related to our variable of interest and control variable.

Another part of endogeneity is reverse causality which refers to when two variables are jointly determined. Endogeneity can result in misleading hypothesis test and produce bias result (Brooks, 2014). In order to determine if endogeneity existed within in our model we applied the Wald test for detecting reverse causality (Appendix B). The result from the test showed that endogeneity was apparent in our model which if not accounted for could lead to false estimations. To solve for this problem the variables suffering from endogeneity were successfully lagged (-1). Besides when tackling endogeneity, the use of lags is useful when the dependent variable take time to change, the result from a change in the explanatory variable does not immediately reflect a change in the dependent variable.

3.3.9 Multicollinearity

Another aspect that can go wrong in an OLS model is the occurrence of multicollinearity which appears when the explanatory variables are very highly correlated with each other. Brooks (2014) explains how it is possible to distinguish between two classes of multicollinearity: perfect multicollinearity and near multicollinearity. Perfect multicollinearity occurs when there is an exact relationship between two or more variables and will usually be observed when the same explanatory variable is inadvertently used twice (Brooks, 2014). A rule of thumb is that when correlation > 0,8 there is potential multicollinearity, and this is the problem most likely to encounter in practice. The easiest way to detect multicollinearity is to set up a correlation matrix between the independent variables. A common way to address this coefficient-related issue is to drop one of the collinear variables, use a ratio or/and increase the sample size. The reliability of the regression is inferred by this where the most common consequences of near multicollinearity is that the regression becomes very sensitive to small changes in the specification and the individual coefficients will have high standard errors while the R-squared will be high. Hence, this makes the regression appear fine, however, the individual variables are not significant (Brooks, 2014). The correlation matrix ensures there is no multicollinearity between our explanatory variables (Appendix C). However, it is worth mentioning the high correlation between the variable hedging maturity and hedge ratio (0.9). This was expected since maturity cannot be 0, thus there is a direct response between hedging maturity and hedge ratio.

3.3.10 Omitted Variable Bias

Another coefficient-related issue is omitted variable bias. According to Angrist and Pishke (2008) the omitted variables bias formula describes the relationship between regression estimates in models with different sets of control variables. Furthermore, they explain that longer regression i.e. the ones with more controls, has a causal interpretation, while a shorter regression does not. Omitted variables are typically the main source of endogeneity in corporate finance and omitted variables can be described as the explanatory variables that should be included in the specification are not. Brooks (2014) describes an omitted variable as a relevant variable for explaining if the dependent variable has been left out of the estimated regression equation, leading to biased inferences on the remaining parameters. Although simple, the omitted variables bias formulas importance stems from the fact that if you claim an absence of omitted variables bias, you are thenceforth also saying that the regression you have got is the one you want and the regression you want usually has a causal interpretation (Angrist & Pishke, 2008).

3.3.11 Panel Data

Panel data (sometimes called longitudinal data), have both time-series and cross-sectional dimensions. A panel data structure usually comes from measuring the same sample of entities (cross section units) over several time periods such as financial data over quarters. A panel of data embodies information across both time and space and the panel keeps the same entities and measure some quantity about them over time (Brooks, 2014). The easiest way to deal with a panel data structure is to ignore the time dimension and pool the data into larger cross section (pooled regression). The two tools /estimation methods which are commonly used to address the time or cross section heterogeneity are fixed effects and random effects. Theoretically, both fixed effects and random effects can be used both cross-sectionally and across time, however, random effects are very uncommon for time series. Random effects and fixed effects can't be mixed since they have one contradictory assumption in that random effects requires no correlation between error term and the variables (exogeneity), as opposed to fixed effects. Roberts and Whited (2012) describe that the main benefits of using panel data is that it is very informative in the way it controls for individual heterogeneity by observing the same entities repeatedly over time, thus isolating the influence of permanent, entity-specific characteristics. It is also possible to examine how the cross-sectional relationship between variables changes over time. Furthermore, panel data controls for time specificity such as macroeconomic factors, hence making it's possible to isolate the effect of time-specific that affect all entities similarly. Data with variation both cross-sectionally and over time is more informative and generalizable than cross-sectional data measured at a single point in time, or time-series data for a single entity. It also reduces omitted variable bias and thus gives less estimation problems. Moreover, panel data gives our study more observations, more variation, more degrees of freedom, higher efficiency and less collinearity (Roberts and

Whited, 2012). Lastly, if the model is structured properly, a panel of data can remove the impact of certain forms of omitted variables bias in our regression results (Brooks, 2014).

3.3.12 Fixed Effect

One of the most commonly used tool for estimation methods to address cross section heterogeneity is fixed effects. It is an error component model that basically assumes that unobservable entity-specific effects are fixed parameters to be estimated (Roberts & Whited, 2012). The fixed effect strategy requires panel data, i.e., repeated observations on the same objectives and the basic assumption is that it is varying across cross sections (Angrist & Pischke, 2008). However, it cannot be used if the variable of interest is not time varying i.e. unless time-invariant variables are of interest. Brooks (2014) describes fixed effects as a model used for panel data that employs dummies to account for variables that affect the dependent variable cross-sectionally but do not vary over time. Alternatively, variables that affect the dependent variable over time but do not vary cross-sectionally can be captured by the dummies (Brooks, 2014). Low p-values often means cross sectional heterogeneity and generally means that one should use fixed effects. However, there are situation when random effects are more appropriate. A fixed effect estimation is de-meaning all variables in time which makes it more feasible for large sample estimations. Another basic assumption on cross sectional heterogeneity is that there is endogeneity, i.e. correlated with at least one of the variables.

4 Analysis and Discussion

4.1 Descriptive Statistics

The result of the descriptive statistics is presented in table 1. The final sample includes quarterly reported numbers from 197 companies. Furthermore, it is worth mentioning that since maturity cannot be 0 it is impossible to interpret the average value of hedging maturity for the sample as a whole. All of the variables are positively skewed, and most variables have a high level of kurtosis, suggesting that the data is not normally distributed and contains outliers.

Variables	N	Minimum	Maximum	Mean	Median	Std.Deviation	Skewness	Kurtosis
Hedging Maturity	1581	0	3.327	0.761	1.000	0.771	0.499	2.497
Long Term Debt	1581	0	34.000	0.354	0.238	1.500	21.444	480.894
Firmsize	1581	0	117886000	3790388.	374899.0	11543803	6.830	59.537
Dividend Payout	1581	0	0.886	0.031	0.000	0.119	4.654	26.220
Financial Leverage	1581	0	342.250	1.393	0.329	15.637	20.388	434.784
Hedge Ratio	1581	0	1.450	0.263	0.118	0.309	0.854	2.615

Table 1. Descriptive Statistics

Our independent variable of interest which is long-term debt ratio has a minimum value of 0.00 and a maximum value of 34.00 which is a clear indication of existing extreme outliers in the sample. The average long-term debt ratio for the companies in the sample is approximately 0.35 and the median of 0.238 suggest the majority of companies having a below average ratio of long-term debt to total assets. The distribution of the independent variable long-term debt is positively skewed and leptokurtic (Brooks, 2014). Furthermore, the standard deviation is reported to be 1.5 which is roughly 4 times as high as the mean value for the long-term debt ratio. When the standard deviation is larger than the mean, there is a larger spread in the data compared to when the data is more clustered (smaller deviation). Due to the distribution and characteristics of our independent variables we mitigated the extreme outliers impacting our analysis. In addition, descriptive diagnostics were conducted to better understand the variables within our sample.

4.2 Test for Equality

Hedgers vs Non-Hedgers				
	LT DEBT	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE
Hedgers (Mean)	0.311	14.439	0.030	0.377
Non-Hedgers (Mean)	0.167	11.457	0.022	0.302
T-test	0.000	0.000	0.068	0.000

Table 2. Test for Equality

The test of difference for mean show that firms which engage in hedging holds a higher ratio of long-term debt to total assets compared to those firms who do not hedge. Firms who hold hedging positions has a mean average of 0.31 compared to non-hedgers who have a mean value of 0.16. This suggests that firms with more long-term debt in their capital structure are more likely to use hedging positions than firms with lower levels of long-term debt in this sample.

The mean representing firm size is significantly higher among those who engage in hedging and those who do not. The significant difference between the groups shows that in this sample, larger firms uses hedging to a further extent than smaller which supports the fact of larger firms hedging more (Stulz, 1996).

The level of financial leverage is higher for the firms who use hedging compared to the ones who do not. The average financial leverage for hedging firms is 0.37 while it is 0.3 for non-hedgers. These results support the theory of companies with higher levels of financial leverages engaging more extensively in hedging than firms who have lower levels of financial leverage (Haushalter, 2000; Froot et. al., 1993).

The first stage diagnostic for the difference between hedgers and non-hedgers suggest that our sample follows previous studies findings. However, the result from test for equality of means with regards to the length of positions for hedging companies the results are different. The result from test of equality is presented in table 2.

Long vs Short Maturity				
	LT DEBT	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE
Long (mean)	0.325	14.468	0.025	0.383
Short (mean)	0.246	14.311	0.054	0.354
T-test	0.000	0.266	0.000	0.145

Table 3. Long vs Short Maturity

Among the firms who hedge, the ones who hold long positions have a higher level of long-term debt. The average long-term debt ratio for holding long hedging positions is 0.32 while it is 0.24 for shorter positions. The result provides evidence for a difference in long-term debt for long and short hedging maturity. There is no difference in firm size with regards to the length of hedging positions. The level of dividend payout is higher for firms holding shorter positions compared to firms holding longer positions. Finally, the result shows no significant difference with regards to long and short maturity for the variable financial leverage.

4.3 Regression Models

In this section we will present the regression models performed for this study where the relation between the explanatory variables and hedging maturity is measured. The result from the OLS regression will be presented and valuated.

The construction of the OLS regression is based on previously conducted research (Haushalter, 2000). The variable of interest long-term debt ratio is a leverage ratio based on the common long-term debt to total assets. The control variables firm size, dividends and financial leverage are proven determinants of hedging (Tufano, 1996; Mian, 1996; Haushalter, 2000; Haushalter et. al., 2006). The purpose of this regression is to examine if long-term debt determines the level of hedging maturity:

$$\text{Hedging Maturity} = \alpha_0 + \beta_1 LTD + \beta_{2\text{-}5}\,\text{Control Variables} + \varepsilon_u$$

4.4 Regression Analysis

The regressions presented in this section are labeled with statistical significance at 1%(***), 5%(**) and 10% (*). All the variables within the regressions for pooled OLS regression and fixed effect presented in in this section have been treated with attempt to achieve a more normal distribution and white period specification have been applied to ensure robust standard errors with standard errors clustered around the means. In order to enhance the validity of our analysis we choose to run two regression methods. The main reason for this approach is to account for the effect of omitted variables within the regressions. The application of fixed effect deals with omitted variable bias but is less efficient.

	Pooled	Fixed Effect
Long Term Debt	0.057	0.068
	(0.441)	(0.279)
Dividend Payout	-0.504**	0.108
	(0.011)	(0.526)
Financial Leverage	0.045	-0.001
	(0.406)	(0.957)
Firmsize	0.027**	0.038**
	(0.017)	(0.036)
Hedge_Bin	1.296***	1.040***
	(0.000)	(0.000)
Intercept	-0.289**	-0.300
	(0.017)	(0.182)
Number of observat	1596	1596
R-Squared	0.813	0.965

Table 4. POLS and FE Regression with Hedging Maturity as Dependent Variable

The result from the OLS regression with both pooled and fixed is presented in table 4. The coefficient of determination for both settings for the OLS regression is reported to be high. The regression model without fixed effect explains the variation in hedging maturity by 81.3 %. Although the coefficient of determination for the fixed effect regression is higher it is important to acknowledge the lesser efficiency with fixed effects since it accounts for omitted variable bias.

Our variable of interest, long-term debt shows non-significant coefficients for both the pooled and fixed effect. The result from these regressions indicates there is no evidence for long-term debt determining the level of the dependent variable hedging maturity and thus we find no support for our hypothesis.

The result from the regression indicates a significant effect in the level of hedging maturity among some of the control variables. There are three independent variables which are significant for the pooled method, dividend payout, firm size and hedge bin (hedge ratio). Whilst the variable explaining dividend payout is significant at 5% level in the OLS, it becomes insignificant when the possibility of omitted variables is accounted for. The interpretation of this is that there are explanatory variables of hedging maturity not included in the regression. The negative coefficient suggests that dividend payouts reduce the level of the dependent variable hedging maturity. The result of dividend payout having a negative coefficient (negative impact on hedging maturity) could be explained with previous studies arguing how firms paying dividend hedge less and thus may affect the average length of hedging maturity as well (Haushalter, 2000). Furthermore, financial leverage appears to have no significant impact on the length of hedging positions given the current setting. These findings suggest that the proven relation between financial leverage and hedging does not apply for hedging maturity, with regards to previous studies where higher levels of financial leverage lead to increased levels of hedging (Haushalter, 2000; Tufano, 1998; Smith & Stulz, 1985).

The level of firm size is shown to increase the level of hedging maturity at a significant level of 5%. However, when fixed effect is applied the variables interaction with hedging maturity increases. The fact that firm size increases hedging maturity is in accordance with previous studies showing the relation between firm size and hedging (Nance et.al,1993). The control variable hedge_bin is significant by default since hedging maturity cannot be 0 if a firm chooses to hedge.

As mentioned in the method section, the Wald test showed that there was reverse causality in our independent variables, meaning the regression suffered from endogeneity. To remove the effect of endogeneity we ran the OLS pooled and fixed effect regression with lagged values for the independent variables. The result from the pooled and fixed effect regression estimated with lagged explanatory variables is presented in table 5.

	Pooled	Fixed Effect
Long Term Debt	0.084	0.010
	(0.294)	(0.828)
Dividend Payout	-0.526**	0.079
	(0.013)	(0.677)
Financial Leverage	0.041	0.003
	(0.390)	(0.915)
Firmsize	0.026**	0.048**
	(0.026)	(0.015)
Hedge_Bin	1.297***	1.093***
	(0.000)	(0.000)
C	-0.285**	-0.440*
	(0.024)	(0.070)
Number of observations	1516	1516
R-Squared	0.812	0.967

Table 5. POLS and FE Regression with Hedging maturity as Dependent Variable: Lagged Values

The result from the lagged regressions produces similar, although not identical result. The result from the lagged regression gives no support for our hypothesis. The variable of long-term debt is still insignificant for both methods with a coefficient of 0.08 and 0.01 respectively. This further suggests that the variable of long-term debt has no significant impact on the dependent variable hedging maturity when the control variables are included in the model.

Dividend payout is still significant with a coefficient of -0.526 in the pooled setting, which is a small increase compared to the result from non-lagged values. The variable representing a firm’s financial leverage is still insignificant and its explanation for the dependent variable cannot be determined. The most apparent result from the mitigating of reversed causality is that the coefficient for firm size with fixed effects is significant at 5%.

4.5 Discussion

The result from our analysis gives weak support for a positive relationship between long-term debt and hedging maturity. The result indicates that the most significant determinant of the level of hedging maturity is firm size. It has previously been proven that larger firms hold more long-term debt (Stohs & Mauer, 1996) than smaller firms and therefore it is reasonable to believe that there may exist a positive relationship between the variables. Higher levels of long-term debt were reported for hedging firms who hold longer positions but its relation to hedging maturity with the control variables was confirmed to be insignificant.

Long-term debt has been proved to be related to higher level of financial leverage which has been proven to be a determinant for hedging (Stohs & Mauer, 1996; Haushalter, 2000). However, the result from our analysis found no evidence for a significant relationship for either long-term debt or financial leverage. One explanation for this result may be that long-term debt is mainly apparent among companies who bear the characteristics of being large, stable and having few growth options, whilst large hedging firms tend to have more growth options (Barclay & Smith, 1995; Nance et. al, 1993). This would explain why there is a weak positive relation between long-term debt and hedging maturity, but it is insignificant when firm size is accounted for.

The result provided strong evidence for firm size as a possible determinant for hedging maturity. Finally, the capital structure may not be a direct cause for the length of hedging positions a firm takes but rather a characteristic of hedging firms. Although a firm's capital structure can be observed and categorized in relation to its hedging policies, the choice of debt may not be a prominent determinant for the length of its hedging strategies.

5 Conclusion

The aim of this study is to test if long-term debt is a determinant for hedging maturity. The relationship is tested by employing OLS regression with determinants for hedging as control variables. To ensure robust standard errors clustered around the mean we specified each model with white period. The study was conducted on the American oil and gas market due to the companies characteristics in regard to hedging activity.

We found very limited evidence for a positive relationship between long-term debt and hedging maturity. The characteristics of a firm’s capital structure seem to be insignificant when firms decide the length of their hedging positions. The possible link between debt maturity and hedging maturity could not be proved. In addition, the determinants to why firms engage in hedging appear to be a determinant for hedging maturity as well. However, due to no similar study has been conducted on this particular subject, we as authors hope to inspire further studies within the field of hedging maturity.

5.1 Future Research

Further research can be conducted on the maturity aspect of corporate derivative portfolios in companies across different industries and markets hedging several different types of exposures. Moreover, future studies are encouraged to investigate the empirical aspects of the determinants of hedging maturity in other specific geographic locations and market exposures which has not extensively been studied before. There is also potential for future research to put more weight on the speculative aspect of hedging and how selective hedging influence companies derivative portfolios. Lastly, a similar study could examine the maturity dimension of corporate derivative portfolios with varying independent variables such as investigating the relationship between a company’s growth and hedging maturity.

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Appendix

Appendix A: Descriptive statistics

Descriptives

	HEDGING MATURITY	LTD	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGE RATIO
Mean	0.761186	0.354931	3790388.	0.031640	1.393327	0.263335
Median	1.000000	0.238844	374899.0	0.000000	0.329408	0.118164
Maximum	3.327698	34.00000	117886000	0.886100	342.2500	1.450419
Minimum	0.000000	0.000000	4.000000	0.000000	0.000000	0.000000
Std. Dev.	0.771174	1.500022	11543803	0.119369	15.63748	0.309545
Skewness	0.499366	21.44485	6.830703	4.654079	20.38874	0.854306
Kurtosis	2.497231	480.8946	59.53707	26.22030	434.7846	2.615391
Jarque-Bera	82.35962	15165923	222860.0	41226.17	12391136	202.0568
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1203.435	561.1460	5.99E+09	50.02310	2202.851	416.3322
Sum Sq. Dev.	939.6408	3555.104	2.11E+17	22.51348	386358.5	151.3931
Observations	1581	1581	1581	1581	1581	1581

Winsorize level1 and logged	HEDGING MATURITY	LTD	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGE BIN
Mean	0.761186	0.230734	12.58408	0.025694	0.347953	0.540797
Median	1.000000	0.214179	12.83441	0.000000	0.284734	1.000000
Maximum	3.327698	0.844626	17.93762	0.549694	2.030834	1.000000
Minimum	0.000000	0.000000	6.666957	0.000000	0.000000	0.000000
Std. Dev.	0.771174	0.209183	2.747519	0.091486	0.347566	0.498491
Skewness	0.499366	0.750543	-0.195253	4.093607	2.610519	-0.163734
Kurtosis	2.497231	3.082709	2.053968	20.06530	12.26146	1.026809
Jarque-Bera	82.35962	148.8841	69.00218	23600.04	7446.107	263.5473
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1203.435	364.7899	19895.43	40.62284	550.1134	855.0000
Sum Sq. Dev.	939.6408	69.13657	11927.20	13.22418	190.8671	392.6186
Observations	1581	1581	1581	1581	1581	1581

Appendix B: Wald Test

Wald Test: Firm
Equation: COR

Test Statistic	Value	df	Probability
t-statistic	0.240528	1590	0.8100
F-statistic	0.057854	(1, 1590)	0.8100
Chi-square	0.057854	1	0.8099

Null Hypothesis: C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(6)	0.002806	0.011665

Wald Test: Dividend
Equation: COR

Test Statistic	Value	df	Probability
t-statistic	-2.488994	1590	0.0129
F-statistic	6.195093	(1, 1590)	0.0129
Chi-square	6.195093	1	0.0128

Null Hypothesis: C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(6)	-0.445378	0.178939

Wald Test: Financial Leverage
Equation: CORRECT_ONE

Test Statistic	Value	df	Probability
t-statistic	0.138642	1590	0.8898
F-statistic	0.019222	(1, 1590)	0.8898
Chi-square	0.019222	1	0.8897

Null Hypothesis: C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(6)	0.007714	0.055639

Wald Test: LTD
Equation: COR

Test Statistic	Value	df	Probability
t-statistic	1.715608	1589	0.0864
F-statistic	2.943311	(1, 1589)	0.0864
Chi-square	2.943311	1	0.0862

Null Hypothesis: C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(6)	0.128118	0.074678

Appendix C: Correlation Matrix

Correlationmatrix	HEDGING MATURITY	LTD	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGE BIN	FIRMSIZE
HEDGING MATURITY	1.000000 -----					
LTD	0.364968 0.0000	1.000000 -----				
DIVIDEND PAYOUT	0.000514 0.9837	-0.018334 0.4663	1.000000 -----			
FINANCIAL LEVERAGE	0.107405 0.0000	0.359835 0.0000	-0.103418 0.0000	1.000000 -----		
TOBINS Q	-0.322022 0.0000	-0.214974 0.0000	-0.045333 0.0715	0.210715 0.0000		
HEDGE BIN	0.907441 0.0000	0.369625 0.0000	0.042551 0.0908	0.109230 0.0000	1.000000 -----	
FIRMSIZE	0.600201 0.0000	0.383528 0.0000	0.255260 0.0000	-0.163498 0.0000	0.588715 0.0000	1.000000 -----

Appendix D: Hedgers vs Non-Hedgers

Descriptives for Hedgers					
	LT Debt	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGING RATIO
Mean	0.311335	14.43948	0.030274	0.377862	0.383813
Median	0.306839	14.63016	0.000000	0.332838	0.396477
Maximum	0.844626	17.93762	0.549694	2.030834	0.705089
Minimum	0.000000	6.666957	0.000000	0.000000	0.000000
Std. Dev.	0.175469	1.904224	0.089482	0.257823	0.183989
Skewness	0.519585	-0.888958	3.555540	3.321985	-0.230876
Kurtosis	3.738216	4.469790	16.41468	19.46405	2.071672
Jarque-Bera	80.36172	267.3935	8596.517	15169.36	55.67647
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	369.5552	17414.02	27.09508	436.4303	477.0792
Sum Sq. Dev.	36.51637	4369.412	7.158278	76.70929	42.04430
Observations	1187	1206	895	1155	1243

Descriptives for Non-Hedgers					
	LT Debt	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGING RATIO
Mean	0.167890	11.45734	0.022319	0.302351	0.000762
Median	0.103214	10.72384	0.000000	0.220036	0.000000
Maximum	0.844626	17.93762	0.549694	2.030834	0.451488
Minimum	0.000000	6.666957	0.000000	0.000000	0.000000
Std. Dev.	0.197460	2.893531	0.093598	0.383906	0.017644
Skewness	1.143874	0.510456	4.530192	2.646256	23.64962
Kurtosis	3.837622	2.343801	23.12436	11.57416	565.6656
Jarque-Bera	245.8245	64.25342	17494.30	4124.533	14533326
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	166.8826	11995.84	19.23909	294.7925	0.833390
Sum Sq. Dev.	38.71752	8757.660	7.542847	143.5516	0.340244
Observations	994	1047	862	975	1094

Hedgers vs Non-Hedgers				
Test for Equality of Means Between Series				
	LT DEBT	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE
Hedgers (Mean)	0.311335	14.43948	0.030274	0.377862
Non-Hedgers (Mean)	0.167890	11.45734	0.022319	0.302351
t-test	0.0000	0.0000	0.0687	0.0000

Appendix E: Hedgers- Long vs Short Maturity

Long Maturity					
	LT Debt	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGING RATIO
Mean	0.325855	14.46845	0.025021	0.383125	0.751249
Median	0.322074	14.65934	0.000000	0.338387	1.000000
Maximum	0.844626	17.93762	0.549694	2.030834	2.949593
Minimum	0.000000	6.666957	0.000000	0.000000	0.000000
Std. Dev.	0.171521	1.820781	0.084064	0.246235	0.776490
Skewness	0.516919	-1.069511	4.102898	3.516414	0.491813
Kurtosis	3.856443	5.201672	20.93865	22.06736	2.238807
Jarque-Bera	72.91861	386.3339	11965.76	16194.02	164.5553
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	316.4051	14236.96	18.46586	360.5207	1917.939
Sum Sq. Dev.	28.53677	3258.886	5.208150	56.99385	1538.694
Observations	971	984	738	941	2553

Short Maturity					
	LT Debt	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE	HEDGING RATIO
Mean	0.246065	14.31108	0.054963	0.354718	0.203654
Median	0.239095	14.22821	0.000000	0.279293	0.180614
Maximum	0.844626	17.93762	0.549694	2.030834	0.705089
Minimum	0.000000	6.666957	0.000000	0.000000	0.001768
Std. Dev.	0.178556	2.237120	0.108429	0.303150	0.143535
Skewness	0.782328	-0.367441	2.144201	2.839545	0.932333
Kurtosis	3.918548	2.678733	7.388350	13.08678	3.711862
Jarque-Bera	29.62690	5.950195	246.2807	1194.791	37.18143
Probability	0.000000	0.051042	0.000000	0.000000	0.000000
Sum	53.15009	3177.060	8.629216	75.90957	45.61846
Sum Sq. Dev.	6.854688	1106.040	1.834067	19.57475	4.594302
Observations	216	222	157	214	224

Long vs Short Maturity				
Test for Equality of Means Between Series				
	LT DEBT	FIRMSIZE	DIVIDEND PAYOUT	FINANCIAL LEVERAGE
Long	0.325855	14.46845	0.025021	0.383125
Short	0.246065	14.31108	0.054963	0.354718
t-test	0.0000	0.2662	0.0001	0.1458

Appendix F: Regression

Dependent Variable: HEDGING_MATURITY
Method: Panel Least Squares
Date: 05/11/18 Time: 15:18
Sample: 2012Q1 2016Q4 IF HEDGING_MATURITY>0
Periods included: 14
Cross-sections included: 114
Total panel (unbalanced) observations: 1187
White period standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.308109	0.053684	24.36680	0.0000
LTD	0.411279	0.155384	2.646861	0.0082

R-squared	0.024144	Mean dependent var	1.436155
Adjusted R-squared	0.023320	S.D. dependent var	0.464444
S.E. of regression	0.458997	Akaike info criterion	1.282136
Sum squared resid	249.6534	Schwarz criterion	1.290694
Log likelihood	-758.9477	Hannan-Quinn criter.	1.285361
F-statistic	29.31848	Durbin-Watson stat	0.125047
Prob(F-statistic)	0.000000		

Dependent Variable: HEDGING_MATURITY
Method: Panel Least Squares
Date: 05/11/18 Time: 16:42
Sample (adjusted): 2012Q4 2016Q2
Periods included: 15
Cross-sections included: 169
Total panel (unbalanced) observations: 1596
White period standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTD	0.057169	0.074249	0.769971	0.4414
FIRMSIZE	0.027029	0.011333	2.385063	0.0172
FINLEV	0.045055	0.054217	0.831002	0.4061
DIVPAY	-0.504364	0.198858	-2.536299	0.0113
C	-0.289450	0.121514	-2.382026	0.0173
HEDGE_BIN	1.296959	0.044917	28.87451	0.0000

R-squared	0.813591	Mean dependent var	0.765370
Adjusted R-squared	0.813004	S.D. dependent var	0.776574
S.E. of regression	0.335814	Akaike info criterion	0.659234
Sum squared resid	179.3060	Schwarz criterion	0.679442
Log likelihood	-520.0686	Hannan-Quinn criter.	0.666739
F-statistic	1387.922	Durbin-Watson stat	0.181110
Prob(F-statistic)	0.000000		

Dependent Variable: HEDGING_MATURITY
Method: Panel Least Squares
Date: 05/11/18 Time: 16:43
Sample (adjusted): 2012Q4 2016Q2
Periods included: 15
Cross-sections included: 169
Total panel (unbalanced) observations: 1596
White period standard errors & covariance (d.f. corrected)
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTD	0.068837	0.063582	1.082661	0.2791
FIRMSIZE	0.038760	0.018543	2.090263	0.0368
FINLEV	-0.001487	0.028048	-0.053013	0.9577
DIVPAY	0.108518	0.171118	0.634169	0.5261
C	-0.300734	0.225632	-1.332856	0.1828
HEDGE_BIN	1.040058	0.079023	13.16149	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.965682	Mean dependent var	0.765370
Adjusted R-squared	0.961124	S.D. dependent var	0.776574
S.E. of regression	0.153117	Akaike info criterion	-0.804974
Sum squared resid	33.01018	Schwarz criterion	-0.171798
Log likelihood	830.3691	Hannan-Quinn criter.	-0.569825
F-statistic	211.8723	Durbin-Watson stat	0.806789
Prob(F-statistic)	0.000000		

Appendix G: Regressions fixed for endogeneity

Dependent Variable: HEDGING_MATURITY
Method: Panel Least Squares
Date: 05/12/18 Time: 16:46
Sample (adjusted): 2013Q1 2016Q2
Periods included: 14
Cross-sections included: 163
Total panel (unbalanced) observations: 1516
White period standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTD	0.084298	0.080370	1.048870	0.2944
DIVPAY	-0.526784	0.213950	-2.462179	0.0139
FINLEV	0.041628	0.048466	0.858912	0.3905
FIRMSIZE	0.026192	0.011827	2.214677	0.0269
HEDGE_BIN	1.297659	0.046118	28.13780	0.0000
C	-0.285403	0.127073	-2.245969	0.0249

R-squared	0.812159	Mean dependent var	0.792744
Adjusted R-squared	0.811537	S.D. dependent var	0.774886
S.E. of regression	0.336396	Akaike info criterion	0.662894
Sum squared resid	170.8749	Schwarz criterion	0.683965
Log likelihood	-496.4736	Hannan-Quinn criter.	0.670739
F-statistic	1305.746	Durbin-Watson stat	0.148019
Prob(F-statistic)	0.000000		

Dependent Variable: HEDGING_MATURITY
Method: Panel Least Squares
Date: 05/12/18 Time: 17:05
Sample (adjusted): 2013Q1 2016Q2
Periods included: 14
Cross-sections included: 163
Total panel (unbalanced) observations: 1516
White period standard errors & covariance (d.f. corrected)
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTD	0.010795	0.049796	0.216785	0.8284
DIVPAY	0.079681	0.191760	0.415526	0.6778
FINLEV	0.003670	0.034710	0.105724	0.9158
FIRMSIZE	0.048637	0.020091	2.420795	0.0156
HEDGE_BIN	1.093032	0.076907	14.21246	0.0000
C	-0.440191	0.243203	-1.809974	0.0705

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.967477	Mean dependent var	0.792744
Adjusted R-squared	0.963092	S.D. dependent var	0.774886
S.E. of regression	0.148866	Akaike info criterion	-0.859895
Sum squared resid	29.58513	Schwarz criterion	-0.224267
Log likelihood	832.8007	Hannan-Quinn criter.	-0.623226
F-statistic	220.6301	Durbin-Watson stat	0.733070
Prob(F-statistic)	0.000000		

Appendix H: Summary of Variables

Hedging Maturity: Each period is assigned a multiple. T=1, T+1=2…. T+5=6. The total value of hedged position for the specific time, times the assigned multiple for that time period. Total value (post multiple) is divided by the total amount hedged for quarter.

$$\frac{\sum_{t=1} Hedged\ Amount * (T + n)}{Total\ Amount\ Hedged}$$

Long-Term Debt: Long-term debt over Total Assets.

Firm Size: The natural log of Total Assets.

Dividend Payout: Paid dividend/ net income

Financial Leverage: Long-term debt + Short-term debt / Total Assets

Hedging Binary: Equals one if a firm is hedging (using derivatives) within the observed period and zero otherwise.