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Cash Holdings from a Risk Management Perspective

- A study on high investment firms

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ABSTRACT

Due to a globalized market place, risk management has grown in importance and become a central part of firms' corporate strategies. The incentives for engaging in risk reducing activities revolve around reduced agency costs and exploitation of financial advantages. According to the precautionary motive for holding cash, firms must ensure stable and secure access to capital for future investments. This is most prominent for firms with high investment opportunities, and firms who rely on R&D and high capital expenditures to support future operations. Risk management, and hedging in particular, reduces the need for costly external funding, letting firms invest in risky projects. This study is designed to look at whether hedging and cash holdings can be seen as substitutive risk management tools in the manner that hedgers are allowed to hold lower cash reserves. The study also examines if this relationship is strengthened under possible underinvestment problems. With a deductive approach, we investigate the effect hedging has on cash holdings using multivariate regression analysis. Based on this we find evidence that firms with high investment opportunities hold less cash when they hedge. We also find that hedgers lower their cash reserves and therefore we suggest that, from a risk management perspective, hedging and cash holdings can be seen as substitutes.

Keywords: *Cash Management, Cash Holdings, Risk Management, Hedging, Underinvestment problems, Investment Opportunities*

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LIST OF ABBREVIATIONS

2SLS	Two-Stage-Least-Squares
BLUE	Best Linear Unbiased Estimators
GNP	Gross National Product
IV	Instrumental Variable
NPV	Net Present Value
MM	Modigliani-Miller
OLS	Ordinary Least Squares

1. INTRODUCTION

The introductory chapter motivates the relevance of cash management and hedging activities for firms with large investment opportunities. The discussion is followed by a problem statement and a research question. Finally, we present aim and objectives and limitations of the study, as well as a description of the target group.

"Risk is like fire: If controlled it will help you; if uncontrolled it will rise up and destroy you."

Theodore Roosevelt

This quote illustrates the importance of managing risks, which has become a central part of firms' corporate strategies. As modern financial theory has evolved, theories that explain the value-adding effect of risk management initiatives have led firms to recognize the countless advantages from engaging in risk management (Culp, 2001).

The risk management incentives include theories that revolve around reduced agency costs and exploitation of financial advantages. Previous research has found that managing risk is especially important for firms with large investment opportunities, likelihood of financial distress, and volatility in cash flows (Marin and Niehaus, 2011). A prominent issue for such firms is potential underinvestment problems, an agency problem that occurs when firms avoid less risky projects to increase own wealth at the cost of its creditors (Gay and Nam, 1998). Risk management reduces the need for costly external funding, letting firms invest in risky projects. Also, companies avoid pressure from creditors in form of covenants and high interest rates, as the risk of non-repayment is reduced. Other ways for risk management to add value is by reducing the likelihood of financial distress, take advantage of tax benefits, and make managers more open to invest in risky projects as they can use internal funds for investments (Culp, 2001).

There are several ways to manage risks. A common solution is to hedge against risk exposures through the use of derivatives, while another alternative is to reduce risk by holding excess cash (Culp, 2001). Firms with volatile cash flows can hedge to reduce this volatility or hold cash reserves to reduce the effect of volatile cash flows. As both reduce the effect of unforeseen events, these risk management tools can be seen as alternatives (Nance, Smith and Smithson, 1993; Marin and Niehaus, 2011). Hedging could therefore reduce the need to hold costly cash. All firms are however expected to hold cash reserves, but firms that hedge should in theory hold less cash. Cash availability is important as it affects a company's ability to react fast on investment opportunities, which might be critical for survival (Mello and Parsons, 2000).

The motives for holding cash were pointed out already in the 1930s by John Maynard Keynes. He explained primarily two reasons for holding cash; the transaction motive and the precautionary motive. A company's cash level determines to which extent it can finance new investments without having to raise external funds. Thereby, holding cash may limit transaction costs from raising external capital, avoid having to liquidate assets to fund projects and help the firm cover short-term needs. The precautionary motive refers to the firm's ability to meet future obligations and act on investment opportunities, which makes cash holdings a mechanism to avoid potential underinvestment problems. Cash reserves as well as hedging can therefore help firms prepare for unexpected future events.

From a financial perspective, managing risk adds value by decreasing the exposure to uncertainties (Miller, 1977; Myers and Majluf, 1984; Froot, Scharfstein and Stein, 1993; Allayannis and Weston, 2001) Through hedging, a company allows to decrease its cash levels and still manage to reduce agency costs. Underinvestment issues are prominent in firms that have high investment opportunities with large funding needs, and can be reduced through easy access to cash without including external parts. Implementing risk-reducing activities may therefore lead to lower risk and add value to more stakeholders.

Biotech and medical equipment firms are characterized by high investment opportunities, which encourage risk-limiting activities to avoid potential underinvestment problems. The healthcare sector has experienced large changes in the past decade. This has led firms to focus on good innovations for optimal returns, as traditional market access models are no longer sufficient to capture market shares (The Economist, 2014). This results in an increased need for access to capital to invest in research and development (R&D), as well as improvement expenditures. US healthcare expenditures, as a percentage of GNP, have grown faster than in any other market and continue to do so (Donzon, 1992). The importance of continuous development and high capital expenditures is prominent within the Biotech and Pharmaceuticals industry and in the Medical Equipment and Devices industry, since R&D expenses and capital investments are central aspects. Firms that operate in these industries therefore require access to excessive funds. Also, Boston Consulting Group has stated that as much as 90% of research expenditures are actually being wasted since drugs fail and development cannot proceed, which adds on the need for massive funding (The Economist, 2014).

Previous research has examined the relationship between cash holdings and hedging for financially constrained firms (Bolton, Chen and Wang, 2011; Marin and Niehaus, 2011). Few studies have however focused on the two risk management tools as alternative strategies. Little attention has also been paid to firms with high investment opportunities. These firms are vulnerable to underinvestment problems if internal capital is insufficient to fund investments. Hedging reduces overall risk, which allows these firms to use their internal cash to fund projects, and limits potential underinvestment issues.

1.1 Problem Statement

Both hedging activities and cash reserves ultimately serve the same purpose, namely reducing the effect of volatile cash flows, and could therefore be seen as alternative risk management tools (Nance et al, 1993; Opler et al, 1999; Culp, 2001; Bolton et al, 2011). The four theoretical motives for risk management to create value[1] should therefore affect both hedging and cash holdings. The risk management incentives imply that firms that are especially vulnerable to these problems also have the most to gain from managing risks.

Firms with large investment opportunities and high expenditures may face these potential problems and are therefore prone to engage in risk reducing activities. Firms in the Medical Equipment and Devices industry produce and manufacture healthcare products, and are dependent on stable cash flows to support production. Similarly, the Biotech and Pharmaceutical industry is highly dependent on R&D to be able to compete. For example, R&D intensive firms are more likely to hedge since they in general experience difficulties in raising external funds due to the nature of their principally intangible assets (Froot et al, 1993). Not only are intangible assets undesirable collateral, but it is also hard to ensure the quality of R&D projects, resulting in asymmetric information between management and creditors. Since cash is critical for the firm's operations, these industries are dependent on stable and secure access to capital (Opler and Titman, 1994). Mikkelson and Partch (2003) find that firms with high R&D costs hold more cash, which can be explained by their limited access to capital markets. The fact that firms with large investment opportunities hold more cash can also be motivated by the underinvestment problem.

In this paper we seek to examine whether a substitutive relationship exists between hedging and cash management in firms with large investment opportunities. Also, we study if this relationship is strengthened in the presence of potential underinvestment problems. Even though cash holdings and hedging can theoretically be seen as substitutes, this does not imply that hedging firms should not hold cash reserves, but that the need for larger reserves is reduced.[2] To the extent of our knowledge, this area has not been fully investigated. We expect that firms that hedge hold less cash, lower their cash holdings when they hedge and that this relationship is strengthened in the presence of potential underinvestment issues.

[1] Potential Underinvestment Problems, Managerial Risk Aversion, Convex Tax Function and Costs of Financial Distress (Culp, 2001).

[2] We define cash holdings and hedging as alternative risk management tools in the manner that a decision to hedge may also influence a company's need to hold cash reserves. However, we do not imply that hedgers do not need to hold cash reserves, and mean that a decision to hedge is also determined from other incentives and aspects than a company's cash holdings.

1.2 Research Question

In order to determine whether cash holdings are affected by hedging, and if cash holdings and hedging can be seen as alternatives in the presence of possible underinvestment problems, the following research question has been formulated:

> *Does hedging reduce cash holdings for firms with substantial investment opportunities, and is this relationship strengthened by potential underinvestment problems?*

1.3 Aim and Objectives

The aim of this study is to extend the scope of previous research and examine how firms with substantial capital needs manage risks. For firms with high growth opportunities and investment needs, access to capital is critical and the risk for underinvestment problems is increased. According to the theoretical framework, these firms will be more eager to engage in risk management activities. This study examines whether these firms' decision to hedge also affects the amount of cash held by the firm.

The study is based on previous research primarily surrounding the determinants of cash holdings, as well as the determinants of firms' hedging policies. Gay and Nam (1998) analyzes the underinvestment problem as a determinant for corporate hedging decisions. They find that firms with low levels of cash, and high growth opportunities, are most exposed to underinvestment problems. Opler et al (1999) examine the determinants of cash holdings and find that firms with large growth opportunities hold relatively more cash. In later years, papers such as Marin and Niehaus (2011) and Bolton et al (2011) have studied the relationship between cash holdings and hedging for financially constrained firms.

Marin and Niehaus (2011) argue that hedging and cash holdings can be seen as substitutes for financially constrained firms, and reason that in theory this should be applicable to unconstrained firms as well. Bolton et al (2011) propose that a firm's optimal cash level cannot be explained by a target capital-ratio alone. Instead, optimal cash holdings need to be seen from a dynamic risk management perspective. They find that cash holdings and hedging activities act as complementary risk management tools. We aim to extend the scope of previous research by further examining the relationship between cash holdings and hedging, and include potential underinvestment problems, to find whether this strengthens the relationship. Also, we do not separate between financially constrained and unconstrained firms to see if the relationship holds regardless of financial health.

1.4 Scope and limitations

We examine 90 US firms in the Biotech and Pharmaceuticals and the Medical Equipment and Devices industries listed on the S&P 1500, which includes small-, mid- and large cap firms. The study is conducted over the time period 2009-2013, giving a total sample of 450 firm years. These five years offer the most updated available figures at the time of our data collection and follows the recent financial crisis, a period that to our knowledge has not yet been researched. Furthermore, the study will be conducted on the US market since first, it is one of the largest healthcare sectors in the world, and second it is characterized by high growth firms (Donzon, 1992). This means that the results will be applicable primarily for firms operating in this area. Firms in other markets might manage their risks differently due to possible differences in regulations and in the economical environment. However, since the US is one of the world's largest economies, results on this market are of global interest.

1.5 Target group

This paper is intended for researchers and students who have an interest in corporate finance, and in the relationship between a firm's decision to hedge and its effect on cash management. Furthermore, our findings can be of interest for financial managers, management consultants, and investors who work or are interested in high growth and investment companies.

1.6 Outline

Chapter two includes a thorough presentation of the theoretical and empirical framework on which this thesis is built. The motives for risk management are described and empirical research on cash holding and hedging determinants is presented. Chapter three presents the methodological framework that supports this study. Further, we present and explain the choices of variables. Chapter four presents the final results while chapter five gives an extensive analysis of our findings. Finally, chapter six concludes this study and presents proposals for further research.

2. THEORIES AND PREVIOUS RESEARCH

The chapter outlines the relevant theories and gives a thorough review of previous empirical studies. We present the MM perfect capital market theory, which is followed by cash management theories and research. Then the relevant hedging theories and studies are presented. Finally, empirical evidence on cash management and hedging as alternative risk management tools is discussed.

Modigliani and Miller's (MM) irrelevance proposition from 1958 is the foundation for most economic theories. The irrelevance proposition states that under ideal capital markets,[3] risk management activities will not contribute to value creation.

However, market imperfections do occur and violate these assumptions. Disruption of the MM assumptions creates an opportunity to enhance shareholder value by engaging in corporate risk and cash management through different actions like derivatives hedging and excessive cash holdings. Hedging activities can reduce the volatility of firms' cash flows, while holding additional cash may reduce the dependency of continual inflows of cash. Both ways can thereby reduce the variance in firm value. As a direct implication, the probability of a lower firm value decreases, and the costs stemming from capital market imperfections are also reduced (Bartram, 2000). As previously mentioned, risk and cash management serve the same purpose and can therefore be seen as substitutes (Culp, 2001).

2.1 Cash Management Theory and Previous Research

Keynes (1936) defines primarily two advantages from holding cash, the transaction cost motive and the precautionary motive. First, the transaction cost motive is based on short-term needs and explains the benefit of avoiding transaction costs when raising funds as well as not having to liquidate assets. Second, the precautionary motive relates to the value of using cash to finance investments in the future as well as other obligations the firm might have. The costs related to these motives include brokerage costs, insufficient investments from deficient liquidity and agency costs (Miller & Orr, 1966; Miller, 1977). The most relevant for our sample firms is holding cash as a motive to prevent potential underinvestment problems. The drawbacks of holding cash are a possible tax disadvantage, excessive managerial spending

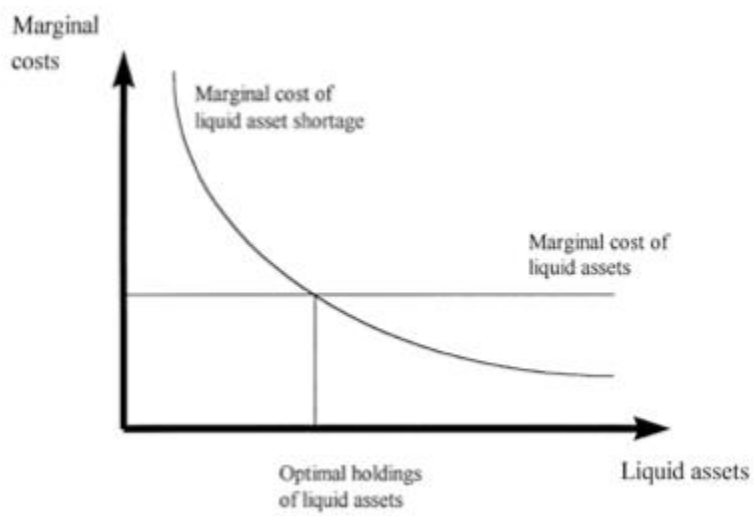
[3] •1. Perfect capital markets: No taxes, costs of financial distress, transaction costs or other institutional frictions exist in the market
•2. Symmetric information: All market participants have equal access to information as well as identical perceptions about how the information will impact asset prices
•3. Given investment strategies: Firms' investment programs are fixed and known to all investors, and assumed to be independent of how firms choose to finance themselves
•4. Equal access to capital markets: Every market participant has exactly the same access to the financial markets under the same terms

and a lower rate of return due to a liquidity premium (Opler et al, 1999; Harford, 1999). Also, a firm that holds large cash reserves increases the risk of being acquired.

2.1.1 The Transaction Cost Model

The trade-off theory of capital structure, introduced by Miller in 1977, explains how corporations usually are financed partially with debt and partially with equity. In the trade-off model the value of a company is maximized through the balance between costs and benefits associated with debt and equity financing. In order to attain an optimal capital structure that maximizes total market value, firms have to pursue debt levels that balance the value of interest tax shields to the various costs of bankruptcy or financial distress. Liquid assets can reduce the risk of financial distress, and thereby the costs associated with it (Keynes, 1936). Optimal cash holdings can be seen as an extension of the trade-off theory called the transaction cost model. An optimal level of cash increases company value when it is costly for firms to be short of cash. In figure 1 the transaction cost model shows the relationship between the marginal benefits and costs of holding cash. Firms set optimal targets based on a weighted balance between these two aspects. In optimum, the marginal benefits of holding cash equals the marginal costs of holding the cash. Managers have to define and evaluate the benefits of additional liquid assets to cutbacks of these assets (Opler et al, 1999).

Figure 1 - The Transaction Cost Model



Note: The transaction cost model shows the optimal holdings of liquid assets, which is given by the junction of the marginal cost of liquid asset shortage and the marginal cost of liquid assets curve. The marginal cost of liquid asset shortage is a declining curve, while the marginal cost of liquid assets is non-declining.

Source: Opler et al. (1999)

The first empirical results for the trade-off theory and corporate cash holdings were presented by Kim, Mauer, and Sherman in 1998. They analyze the costs and benefits of corporate liquidity holdings by conducting a study of 915 US firms within industrials during the period from 1975 to 1994. Their findings are consistent with theory, and show that firms that experience volatile earnings face higher external financing costs. As a result, these firms hold a higher relative amount of liquid assets. Further, by measuring firms' growth opportunities with market-to-book ratios, they find that firms with substantial growth options also have significantly higher cash holdings. The same study also shows a negative relationship between firm size and cash holdings, which is consistent with Opler et al.'s (1999) transaction costs model, and can be explained by the positive relation between firm size and access to capital markets.

By examining a sample of 1048 US firms from 1971 to 1994, Opler et al. (1999) studied how firms actually change their cash holdings over time depending on growth opportunities, firm size, dividends, and capital expenditures. Besides presenting results consistent with Kim et al. (1998), they also measure firms' credit quality by incorporating a form of Altman's Z-Score. The results from this analysis showed, as anticipated, that firms with higher credit quality in general hold less liquid assets (Opler et al, 1999). This can be explained by their larger access to capital markets, which makes them less dependent on holding liquid assets. In a study from 2012, Gill examines ten factors motivated from theories related to working capital requirements, corporate governance and additional variables that were studied in previous empirical work. The results show that market-to-book ratio, net working capital, leverage, firm size, board size and CEO duality affect corporate cash holdings for manufacturing firms in the Canadian market. Also, the regulatory environment has been proven to have a strong impact on a firm's cash holdings (Ferreira & Vilela, 2004).

2.1.2 The Precautionary motive and the Pecking Order Theory

Information asymmetry between stakeholders may result in agency costs and can explain why firms hold excessive cash instead of an amount that maximizes shareholder value (Kim et al, 1998). Firms that do not hold liquid assets and experience cash flow shortfalls might avoid investing in positive NPV projects, and rather hold excess cash to prevent possible financial distress costs (Opler et al, 1999). This motive is also referred to as the precautionary motive for holding cash and is the most relevant motive for firms with large investment opportunities (Keynes, 1936; Marin & Niehaus, 2011). The discount outsiders require on securities due to lack of information may be so large that management might avoid issuing them, and rather choose to reduce investment activity. An example where this type of agency problem may occur is in R&D intensive firms. These firms often have unique projects, so management has to be careful with communicating details even to stakeholders. Also, these investments are often risky, have a low success rate and the firms are therefore expected to hold more liquid assets (Opler & Titman, 1994).

The pecking order theory seeks to explain an optimal financing strategy and takes on capital structure decisions by including the assumptions of asymmetrical information as a significant factor. As a consequence of asymmetrical information, companies follow a certain funding order when determining their financing decisions (Myers and Majluf, 1984). The basis of the pecking order theory is that firms prefer internal funds to external funds, and debt before equity, as this is the least expensive way of financing. The pecking order theory supports holding cash as external funding should be avoided. Denis and Sibilkov (2010) perform an empirical study and find that higher cash holdings allow constrained firms to invest in positive net investments that would otherwise be evaded. They also find evidence of financially constrained firms holding high levels of cash to avoid external financing. According to financial theory, firms with large investment opportunities should therefore hold a significant amount of cash. This notion has also been confirmed in several empirical papers (Nance et al, 1993; Kim et al, 1998; Opler et al, 1999).

2.2 Hedging Theories and Previous Research

The Keynesian hedging pressure theory (1930) states that the commodity futures market serves as insurance, and is always in backwardation[4], which allows manufacturers to transfer risk for a risk premium. As risk reduction can increase firm value, this is the main motive for hedging (Allayannis and Weston, 2001). Other rationales for hedging have also been developed through the years including higher debt capacity, progressive tax rates, lower expected costs of financial distress, secured internal financing and reduced information asymmetries (Miller and Modigliani, 1963; Myers, and Majluf 1984; Smith and Stulz, 1985; Froot et al, 1993). A disadvantage with hedging is the high costs of using derivatives without knowing if it will actually pay off (Smith and Stulz, 1985; Froot et al, 1993; Geczy, Minton, and Schrand, 1997).

In 1993 Froot, Scharfstein, and Stein pointed out that risk management is crucial for primarily three reasons. Firstly, firm value can be created through investment in positive NPV projects. Secondly, internal generation of cash in order to fund these investments is an important key for firms to maintain high levels of investments. Firms that fail to generate sufficient cash flows tend to lower their investments below the optimal level because of costly external financing (Gay and Nam, 1998). Thirdly, external factors such as interest rates, commodity prices, or movements in exchange rates can all disrupt critical cash flows. Risk management can ensure that sufficient internal funds are available to make value-enhancing investments (Froot et al, 1993).

[4] Normal backwardation is a higher expected futures spot price than the current spot rate, and a futures contract is likely to generate a positive return in a long position.
[http://financial-dictionary.thefreedictionary.com/Backwardation Accessed 08.05.2015]

Variability in internal cash flow must result in either a variability of externally raised funds or a reduction in investments (Froot et al, 1993). The latter alternative may affect firm value by for example causing underinvestment problems and, along with expenses connected to raising external capital, firms are motivated to engage in risk management. Nance et al. (1993) and Geczy et al. (1997) find that capital-intensive firms are more likely to use derivatives, while firms with high levels of short-term liquidity are less likely to use derivatives.

Froot et al. (1993) developed a framework for analyzing risks and implementing optimal hedging strategies for firms to coordinate between optimal levels of investment and financing policies. Their study showed that firms experiencing rising marginal costs of external financing should always choose to hedge their cash flows. In some cases, however, a company's investment opportunities might change in the same manner as its operations and cash flows. This means that supply and demand for internal funds match, and the company will not have a reason to hedge. For such companies, engaging in hedging activities is less valuable (Froot et al, 1993). Accordingly, it is more valuable to hedge investment opportunities that are negatively correlated with the firm's current cash flows.

2.2.1 The Underinvestment problem

The underinvestment problem is an agency issue in which a firm denies low-risk projects to increase own wealth at the cost of its creditors (Gay & Nam, 1998). As the low-risk investments only generate steady cash flows to creditors, but no profit to shareholders, companies avoid these investments even if they enhance overall firm value (Miller, 1977). The underinvestment problem often occurs when firms' cash flows are negatively correlated with its investment opportunities, leading them to seek external financing. Firms mostly exposed to possible underinvestment problems are those with high growth opportunities and low levels of internal cash (Gay and Nam, 1998).

In fear of underinvestment issues, creditors will demand higher interest rates or debt covenants. Risk management can mitigate these agency costs by decreasing the riskiness of projects. Firms that engage in risk management can therefore increase their debt levels without increasing the chance of encountering underinvestment costs (Bartram, 2000). Since information asymmetry increases the premium creditors take for their risk, capital-intensive firms have an incentive to hold more cash. Cash can therefore reduce agency costs that arise from external funding. Hedging serves the same purpose. By hedging, firms may reduce cash flow volatility and the need for external funding. Hedging can thereby mitigate potential underinvestment and cash flow problems (Morellec and Smith, 2007).

The positive relationship between R&D and derivative usage is confirmed empirically by several studies conducted around the underinvestment hypothesis (Nance et al, 1993; Geczy et al, 1997; Gay and Nam, 1998). In contrast, another empirical research conducted by Mian

(1996) indicates the opposite. By using growth opportunities as a proxy for underinvestment issues, Mian finds a negative relationship between firms' future investment opportunities and derivative usage, which contradicts the underinvestment hypothesis. A reason to these inconsistent results may be the constraints in accounting regulations on hedging of predicted exposures (Gay and Nam, 1998). However, a particular firm's optimal hedging strategy depends not only on the internal financing strategy, but also on market competition as well as on the hedging strategies adopted by competitors (Froot et al, 1993).

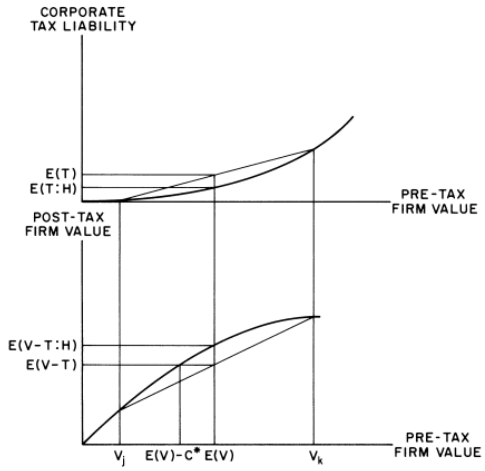
Gay and Nam (1998) build their work on Froot et al. (1993), and investigate hedging policies adopted by firms experiencing underinvestment problems. Consistent with prior results, Gay and Nam (1998) find a positive relation between growth opportunities and derivative usage. Their study was carried out around three main hypotheses developed from the underinvestment theory; (a) firms with greater investment or growth opportunities will make better use of derivatives, (b) firms with enhanced investment opportunities concurrent with low levels of cash stocks will make better use of derivatives than similar firms with high cash stocks, and (c) firms with a higher correlation between cash flows and investment expenses will use derivatives less. They find that some companies experience a positive correlation between their internal cash flows and their investment expenditures, which reminds of a potential natural hedge. Empirically, firms experiencing this correlation also hold smaller derivative positions. Finally their findings indicate a relationship between cash holdings and hedging with derivatives, namely that firms with enhanced investment opportunities use derivatives more when they hold less amounts of cash (Gay and Nam, 1998). Focusing on currency exposure in particular, Géczy et al. (1997) find similar results indicating that firms with great growth opportunities, but limited access to financing, are more likely to hedge against currency risk compared to companies with better access to funding.

2.2.2 Other risk management theories

Managers are often undiversified in their wealth and dependent on the performance of their firms. This makes them reluctant to take on risk and gives them an incentive to secure the firm's future existence. As a result, managers engage in risk reducing activities at the expense of well-diversified investors, or in other words, the shareholders (Bartram, 2000). If managers instead are not allowed to reduce their risk exposure, risk aversion may cause them to underinvest (Smith and Stulz, 1985). Reluctance to risk may cause managers to reject positive NPV projects, which can be directly value destroying for the firm. Risk management can avoid this problem, and may result in a willingness to invest in riskier projects. However, holding excess cash may also lead to increased agency problems through excessive managerial spending. Harford (1999) as well as Dittmar and Thakor (2007) provide support for the view that high levels of cash may be value destroying, while Mikkelson and Partch (2003) reason that cash hoarding may in fact be essential to operations, and find no evidence that firms with higher cash holdings perform worse than firms with lower cash levels.

From a tax perspective, risk management is more efficient for firms with volatile income and a convex tax curve (Bartram, 2000). Firms that are subject to a convex tax scheme can reduce its tax liability through the use of derivatives for hedging purposes (Figure 2*)*. For the convex tax scheme to exist, the firm must either be subject to a marginal tax rate that increases progressively with the size of pre-tax income, or it must be induced by tax regulations (Bartram, 2000).

Figure 2 - Post-tax firm value from hedging activity



$V_j[V_k]$:pre-tax value of the firm without hedging if state j[k] occurs.
E(V): expected pre-tax value of the firm without hedging.
E(T): expected corporate tax liability without hedging.
E(T:H): corporate tax liability with a costless, perfect hedge.
E(V-T): expected post-tax firm value without hedging.
E(V-T:H): post-tax firm value with a costless, perfect hedge.
C: maximum cost of hedging where hedging is profitable.*

Note: The figure illustrates how costless hedging can reduce the variability of pre-tax firm value by reducing the expected taxes, resulting in a rise in expected post-tax firm value.

Source: Smith & Stulz (1985)

Firms' tendency to engage in hedging based on tax incentives depends on the regulations where they operate. For US firms, Graham and Smith (1999) find that fifty per cent of all firms tend to face a convex effective tax function, a conclusion drawn from a study of more than 80,000 firm-year observations. However, they also find that the potential tax savings are neither equally distributed among all firms, nor do all firms have substantial tax-based incentives to hedge. Only in extreme cases can firms make significant savings, and tax-based hedging is not mutually exclusive from other hedging incentives. Firms that do face a convex tax curve, and thereby potential tax benefits, have an incentive to hedge (Graham and Smith, 1999). Firms that do have an incentive to hedge for tax purposes should not hold high

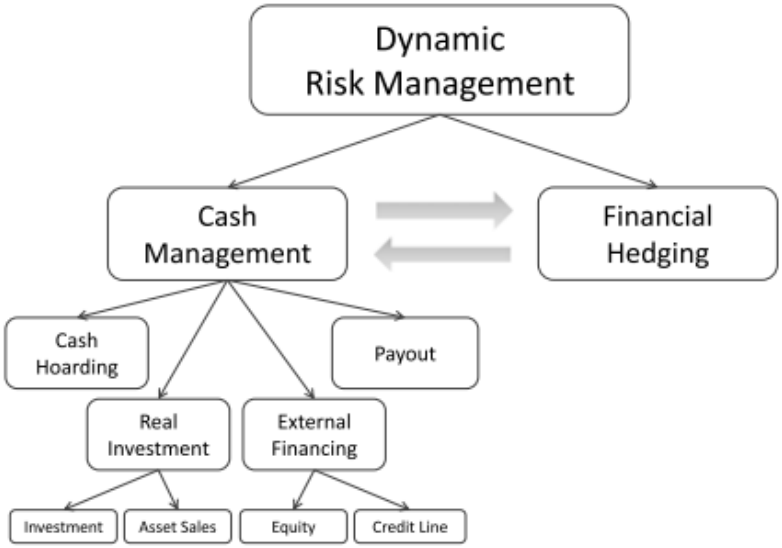
levels of cash, as this increases the tax liability (Opler et al, 1999). This means that firms that hedge can get a tax benefit from avoiding high cash levels.

Firms are financially distressed when they fail to meet their obligations towards creditors. Engaging in risk management activities may reduce the probability of costly default. This situation is mostly triggered by cash flow volatility, which may lead to insufficient access to liquid assets (Miller, 1977). Risk management can reduce the probability of financial distress costs by reducing the volatility in cash flows, and thereby the chance of defaulting on debt obligations (Smith and Stulz, 1985). Reducing the probability of financial distress through risk management will also let the firm take on additional leverage, which can increase the value of the tax shield. Previous research show mixed findings in regards to costs of financial distress and risk management. Graham and Rogers (2002) find that firms use financial derivatives to deal with the probability of financial distress costs, while Mian (1996) cannot find any evidence that supports such decisions. Larger cash levels can reduce the chance of defaulting on obligations through holding reserves (Smith & Stulz, 1985). Hedging on the other hand gives more stable cash flows, meaning that firms that hedge and have a risk of defaulting have an opportunity to hold less cash. Denis and Sibilkov (2010) argue that constrained firms with high levels of investments may hold low cash levels due to persistently low cash flows.

2.3 Cash Management and Hedging as Substitutes

Bolton et al. (2011) argue that cash management and derivatives hedging are complementary forms of risk management. The authors focus on financially constrained firms and aim to find a forceful corporate risk management framework that illustrates hedging policies, cash holdings, external financing, payout, and corporate investment for financially constrained firms (Figure 3). The framework is built on empirical results and emphasizes the importance of including the demand for capital when determining the level of cash holdings (Smith and Stulz, 1985; Froot et al, 1993; Graham and Smith, 1999). A target cash-capital ratio is thereby too limited to explain individual firms' desired cash levels (Bolton et al, 2011).

Figure 3 - Dynamic risk management



Note: The dynamic risk management framework shows how cash management and financial hedging is interrelated. The figure also includes several firm aspects that affect cash management decisions.

Source: Bolton et al (2011)

The pecking order theory is used to explain the relationship between cash management and hedging, which argues that firms prefer internal financing and avoid raising funds from outsiders. To mitigate this probability they can either hold more cash to use for investment purposes or hedge to secure steady cash flows, which reduces the need for costly cash holdings. While cash can help reduce residual risk[5], derivatives hedging may limit systematic risk[6] (Bolton et al, 2011). Comparable firms often have significantly dissimilar cash levels, which demonstrates that optimal cash holdings are determined by several factors (Opler et al, 1999).

Marin and Niehaus (2011) also examine the joint decision to use derivatives for hedging purposes and finding the right level of cash. With the purpose of exploring and examining possible interactions between alternative risk management tools, they focus on firms facing financial constraints. These firms face an increased level of uncertainty, so cash flows become particularly important. According to the theoretical framework, a connection between different risk management tools should be applicable to all firms regardless of their financial health (Marin and Niehaus, 2011). A drawback when considering only financially

[5] "Any risk remaining to an investment after all other risks have been eliminated, hedged or otherwise accounted. Some residual risks may not be known during risk analysis, and indeed may not be knowable." [http://financial-dictionary.thefreedictionary.com/Residual+Risk Accessed 08.05.2015.]

[6] "Risk caused by factors that affect the prices of virtually all securities, although in different proportions. Examples include changes in interest rates and consumer prices. Although it is not possible to eliminate systematic risk through diversification, it is possible to reduce it by acquiring securities." [http://financial-dictionary.thefreedictionary.com/systematic+risk Accessed 08.05.2015]

constrained firms is that the collateral costs associated with taking on a hedging position might impact the decision. The costs alone may limit severely constrained firms in their decision to hedge, which results in a stronger relationship between hedging and cash hoarding (Mello and Parsons, 2000).

Table 1 on the follow page, presents the most relevant studies connected to this topic and their results. Previous research has proven that cash holdings and hedging may work as potential substitutes regarding uncertain future cash flows and costly external capital. Empirics also verify that corporate hedging decisions are taken in relation to firms' accessibility to capital (Mello and Parsons, 2000; Marin and Niehaus, 2011). The results for unconstrained firms are however mixed. Depending on how financial constraints are defined, Marin and Niehaus (2011) indicate a positive sensitivity of hedging to cash holdings, while others find no relation at all for unconstrained firms (Bolton et al, 2011). Therefore we study if hedging affects cash holdings in high investment firms and if this relationship is stronger in the presence of potential underinvestment problems. This will be tested according to the methodology presented in the following chapter.

Table 1 - Results from previous research

AUTHORS	TIME PERIOD	METHODOLOGY	FINDINGS
		CASH HOLDING ARTICLES	
Kim et al. (1998)	1975-1974	Multivariate Regression	Firms with volatile earnings hold more cash, while firm size is negatively correlated to liquid assets.
Opler et al. (1999)	1971-1994	Multivariate Regression	Evidence of a target adjusted cash holdings model. Also, firms with strong growth opportunities hold more cash.
Harford (1999)	1977-1993	Multivariate Regression	Firms may hold less cash to avoid excessive spending.
Denis & Sibilkov (2010)	1985-2006	Simultaneous Equation	Financially constrained firms hold high cash levels to avoid external financing. Greater cash levels allow for higher levels of investments.
Gill (2012)	2008-2010	Multivariate Regression	Market-to-Book, Net Working Capital, Leverage, Size, Board size and CEO duality significantly affect corporate cash holdings.
		HEDGING ARTICLES	
Smith & Stulz (1985)	-	Analysis of Financial Theory	Taxes, Costs of financial distress and Managerial risk aversion motivates risk management.
Froot et al. (1993)	-	Multivariate Regression	Finds a benefit to hedging when external sources of finance are more costly to corporations than internally generated funds.
Nance et al. (1993)	1986	Questionnaire Survey	Firms that hedge have convex tax functions, high growth options, are lager and have fewer hedging substitutes.
Mian (1996)	1992	Multivariate Regression	Finds no relationship between hedging and costs of financial distress, and mixed results between tax and hedging.
Getczy et al. (1997)	1990	Multivariate Regression	Financially constrained firms with growth opportunities are likely to use derivatives.
Gay & Nam (1998)	1995	Multivariate Regression	Firms with low levels of cash, and high growth opportunities, are most exposed to underinvestment problems.
Graham & Rogers (2002)	1994-1995	Multivariate Regression	Firms use derivatives to deal with the probability of financial distress.
		CASH HOLDING AND HEDGING	
Bolton et al. (2011)	-	Multivariate Regression	Cash and Hedging can be seen as complementary risk management tools
Marin & Niehaus (2011)	1997-2004	Simultaneous Equation	Cash and Hedging can be seen as complementary risk management tools

Note: The table displays the most relevant previous research, their examined time period, methodology and main findings.

3. METHODOLOGY

The chapter describes the methodological approach applied in this research. The sampling method and variables are described in detail, and an in-depth discussion regarding the econometric technique is presented.

3.1 Methodological approach

The methodological approach applied in this study is based on previous research and relevant economic theories. A deductive approach is adopted to examine whether cash holdings and hedging are viewed as substitutive risk management tools (Jacobsen, 2002). Further, we implement a quantitative approach, as the objective is to analyze quantitative data and identify causal relationships between hedging activities and corporate cash holdings. We also examine this relationship for firms with potential underinvestment problems. A quantitative methodology is used since the study will be conducted and analyzed through regressions and hypothesis testing, which in turn relies on data measured and collected for a large sample of firms (Lundahl and Skärvad, 1999).

Through the years, research based on a deductive approach has endured some criticism. One aspect that has been pointed out is the view that a deductive approach may be limiting and that the methodological approach itself carries an imminent risk of neglecting important information and data in the field of study (Jacobsen, 2002). To address these possible limitations, we rely on a thorough review of previous empirical research and base our study on existing theories. Further, we use acknowledged sources like Bloomberg, Thomson Reuters Datastream, and S&P Capital IQ, as well as annual reports to collect our data. In order to reduce the risk of selection bias, we include all relevant firms from S&P 1500 in our data sample. We do acknowledge that choosing a specific index may cause some selection bias. However, including all relevant firms from this index gives a better picture of the market than picking a random sample from the index.

3.2 Reliability and Validity

In economic research, it is important that the study fulfills the requirements of reliability and validity. Reliability refers to the extent a test yields the same results on repeated trials, and how much these results are influenced by errors like outliers and irregular data. Our result should, given high reliability, show the same results if the study was conducted twice (Bryman and Bell, 2007). To increase the reliability of our study, we choose trustworthy sources for our data collection. As mentioned, we use recognized databases like Bloomberg, S&P Capital IQ, and Thomson Reuters Datastream to gather necessary data. The financial data collected from these sources is derived from each individual firm's financial

information, meaning that the information has been approved by professional auditors. In cases where the information needed is not available in any of these databases, we collect the data directly from the companies' annual reports. We therefore consider our sample data to be highly reliable. We are aware that the data, despite coming from reliable sources, may contain errors and therefore do our best to strengthen the reliability of our sample in several ways. First, we include a list of all the firms in our sample to increase the replicability (Appendix 1). Second, we choose a period of five firm years to minimize the irregularity of available information and to increase the scope of our data.

Validity is also of great importance in financial research. Bryman and Bell (2007) argue that the validity of a research paper might be of even greater importance than the reliability, and describe it as how well the applied methodology measures what it is supposed to measure. According to Lundahl and Skärvad (1999), there are two forms of validity, namely internal and external validity. Internal validity is referred to as a causal relationship between the independent and dependent variable, meaning that a regressor explains some of the changes in the regressand. The variables we include in our study are well supported by previous research and we conduct causality tests to support this relationship. Therefore we believe that our study has a high internal validity. External validity concerns how well our research results can be generalized to other situations (Bryman and Bell, 2007). We believe that our sample represents the US biotech and pharmaceutical industry and the US medical devices and equipment market well. By including all companies in these industries included in S&P 1500, we manage to represent all market capitalizations. We are aware that our results will denote the US market, but since this is one of the world's largest economies our results are interesting from an international perspective as well.

3.3 Sample and sampling method

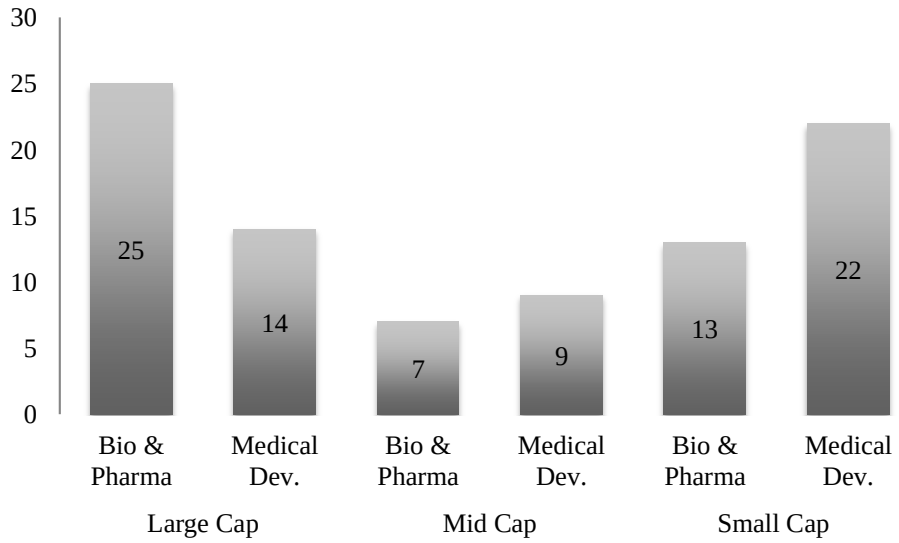
Our aim is to examine listed US firms within the biotech and pharmaceuticals, and the medical equipment and devices industries. In our index, 93 firms operate within these industries, but three are excluded since they are represented in more than one market capitalization during our time period. Only firms that are exposed to hedgeable risk are included in our sample.

All market capitalizations are included since we believe there might be differences in the level of risk exposure depending on firm size, and in how the firms deal with this exposure. Some researchers that have conducted similar studies have chosen to exclude small firms, arguing that the fixed costs of initiating risk management programs outweighs possible benefits for these smaller firms (Géczy et al, 1997; Allayannis and Weston, 2001). However, due to the characteristics of our sample firms, we believe that small firms have an incentive to hedge. Also, we find small cap firms that hedge and therefore think it is relevant to include these firms. By covering the entire market we will get more dynamic results. We examine the period 2009-2013 since we want an up-to-date analysis, and a period that has not yet been

researched. We do not include 2014 in our period as the annual reports for fiscal 2014 has not been released for all sample firms when we collect the relevant data.

The final sample consists of 90 firms including 39 large cap, 16 mid cap and 35 small cap corporations, giving 450 firm years before data loss. Figure 4 provides the distribution between market capitalizations and industries, showing that firms from all categories are present in our final sample. A complete list of all companies included in our final sample is presented in Appendix 1. A further explanation of the impact this distribution can have on our results is found in section 4.1.

Figure 4 - Distribution of Market Capitalizations and between industries



Note: The figure shows the distribution between industries and market capitalization. The sample includes 45 Biotech and Pharmaceutical and 45 Medical Equipment and Devices firms spread between large-, mid- and small-capitalizations. 39 firms are large-cap, 16 firms are mid-cap and 35 firms are small-cap.

3.4 Econometric technique

Identifying a correct model for our study is critical in order to get the right inference and consistent regression results. The model itself must meet statistical requirements and the variables included must correspond to the theoretical framework (Brooks, 2008). The empirical strategy of this research paper is to identify a consistent regression model, from which conclusions can be made about hedging activities' impact on cash holdings.

We expect corporate cash holdings to be a function of several factors;

$$CH_{it} = f(Hedging_{it}, Investment\ Opportunities_{it}, Control\ Variables_{it})$$

where hedging and underinvestment are our main variables of interest and the control variables include size, managerial risk aversion, access to capital markets, likelihood of financial distress, return on assets, and concave tax function. All variables will be further described in later sections. The subscripts indicate company i at time t. As in all econometric methods, unobservable factors that will not be possible to incorporate in a variable will be captured in an error term (Brooks, 2008). We present the models used to test our hypotheses later in the chapter.

Our data consists of a time- and cross-sectional dimension of 450 observations. Since data is not available for all firm years, we have an unbalanced panel. In general two panel approaches are used in financial research, fixed effects model and random effects model. The fixed effects model allows for the intercept to differ cross-sectionally, but not over time, while the slope estimates are fixed in both dimensions (Brooks, 2008). We conduct a Hausman specification test for random effects to find out which approach is the most suitable for our sample, and conclude that random effects is not appropriate. We also conduct a redundant fixed effects likelihood ratio test, and find that pooled regression should not be used (Appendix 3). Therefore, we use fixed effects in the cross-sectional dimension when running the regressions. However, we have a homogenous sample within one country and only two industries with similar characteristics. This reduces the need for fixed effects. Our data also has very limited variation within firms, and we might therefore need variation between firms to capture significant results. Therefore, we also run pooled regressions to see if we get significant results.

3.5 Definition of variables

The chosen variables will strengthen our model when examining hedging activities' effect on cash holdings. The objective when analyzing complex economical situations is to define a model that obtains a high degree of determination (Brooks, 2008). This section will provide a thorough examination of the variables included in our study, which are all used in previous studies of similar character (Kim et al, 1998; Opler et al, 1999; Allayannis and Weston, 2001; Graham and Rogers, 2002; Marin and Niehaus, 2011).

3.5.1 Dependent Variables

We use two measurements for firms' cash holdings to define our dependent variables. The first variable is used to find out whether firms that hedge hold more or less cash compared to firms that do not hedge, while the other variable is made to check if firms change their cash holdings when they hedge. Since our sample includes small-, mid- and large-sized firms, the cash holdings in our dependent variable will be related to total assets. In section 4.1, Descriptive statistics, we find that the mean and median differ substantially for this variable, indicating a skewed sample. We therefore use the natural logarithm to make the *CH* variable

approximately linear, which is also consistent with previous research (Bolton et al, 2011). This regressand will be used in Model 1 and 2.

$$CH = \ln\left(\frac{Cash\ Holdings}{Total\ Assets}\right)$$

A consequence with the definition of the dependent variable that can disrupt the results is that cash holdings may suffer from a potential time lag. This means that there might be a time lag between the cash management decision process and its execution (Greene, 2002). Also, this variable measures specific cash levels at a certain point in time. In order to capture changes in cash levels, we define a second dependent variable, *ΔCH*, as follows:

$$\Delta CH = \frac{(Cash\ Holdings_t - Cash\ Holdings_{t-1})}{Total\ Assets}$$

By also having the change in cash holdings for company i between time t-1 and t as a dependent variable, we manage to capture situations where firms choose to either increase or decrease their cash reserves. This variable is based on previous research by Almeida et al (2004) and Marin and Niehaus (2011), and will be used in Model 3 and 4.

3.5.2 Main Descriptive Variables

Explanatory variables explain the behavior of the dependent variable, and are included to strengthen the model (Brooks, 2008). Our main regressors are intended to measure firms' hedging activities as well as possible underinvestment problems.

Previous research often uses a binary variable as a proxy for hedging to define hedgers and non-hedgers (Allayannis and Weston, 2001; Marin and Niehaus, 2011). A dummy variable is often used when it is not possible to measure or quantify the data of interest in a financial ratio (Weiers, 2011). The dummy variable takes on the value of one for firms that hedge and zero otherwise.

$$D_{Hedge} \qquad \begin{array}{c} Hedging = 1 \\ No\ Hedging = 0 \end{array}$$

The dummy variable equals one if a firm uses commodity derivatives, foreign currency derivatives or interest rate derivatives as well as swaps for hedging purposes, but not when they use it for speculative reasons. This information is collected from a thorough review of

annual reports[7]. Since our aim is to examine hedging in general we do not distinguish between different types of risk exposures. We expect D_{Hedge} to have a negative impact on cash holdings, since hedging reduces cash flow variability and should limit the need for holding excess cash (Kim et al, 1998; Bolton et al, 2011).

For a firm to have an incentive to hedge based on fear of potential underinvestment problems, it must have access to positive NPV projects as well as an overhanging risk of insufficiently generating internal funds (Gay and Nam, 1998). Previous research has used investment opportunities as a proxy for underinvestment (Froot et al, 1993; Mian, 1996; Gay and Nam, 1998). By using the sum of R&D expenses and capital expenditures, divided by total sales, we manage to capture a prediction of future opportunities. However, proxies often capture other effects than what is intended. The R&D variable might for example also capture agency problems, especially for poorly managed firms, since R&D expenses and the use of derivatives may be directly driven by for example excessive spending or risk aversion (Gay and Nam, 1998). Despite this possible problem, the variable is backed by previous research and can be used as an appropriate ratio for our sample firms. We use the natural logarithm to make the variable approximately normally distributed:

$$InvOp = ln\left(\frac{(R\&D+CapEx)}{Total\ Sales}\right)$$

Some studies have used market-to-book and Tobin's Q as proxies for investment opportunities. Market-to-book is used to measure the likelihood of firms having positive NPV projects. The book value captures the value of a firm's assets, while the market value incorporates both growth opportunities and the assets in place (Gay and Nam, 1998). In later years, some researchers have also used Tobin's Q as an alternative to measure firms' investment opportunities. However, since we focus on industries with a high degree of R&D and capital expenditures, we believe our definition of *InvOp* to be the most appropriate proxy for underinvestment. Though, we also conduct a robustness check by using market-to-book (*MtB)* as an alternative proxy to see whether this changes our results. We expect a positive relationship between *InvOp* and our dependent variables CH and ΔCH, since firms want to invest in positive NPV projects without having to raise external capital (Froot et al, 1993; Gay and Nam, 1998; Morellec and Smith, 2007). Note that we use *InvOp* as a control variable for cash holdings, but that it is included in this section since it is used to build our next main variable, $Hedge_{InvOp}$.

[7] We search the annual reports for the following words: hedge, hedging, derivatives, foreign exchange risk, currency risk, interest rate risk and commodity risk. We determine hedgers as firms that clearly state that they use derivatives for hedging, and not speculative purposes.

We also define a variable that captures the relationship between cash holdings and hedging in firms with large investment opportunities, which is our proxy for possible underinvestment problems. This variable is created by multiplying the previously presented variables *InvOp* and D_{hedge}.

$$Hedge_{InvOp} = InvOp\ x\ D_{Hedge}$$

We believe that the relationship between our dependent variable ΔCH and D_{Hedge} is strengthened in the presence of possible underinvestment issues. Earlier studies have examined financially constrained firms and find a significant relationship between cash holdings and hedging for these firms (Bolton et al, 2011; Marin & Niehaus, 2011), which is why we want to see whether the relationship is stronger in the presence of agency costs. All four risk management incentives could have been tested, but due to the nature of our firms, underinvestment is the most prominent factor to investigate. This variable has not been used in previous research. However, we find it the best way to measure this situation as it will capture firms that hedge and have possible underinvestment problems.

3.5.3 Control Variables

Multiple regressions take into account that the dependent variable is affected by more than one factor (Gujarati & Porter, 2010). We include several descriptive variables to better explain the movement of our dependent variables. However, since we do not know all the possible factors that affect our cash holding variables, the regressions will explain simplified situations (Brooks, 2008).

We include a proxy for managerial risk aversion to account for one of the four risk management incentives. This variable should affect firms' decision to engage in cash- and risk management activities. The variable is defined as follows:

$$MRA = \frac{(Shares\ owned\ by\ CEO\ x\ Share\ Price)}{Market\ Value\ of\ Equity}$$

The *MRA* variable is based on CEO stock ownership and share price, since this is directly tied to their wealth, and thereby describes their risk aversion (Gay and Nam, 1998). We believe that managerial risk aversion has a lagged time effect, and therefore take the stock ownership from the previous year. We predict a positive relationship between managerial risk aversion and our dependent variables since higher risk aversion should lead managers to hold more cash (Mikkelson and Partch, 2003).

Another way for risk management to create value is by reducing the likelihood of financial distress (Culp, 2001). Altman (1968; 2000) pointed out the five most relevant business aspects to rely on when calculating the risk of facing distress problems, and developed the Z-Score. The Z-score variable is also used by other researchers (Kim et al, 1998).

$$LFD = Altman's\ Zscore = 1.2 \cdot X_1 + 1.4 \cdot X_2 + 3.3 \cdot X_3 + 0.6 \cdot X_4 + 1.0 \cdot X_5$$

where

X1 = Working capital / Total assets
X2 = Retained earnings / Total assets
X3 = EBIT / Total assets
X4 = Market value of equity / Book value of total liabilities
X5 = Sales / Total assets

The Z-score is calculated by including five standard ratio categories; measurements for liquidity, profitability, solvency, leverage, and activity ratios. The final function results in an index that proxies for likelihood of financial distress. Firms that experience operating losses will get a shrinking ratio. The importance of each ratio is measured by a scaled vector and ranked in order to identify betas for each ratio (Altman, 1968). A drawback of using the Z-score analysis is that the probability of classifying younger firms as bankrupt is relatively higher compared to older firms. However, according to empirics younger firms face a higher likelihood of financial distress (Froot et al, 1993; Gay and Nam, 1998; Marin and Niehaus, 2011). The Z-score is expected to have a positive relationship with our dependent variables, since firms that face a high probability of financial distress should prefer higher cash holdings to mitigate this risk (Opler et al, 1999).

The last way for risk management to create value is by lowering expected taxes for firms with concave tax schedules. The advantage stems from reduced expected taxes by the use of derivatives, which limits the variability of taxable earnings. A convex tax schedule can result from the progressivity of the corporate income tax code, such as tax-loss carryforwards and foreign tax credits. Most public companies, as those in our sample, have pre-tax income above the progressive region, which arises the tax argument for risk management (Gay and Nam, 1998). We define our tax variable as net operating loss carryforwards divided by total assets:

$$TAX = \frac{Net\ Operating\ Loss\ Carryforwards}{Total\ Assets}$$

This way of measuring tax convexity is used by Gay and Nam (1998) and Graham and Rogers (2002). Some empirical studies outside the US use a leverage ratio as tax variable, since non-US firms usually have a concave tax function due to regulations and corporate taxation. These companies may increase their debt capacity and get additional tax shields, but cannot reduce their expected tax liability. US firms can on the other hand take advantage of

this opportunity, and we therefore have to control for this as well. Holding additional cash will increase the tax liability and we therefore expect a negative relationship between *TAX* and *CH,* as well as *TAX* and *ΔCH* (Opler et al, 1999).

Empirically, firm size has been proven to play an important role in determining corporate characteristics, including firms' cash holdings. Firm size can be associated with economies of scale and a lower risk of default (Froot et al, 1993; Gay and Nam, 1998; Bolton et al, 2011; Marin and Niehaus, 2011). We define our size variable as the natural logarithm of total assets:

$$SIZE = \ln(Total\ Assets)$$

Larger firms are likely to find alternative ways of risk management that are less costly than holding excessive levels of cash, indicating a negative relationship between cash holdings and *SIZE* (Opler et al, 1999; Bolton et al, 2011). However, Almeida et al (2004) and Denis and Sibilkov (2010) find that larger firms do hold more cash, which is in line with the pecking order theory. Reduced growth opportunities for these firms makes holding cash less expensive. But larger firms in general also have better access to capital markets, and thus a reduced need to hold excessive cash reserves (Opler et al, 1999). Due to the nature of our firms, we expect to find a negative relationship for *SIZE,* and we expect them to have large investment opportunities.

Firm profitability is measured as net income in relation to total assets. Profitability might affect cash levels since the more profitable a company is, the less it needs to hold liquid assets as risk assurance. Our sample includes firms in two comparable industries with similar characteristics. However, we include small-, mid-, and large cap, so there might be significant differences between these categories. Since our firms are expected to have large investment opportunities and are supposed to use cash to create additional value, we expect *ROA* to have a negative relationship with *CH* and *ΔCH.*

$$ROA = \frac{Net\ Income}{Total\ Assets}$$

Our last control variable is a dummy variable that proxies for access to capital markets (Kim et al, 1998; Opler et al, 1999). When distributing dividends, firms are expected to have a better access to capital markets. The dummy takes on the value of one when firms pay out dividends to investors, and zero otherwise. We expect firms that distribute dividends to hold less cash, since they are less dependent on internal access to cash. The variables should therefore have a negative relationship with our dependent variables.

$$D_{Dividends} \qquad \begin{array}{l} Dividends = 1 \\ No\ Dividends = 0 \end{array}$$

An overview of each independent variable's expected causal impact on cash holdings is presented in table 2.

Other variables have been motivated as determinants of cash holdings. Some of these, like net working capital and leverage, are incorporated in our Z-Score and we do therefore not include them as individual variables in our regressions. Others, like country regulations, are not relevant for us since we only focus on the US and do not compare results between nations. We believe that the chosen variables will provide valid results for our research question.

Table 2 - Expected impact on cash holdings

Variable	Expected Impact
D_{Hedge}	-
InvOp	+
$Hedge_{InvOp}$	-
MRA	+
LFD	+
TAX	-
SIZE	-
ROA	-
$D_{Dividend}$	-

Note: The figure shows how our independent variables are expected to affect cash holdings. The expected impact is based on theory and results from previous empirical studies, and adjusted according to our sample firms.

3.6 Endogeneity

A common problem in economic research is endogeneity issues, which is defined as correlation between at least one of the independent variables and the error term (Wooldridge, 2010). A regression with an endogenous variable on the right-hand-side gives rise to bias and estimation error, and thus inconsistent parameter estimates (Angrist, 2008). In the presence of endogeneity issues, estimating a regression with Ordinary Least Squares (OLS) will not be the best estimator of betas, as the fourth OLS assumption will be violated (explained in section 3.7). Instead, a simultaneous equation system must be used to deal with these issues (Greene, 2002).

There are three main causes of endogeneity. First, omitted variables are explanatory variables that are left out of a model because they are unobservable or difficult to proxy. Thus, they end up in the error term. Endogeneity problems arise if these variables are correlated with any of the independent variables. Since we have panel data, the use of fixed effects automatically takes care of this problem by the nature of the cross-sectional dimension (Greene, 2002). Second, some variables need to be proxied as they are difficult to quantify.

Conceptual dispersions occur between the proxies and their unobserved equivalents, giving rise to measurement error. These dispersions end up in the error term and may cause biased estimates. Measurement error is not a problem if the goal is to show correlation between a proxy and an observable measure (Wooldridge, 2010). Our goal is to make general conclusions about cash holdings so this problem might occur in our proxy for underinvestment. However, our proxy has been argued for in previous research and should therefore be a strong indicator of underinvestment (Gay and Nam, 1998). Third, reverse causality means that the dependent variable is affected by the explanatory variables, and that one or some of the explanatory variables are also affected by the dependent variable. Since cash holdings and hedging are explained by several empirical studies as substitute risk management tools, we suspect that our model might suffer from simultaneity issues (Nance et al, 1993; Bolton et al, 2011; Marin and Niehaus, 2011).

Since omitted variables and measurement errors are already accounted for in our model, we only test for reverse causality. Hedging and cash holdings can theoretically be seen as alternative risk management tools, which imply a possible reverse causality issue (Marin and Niehaus, 2011). Investments and cash holdings may also be affected by endogeneity problems since cash might determine how much a firm can invest in projects with internal funds. However, investment opportunities should not be affected by simultaneity problems since cash holdings do not affect the investment opportunities a firm has, only whether the firm actually can pursue the projects. Therefore, we do not find it necessary to test for reverse causality between cash holdings and investment opportunities.

3.6.1 Instrumental variables

We conduct a Hausman test to test for possible simultaneity issues. To do so we identify instrumental variables (IVs) for our predicted endogenous variable. An important factor regarding IVs is that the instruments have to be relevant, which means that they must be able to explain variation in the endogenous variable significantly. A valid IV is also correlated with the endogenous variable, but not with the error term. The IV can never affect the dependent variable directly, only indirectly through the endogenous variable. Relevance and direct correlation can be tested, but since the error term is unobservable we have to rely on economic theory and logical reasoning for assessing exogeneity (Greene, 2002).

Roberts and Whited (2012) argue against the use of IVs, claiming that good IVs are next to impossible to find. Since the instrument's exogeneity cannot be tested, the IVs must be based on thorough economic justification. Further, often more than one regressor is endogenous, meaning that inference can be compromised if instruments for all these variables cannot be found. Also, IVs encounter a tradeoff between internal and external validity. This means that if the IV takes care of the endogeneity problem, the results may only be applicable to our sample.

Marin and Niehaus (2011) use two variables as instruments for hedging, and argue that these instruments proxy CEO compensation. The proxies are based on stock options and restricted stock owned by CEO, and they state that: *"Stock options awarded to the CEO, because of their convex payoff structure, can lead to risk taking, and thus a lower likelihood of hedging. Restricted stock, on the other hand, gives a CEO an incentive to reduce risk through hedging."* (pp. 14). They mean that these IVs identify a firm's hedging activity without directly affecting cash holdings. However, we argue that there is a strong relationship between managerial risk aversion, based on stocks held by CEO, and cash holdings. This means that instruments' exogeneity condition is not fulfilled for these IVs. There is however limited research on the relationship between cash holdings and hedging, which builds on the difficulties in finding valid IVs. Despite a thorough review of previous research, we have not been able to identify a valid IV for hedging. Difficulties in finding good IVs can be explained by the implications described in Roberts and Whited (2012). Since we cannot find better IVs for hedging, we find it appropriate to test the relevance of the IVs supported by Marin and Niehaus (2011) to be able clarify possible simultaneity issues. This will be done in a simultaneous equation system:

$Structural\ Equation$:

$$CH_{it} = \alpha_0 + \alpha_1 D_{Hedge_{it}} + \alpha_2 InvOp_{it} + \alpha_3 TAX_{it} + \alpha_4 LFD_{it} + \alpha_5 MRA_{it} + \alpha_6 ROA_{it} + \alpha_7 D_{Dividend} + \alpha_8 SIZE_{it} + \varepsilon_{it}$$

$Reduced\ form\ Equation$:

$$D_{Hedge_{it}} = \beta_0 + \beta_1 LogStOptions_{it} + \beta_2 InvOp_{it} + \beta_3 TAX_{it} + \beta_4 LFD_{it} + \beta_5 MRA_{it} + \beta_6 ROA_{it} + \beta_7 D_{Dividend} + \beta_8 SIZE_{it} + \omega_{it}$$

We choose the stock option variable as an IV to perform a Hausman test for endogeneity, and test the relevance of the instrument by regressing the residuals from the reduced form equation in our structural equation (Appendix 2). The IV fulfills the relevance criteria and a Hausman test is conducted to find whether the theoretical expectations regarding simultaneity apply. We adjust our data as cross-sectional and perform a Hausman test with 2SLS, based on Greene (2002). The J-statistics from this test is insignificant which means that the null hypothesis of exogeneity cannot be rejected. We are therefore not able to confirm any reverse causality issues. The results from the 2SLS and the Hausman test are also presented in Appendix 2. However, we understand that the results indicating no endogeneity is based on a bad IV, and realize how this might affect the results.

Even though the relevance criterias fulfilled and the IV is based on previous research, we cannot find a well-grounded argument for the instrument's exogeneity condition. This means that we are not able to determine whether the results of no endogeneity from the Hausman test holds. For this reason, as well as Roberts and Whited's (2012) arguments against IVs, we choose not to use a simultaneous equation system to test our hypotheses. Since we cannot find evidence of endogeneity our models are estimated in a multiple regression analysis using OLS, provided that the other underlying assumptions hold.

3.7 Ordinary Least Squares

OLS is the mostly used model in econometrics, and is applied to examine the linearity of the dependent and explanatory variables in a regression analysis. For OLS to be the best model for our sample and be BLUE[8], the regression needs to fulfill five important criterias[9]. If these assumptions are not violated we can consider our models to be reliable and consistent.

The first OLS assumption implicates that the average of the expected errors is zero. By including a constant this assumption is automatically fulfilled. The second requirement refers to the assumption of homoscedasticity. This implies that the variance among the residuals in a regression model should be constant. We test the null hypothesis of homoscedasticity using White's heteroscedasticity test, which shows that we have heteroscedasticity in our sample. We correct for this by using White's diagonal robust standard errors (Brooks, 2008).

The third assumption regards non-autocorrelation, which means that the errors are assumed to be uncorrelated with a covariance of zero both in the cross-sectional- and time dimension. Testing for autocorrelation is most relevant for time-series data, and is rarely tested for panel data. Our sample period is also relatively short, which makes it difficult to observe trends over time. We therefore do not conduct any extensive tests for this potential issue. However, we test this assumption with the Durbin-Watson test for robustness. Durbin-Watson statistic takes on values between 0 and 4, where 2 is desirable and indicates no autocorrelation (Gujarati and Porter, 2010). Our regressions have a Durbin-Watson statistic close to 2, and should thereby not suffer from autocorrelation problems. The fourth assumption states that the descriptive variables have to be non-stochastic, which implies that they are not correlated with the error term. If any of the independent variables are correlated with the error term, the

[8] Best Linear Unbiased Estimator
"The term best linear unbiased estimator (BLUE) comes from application of the general notion of unbiased and efficient estimation in the context of linear estimation."
[http://srmo.sagepub.com/view/the-sage-encyclopedia-of-social-science-research-methods/n56.xml Accessed 11-05-2015]

[9] 1. The average values of the errors are zero.
2. The variance of the errors is constant.
3. The covariance between the errors is zero.
4. The regressors are uncorrelated with the error term.
5. The errors are normally distributed.

OLS estimator will be inconsistent and thus the regression will give biased results. These issues are referred to as endogeneity problems and are accounted for in earlier sections.

The last assumption refers to the normality of the disturbance terms and is tested with a Jarque-Bera Normality test. We find no evidence of normally distributed errors. However, since all the other assumptions are fulfilled, and our sample consists of a large number of observations, economic literature argues that this assumption is negligible (Brooks, 2008; Wooldridge, 2010). Besides the five OLS assumptions, we also check for multicollinearity among the independent variables. This is done in a correlation matrix (Brooks, 2008). None of the variables have a correlation exceeding 0.6, and therefore we find no evidence of multicollinearity (Appendix 3). Altogether, the test results indicate a stable and correctly specified model.

3.8 Regressions and Hypotheses

The econometric technique as well as the variables included in the models are presented and described above. The regressions we run to conduct the study are presented below.

$$CH_{it} = \alpha_0 + \alpha_1 D_{Hedge_{it}} + \alpha_2 InvOp_{it} + \phi K_{it} + \varepsilon_{it} \qquad \text{Model 1}$$

$$CH_{it} = \alpha_0 + \alpha_1 D_{Hedge_{it}} + \alpha_2 InvOp_{it} + \alpha_3 Hedge_{InvOp} + \phi K_{it} + \varepsilon_{it} \qquad \text{Model 2}$$

$$\Delta CH_{it} = \gamma_0 + \gamma_1 D_{Hedge_{it}} + \gamma_2 InvOp_{it} + \phi K_{it} + \varepsilon_{it} \qquad \text{Model 3}$$

$$\Delta CH_{it} = \gamma_0 + \gamma_1 D_{Hedge_{it}} + \gamma_2 InvOp_{it} + \gamma_3 Hedge_{InvOp} + \phi K_{it} + \varepsilon_{it} \qquad \text{Model 4}$$

Where:

CH_{it}	*Level of Cash Holdings for firm i at time t*
ΔCH_{it}	*Change in cash holdings for firm i between time t-1 and t*
$D_{Hedge_{it}}$	*Dummy variable for hedging activity for firm i at time t*
$InvOp_{it}$	*Investment opportunities for firm i at time t*
$Hedge_{InvOp}$	*Interaction between hedging and investment opportunities for firm i at time t*
ϕK_{it}	*A set of control variables which are discussed above, including MRA, SIZE, TAX, LFD, ROA,* $D_{Dividend}$*, and a vector of coefficients*
ε_{it}	*Unobservable error term*
α_0, γ_0	*The intercept*
α_K, γ_K	*The Coefficients*

3.8.1 Robustness Test

We also conduct a robustness test to see whether our results are applicable also when using another variable specification for investment opportunities. Market-to-Book, *MtB*, is used to test if the results concerning firms' investment opportunities effect on cash holdings still apply when using a different proxy. The test shows that we get significant results between cash holdings and hedging for firms with high investment opportunities, also when we use a different proxy. This means that our results are not dependent on the choice of variable. The results from the robustness tests are presented in Appendix 5.

3.8.2 Specification of Hypotheses

To study the causal relationship between hedging and cash holdings, two hypotheses are developed. By running our regressions, we are able to answer the research question of whether or not hedging and cash holdings statistically can be viewed as alternative risk management tools, as well as if this connection is strengthened for firms with potential underinvestment problems. The hypothesis testing is performed at a 10 % significance level.

The first hypothesis intends to capture differences in firms' cash levels based on whether the firms hedge or not, and is formulated as follows:

Hypothesis 1 (H_{CH}**):** *Firms that hedge hold less cash compared to firms that do not hedge.*

This hypothesis is tested with Model 1 and 2. We test the relationship between hedging and cash holding levels both with and without potential underinvestment problems, since the relationship might be strengthened in the presence of increased investment opportunities. If the coefficient for D_{Hedge} in the first model is negative and significant, the null hypothesis is rejected. Also, in Model 2 the null is rejected if the coefficient for $Hedge_{InvOp}$ is negative and significant.

The next hypothesis is conducted to capture any changes in cash levels given that the firm hedges. We test whether it is statistically significant that a firm that hedges decrease their cash holdings. The hypothesis is stated as:

Hypothesis 2 ($H_{\Delta CH}$**):** *Firms decrease their cash levels when they hedge.*

We use Model 3 and 4 to test $H_{\Delta CH}$**.** The relationship between hedging and cash holdings is tested both with and without potential underinvestment problems. A negative and significant coefficient for the D_{Hedge} variable in Model 3 rejects the null, implying that a negative relationship between hedging and changes in cash levels occur. In Model 4, the null is also rejected if $Hedge_{InvOp}$ is negative and significant, implying that the relationship also exists under an increased risk of underinvestment problems.

3.9 Interpretation of Regression Results

The coefficient of determination (R^2) specifies the ratio of the variation in the dependent variables that is explained by the regressors (Gujarati & Porter, 2010). Many elements explain the level of cash a firm decides to hold, and cash holdings can therefore not be explained by hedging and investment opportunities alone. We believe that our models are well specified, since we have controlled for aspects with substantial impact on cash holdings. The R^2 will reflect "cross-sectional values" of the data, meaning that we will be able to compare a firm's risk management decision within our time period in the regressions with fixed effects specification (Greene, 2002).

4. RESULTS

This chapter presents the results from the regressions, descriptive statistics of our sample and examines the hypotheses stated in the methodology chapter. Also, the model fit will be presented.

4.1 Descriptive statistics

The final sample consists of 406 observations, due to data loss from missing values. Descriptive statistics for the entire sample is presented in table 3. To emphasize the difference among the sample firm years, we will also present the descriptive statistics for each market capitalization (Appendix 4).

Table 3 - Descriptive statistics for all sample firms

Ratio	Mean	Median	Std.Dev	Minimum	Maximum
Hedging Dummy	0.614	1	0.49	0	1
Cash/Total Assets	0.17	0.13	0.24	0.001	4.11
Total Assets	11,380	1,764	28,044	7.4	212,949
Total Sales	7,538	1,343	18,430	1.40	122,734
Market Value of Equity	15,226	2,915	32,683	89.4	212,543
Return on Asset	0.0077	0.07	0.07	(0.32)	0.70
Dividend Dummy	0.38	0	0.486	0	1
R&D	655.9	77.55	1,593.2	0.0	9,340
R&D/Sales	0.316	0.0812	1.641	0.0	21.67

Note: The table displays the mean, median and standard deviations of all sample firms for important firm aspects. The numbers are in million dollars and contain values from 406 observations.

The total sample presents a comprehensive dispersion among the variables and firm characteristics. In the entire sample, 61% of the firms use derivatives to hedge their risk exposure. If we look at the cash ratio we can see that some firms hold substantial amounts of liquid assets, while others do not hold much cash. However, the average is 17% for the sample as a whole. Firms that hedge hold on average less cash than firms that do not hedge, which is significant at 1% level. Moreover, hedgers hold on average 0.13 cash to total assets, while non-hedgers hold 0.23. There are also large differences in terms of total assets and total sales. The minimum shows a market value of equity of $89.4 million, while the maximum shows $212,543 million.

Looking at return on assets, profitability varies among the firms. The mean and the median indicate that firms on average show profitable figures. 38% of the firms pay out dividends to its investors. R&D expenditures varies from 0 to more than 21 times the sales of the company. On average firms in the total sample spend 31.6% of their sales on R&D, which is

higher than the median. This indicates skewness in the sample and a great variety among the expenditures, which might affect the final results of the models.

We also conduct descriptive statistics for each market capitalization to find possible differences (Appendix 4). Large firms hedge more than the average firm. As many as 86% of the large cap firms in our sample use derivatives, while mid cap (66%) and small cap (34%) firms hedge less. Large cap firms do however hold less cash compared to the other capitalizations, which is consistent with our expectations. Category statistics show that large firms that hedge hold 12% cash while firms that do not hedge hold 19%. Mid cap firms that hedge also hold less cash than non-hedgers with 13% and 23%, respectively. These results are significant at a 1% level. The same relationship is suggested for small cap firms, however these results are not significant.

Further, a majority of the large cap firms pay out dividends, and large firms spend more money on R&D compared to the average firm. Fewer mid cap firms distribute dividends to its investors, and they also invest less in R&D. However, we see that the maximum value corresponds to R&D investments equal to 38% of sales, which indicates that mid cap firms do invest in R&D to the same extent as the average R&D expenditure. Small cap firms experience the most volatile profits and very few pay out dividends. On average they spend 30% on R&D, however a low median indicates skewness in the sample, suggesting that some firms spend much more than others.

4.2 Regression results

The results of our regressions are presented in Table 4. The first column presents each variable included in the regressions, while the following columns provide the results of each regression separately. The first figures show the variable coefficients with asterisks indicating the level of significance, where one, two and three asterisks provide a significance level of 10%, 5% and 1% respectively. The numbers in parentheses provide standard errors, corrected for heteroscedasticity using White diagonal standard errors.

Table 4 - Regression results

	CH				*ΔCH*			
	Model 1		Model 2		Model 3		Model 4	
	Pooled	Fixed	Pooled	Fixed	Pooled	Fixed	Pooled	Fixed
Intercept	-2.5703***	-1.9514	-2.3948***	-2.2415*	0.2605***	1.8309***	0.1409	1.5958***
	(0.2930)	(1.2081)	(0.2848)	(1.2204)	(0.0819)	(0.5048)	(0.0968)	(0.4979)
D_{Hedge}	-0.5376***	0.1157	-0.7518***	0.2049	-0.0841**	-0.0204	0.0416	0.1087
	(0.1298)	(0.1618)	(0.1347)	(0.1740)	(0.0345)	(0.0512)	(0.0373)	(0.1028)
InvOp	0.0453**	-0.0133	0.0397**	-0.0106	-0.0092	-0.0195	-0.0040	-0.0187
	(0.0189)	(0.0386)	(0.0176)	(0.0386)	(0.0068)	(0.0293)	(0.0062)	(0.0292)
TAX	0.0946***	0.0378	-0.1019	0.0995**	-0.1918***	-0.2460***	-0.0718**	-0.1734***
	(0.0160)	(0.0236)	(0.0573)	(0.0473)	(0.0192)	(0.0165)	(0.0361)	(0.0481)
LFD	0.0224***	0.0189*	0.0243***	0.0197*	0.0049*	-0.0065	0.0044	-0.0057
	(0.0067)	(0.0109)	(0.0071)	(0.0108)	(0.0030)	(0.0068)	(0.0029)	(0.0068)
MRA	0.7353	-5.6512***	-0.0127	-5.6219***	-1.1961***	-1.7820**	-0.7188**	-1.801**
	(1.2554)	(1.7637)	(1.2144)	(1.7375)	(0.3093)	(0.7649)	(0.3125)	(0.7247)
$D_{Dividend}$	-0.1503	0.1901	-0.1226	0.1797	-0.0557***	0.0241	-0.0704***	0.0202
	(0.1162)	(0.1507)	(0.1161)	(0.1497)	(0.0195)	(0.0361)	(0.0361)	(0.0358)
SIZE	0.0440	-0.0692	0.0360	-0.0374	-0.0103	-0.2195***	-0.0034	-0.1971***
	(0.0404)	(0.1583)	(0.0393)	(0.1599)	(0.0084)	(0.0665)	(0.0101)	(0.0649)
ROA	3.5102***	1.3767	2.9099***	1.4576	0.6955**	-0.0744	-0.4160	-0.1143
	(0.9963)	(1.1133)	(1.0332)	(1.0734)	(0.2892)	(0.3889)	(0.3250)	(0.3682)
$Hedge_{InvOp}$	-	-	-1.0141***	-0.2987*	-	-	-0.6105***	-0.3462*
	-	-	(0.2613)	(0.1988)	-	-	(0.1787)	(0.2129)
R^2	0.2061	0.8193	0.2369	0.8198	0.7536	0.8854	0.7882	0.8874
F-Statistics	11.259	12.592	11.935	12.458	107.45	16.031	115.79	16.101
Firm Years	356	356	356	356	290	290	290	290

*Note: The results provided in the table are from the panel data sample of firm years between 2009-2013. For all models, results are presented from both pooled and fixed effects regressions. The first numbers are the regression coefficients, while figures in parentheses show the White's standard errors corrected for heteroscedasticity. The asterisks indicate the level of significance, where *, **, and *** stands for 10%, 5%, and 1% significance level respectively. The models R^2 and F-statistics are also presented. Any variable with missing data is excluded from the regressions, which explains the variation in firm-years.*

4.2.1 Hypothesis testing

Hypothesis H_{CH}

The models in table 4 are used to test our hypotheses. The first hypothesis, H_{CH}, suggests that firms that hedge hold less cash than firms that do not use derivatives. The null hypothesis states that firms are indifferent to their cash holdings following their hedging strategies. The pooled regression in Model 1 shows that the D_{Hedge} variable has a significant negative impact on cash holdings, which is consistent with our expectations. This means that the null hypothesis can be rejected at a 1% level based on the pooled regression, but not when we control for fixed effects.

This negative relationship also applies when running Model 2 as a pooled regression. $Hedge_{InvOp}$ suggests a stronger negative relationship, showing that hedging firms with large investment opportunities hold less cash than firms without these opportunities. This result is significant both in pooled and fixed effects regressions. According to the results in Model 1 and 2, we reject the null hypothesis and find that hedgers hold lower cash reserves.

Hypothesis $H_{\Delta CH}$

The second hypothesis, $H_{\Delta CH}$, states that firms that hedge reduce their cash levels. In Model 3, D_{Hedge} is significant in the pooled regression and indicates that hedgers reduce their cash levels by 8.41% compared to non-hedgers. The null is rejected at a 5% level based on the pooled regression. However, this is not confirmed when controlling for cross-sectional fixed effects. Model 4 shows that hedgers with high investment opportunities reduce their cash levels. This is significant for the $Hedge_{InvOp}$ variable both in pooled and fixed effects at a 1% and 10% level, respectively. This means that the null can be rejected regardless of specification.

Table 5 provides the results from the hypotheses tests. The null can be rejected by Model 2 and 4 when we use both pooled regressions and cross-sectional fixed effects, since $Hedge_{InvOp}$ has negative and significant coefficients. In Model 1 and 3, the null can be rejected by the pooled regressions, while controlling for fixed effects give insignificant results for the hedging variable D_{Hedge}.

Table 5 - Results of hypothesis tests

H_{CH}	Model 1		Model 2	
	Pooled	Fixed	Pooled	Fixed
H_0	Rejected	Not Rejected	Rejected	Rejected
D_{Hedge}	0.0024	0.2082	-	-
$Hedge_{InvOp}$	-	-	0.0001	0.0671

$H_{\Delta CH}$	Model 3		Model 4	
	Pooled	Fixed	Pooled	Fixed
H_0	Rejected	Not Rejected	Rejected	Rejected
D_{Hedge}	0.0155	0.6903	-	-
$Hedge_{InvOp}$	-	-	0.0007	0.0477

Note: The figures in the table present the p-values of the main independent variables. If respective values fall below the significance level of 10 %, each model's null hypothesis is rejected.

4.2.2 Control Variables

The variable *InvOp* is positive and significant at a 5% level in the pooled regressions for Model 1 and 2. This means that as firms' investment opportunities increase, they hold more cash. This statement does not hold when controlling for fixed effects. Also, in Model 1 and 2 the *LFD* variable for likelihood of financial distress is significant both in the pooled regressions, and when controlling for fixed effects. This indicates that firms with a likelihood of default hold more cash. *LFD* is also significant in the pooled regression in model 3, stating that firms with a higher likelihood to default increases their cash reserves. The *TAX* variable has a significant and positive coefficient in Model 1 and 2, with *CH* as the dependent variable, suggesting that firms hold more cash when they have a tax advantage. However, in Model 3 and 4, the *TAX* variable has a significant negative coefficient. These results imply that firms with a tax advantage hold higher levels of cash, but decrease their cash holdings when they have a tax benefit.

All models, except for the pooled regressions with *CH* as dependent variable, show a significant and negative relationship for *MRA*. This suggests that firms hold less cash as well as decrease their cash holdings when managers might be risk-averse. The *SIZE* variable has negative coefficients in all models, but is only significant when controlling for fixed effects in the third and fourth models. This indicates that as firm size increases corporations lower their cash holdings, which is consistent with our expectations. The pooled regressions in model 3 and 4 show negative coefficients for $D_{Dividend}$, meaning that firms that give out dividends reduce their cash reserves. Finally, *ROA* is positive and significant in all pooled specifications except for model 4, indicating that profitable firms hold more cash and increase their cash levels.

4.2.3 Model-fit

The model fit is estimated by the coefficient of determination - R^2. Model 1 and 2 show a model fit of around 0.20 for the pooled regressions (table 4). The rest of the models show a high model fit, meaning that a high percentage of firms' cash holding decisions can be explained by hedging and the other variables included in the regressions. We expect a high model fit as we only have two industries in our sample, whose characteristics fit theoretically well with our chosen variables (Opler and Titman, 1994; Gay and Nam, 1998; Kim et al, 1998; Opler et al, 1999; Graham and Rogers, 2002; Gill, 2012). However, since we cannot include all factors that have an effect on the dependent variables, we do not expect a perfect fit that can fully explain firms' cash management decisions. The F-statistic is significant at a 1% level in all the regressions, indicating a strong relationship between the dependent variables and all of the independent variables in the regressions.

5. ANALYSIS

The chapter includes a thorough analysis of the results of our regressions and hypothesis tests, based on the theoretical and empirical framework presented in Chapter 2. We begin discussing the descriptive statistics, then our variables and last some limitations of our study.

5.1 Descriptive results

The descriptive statistics presented in table 3 show that 61% of our sample firms hedge. Allayannis and Weston (2001) studied large US firms with currency risk exposure between 1990-1995 and found that 37% of the firms hedged their risks. This indicates that hedging has grown in popularity in later years, which can be a result of a more globalized marketplace and thus increased risk exposure. However, this can also be due to differences among the sample firms. In our study we only include two industries, while Allayannis and Weston (2001) focus on all non-financial firms. Marin and Niehaus (2011) found that around 50.3% of their sample firms hedged while only focusing on manufacturing firms. This supports the motivation that firms hedge to different extents depending on industry, and R&D firms are likely to have a lot to gain from using derivatives.

According to our descriptive results, larger firms also hedge to a higher extent than smaller firms. This might be explained by the costs associated with initiating a risk management program (Mello and Parsons, 2000). Smaller firms might choose not to hedge and rather pursue investments if they cannot afford to do both. Including small firms in our sample might therefore distort our results, since even if they have potential benefits from hedging, the firms might still avoid using derivatives. From the category statistics, we also see that hedgers hold significantly less cash. This is consistent with our expectations and with findings in previous research (Bolton et al, 2011).

5.2 Cash Holdings and Hedging

Our research question aims to define whether cash holdings and hedging can be seen as substitute risk management tools. To answer this question we conduct four regressions to test how hedging affects the level of cash a firm holds, whether hedgers reduces their cash levels, and if cash holdings and hedging have a strengthened negative relationship in the presence of potential underinvestment issues.

The redundant fixed effects likelihood ratio test justifies the use of fixed effects in the cross-sectional dimension, meaning that fixed effects is the best statistical specification for our models. Model 1 explains the determinants of firms' cash holdings, and cannot provide any significant evidence that supports cash holdings and hedging as alternative risk management

tools when using fixed effects. This is inconsistent with previous research, (Marin and Niehaus, 2011). The fixed effects regression gives no significant results in Model 3 either, which seeks to explain the connection closer by examining if hedgers decrease their cash holdings. The lack of significant results might have multiple explanations.

First, we examine financially unconstrained firms, while previous research has focused on constrained companies. As argued, the higher level of uncertainty makes risk management more important for these firms, and the relationship might be strengthened since they cannot afford to hold excessive levels of cash. The substitutive relationship may thereby be stronger for constrained firms. Financially unconstrained firms may not have to choose between cash hoarding and hedging. Due to a stable financial health, they can choose to hold a cash level above optimum even if it is costly. Also, the costs of using derivatives may alone be a reason not to hedge for constrained firms (Mello and Parsons, 2000). Therefore constrained firms with an incentive to hedge may not actively choose cash as an alternative tool, but do so to avoid hedging costs. This reasoning can also be applied to small cap firms.

Second, our sample includes two specific industries with high R&D expenditures. Due to limited access to capital markets, firms with high levels of R&D may choose to hold more cash even if they hedge (Mikkelson and Partch, 2003). This way they also avoid potential problems with information asymmetries with investors and creditors. However, since holding excessive cash reserves is costly, hedgers in these industries should prefer using this capital for investments rather than as a risk reduction tool. According to this, a positive relationship between these risk management tools is not likely to occur for our sample firms. Third, our results may be affected by the definition of the hedging variable. It would be desirable to capture the value of a firm's hedging position, however since hedging operations are off-balance sheet posts[10] the information is hard to acquire (Froot et al, 1993). The relationship between hedging and cash holdings can be expected to be stronger for firms with high value derivative positions, while firms that only have limited hedging positions can be expected to hold substantially higher amounts of cash. Our results are therefore limited by our binary variable for hedging, while a variable that captures this effect could have given different results.

A fourth reason may be that hedging strategies can depend on market competition and competitors' hedging strategies (Froot et al, 1993). Since our firms operate in the same sector and might be competitors, they can be biased towards competitors' risk management strategy. The real effect may be hidden since firms rather follow market decisions than what could potentially be the best approach for the company. Fifth, Bolton et al. (2011) argue that firms with similar characteristics hold different cash levels, indicating that it is affected by more than one factor. To be able to find a relationship between hedging and cash management, we

[10] It is possible to find information about fair value of hedging, but not real value.

might have to incorporate other measures to find significant results. This result is confirmed by our second and fourth models when accounting for increased investment opportunities.

Finally, our results may be limited due to a homogenous sample and little variation within the firms. To examine whether this affects our results, we test pooled regressions to capture between firm variation. As suspected, we need this variation to reveal a significant relationship between hedging and cash holdings. Running Model 1 and 3 as pooled regressions show that hedging in fact has a negative and significant effect on cash holdings, indicating that hedgers hold less cash compared to non-hedgers, and that hedgers decrease their cash levels. Empirical studies have previously only confirmed this connection for financially constrained firms (Denis and Sibilkov, 2010; Bolton et al, 2011; Marin and Niehaus, 2011). Our results suggest that the relationship also holds for firms facing no financial constraints. This indicates that firms with high investment opportunities use cash and hedging as alternative risk management tools, and that hedgers have a lower optimal level of liquid assets compared to non-hedgers.

We also test the relationship between hedging and cash under potential underinvestment problems to determine whether these agency costs strengthens the relationship. The results from Model 2 suggest that hedgers with an increased risk of underinvestment problems hold less cash than other firms. This negative relationship is supported by the result in Model 4, which indicates that hedging firms also decrease their cash levels with as much as 34% as potential underinvestment issues increase. This suggests that the relationship between hedging and cash holdings as alternative risk management tools is strengthened with high investment opportunities and potential underinvestment problems.

A reasonable explanation to why we find a stronger substitutive relationship for hedgers who experience increased potential underinvestment problems, is that such agency costs can be mitigated through risk management (Culp, 2001). Our sample firms have large investment opportunities, meaning that the relationship is strengthened as firms rather invest their cash in these projects when they hedge. Companies with high investment opportunities are vulnerable to underinvestment problems if they use external capital for new investments (Gay and Nam, 1998). When these firms hedge their risks, they can use their internal cash holdings to fund projects and thereby avoid underinvestment. They do not need to hold large cash reserves for risk management purposes. Holding excessive amounts of cash increases the risk of being acquired, and R&D firms should be aware of this possible threat, since they are already valuable targets due to their unique and innovative operations.

Our results may be affected by the time period of our sample, which we expect to be influenced by the 2007/2008 financial crisis. Opler et al (1999) argue that the main reason for large changes in cash holdings are due to operating losses, and may be why our results show a negative connection during this period. Also, during the crisis cash was difficult to obtain,

meaning that firms had to use their reserves during these years. Building up an optimal cash reserve may take time, which is why our period may reflect low cash levels.

5.3 Other Determinants of Cash Management

There are other factors than hedging that affects a firm's cash levels. As discussed, investment opportunities have a positive effect on cash holdings, which is significant when we allow for between variation in our models. This means that firms with higher investment opportunities hold more cash, which can be explained by the precautionary motive for holding cash. This is also realistic when considering their need to move on good investments (Keynes, 1936). Again, the relationship cannot be proven in the fixed effects specifications, which might once again be due to by a lack of within variation in growth opportunities. Most likely firms' investment opportunities are relatively stable over time.

Another factor that supports the use of risk management tools, and influence the levels of cash holdings, is the likelihood to face financial distress. Our results suggest that firms with a higher probability of financial distress hold more cash, which is in line with our expectations. We also find evidence that these firms increase their cash levels. Both Opler et al. (1999) and Bolton et al. (2011) find similar results, which can be supported by the fact that holding cash can prevent an actual default, since easy accessible funds can be used to repay obligations. On the other hand, Denis and Sibilkov (2010) find that some financially constrained firms with high investment opportunities hold low levels of cash according to persistently low cash flows, a problem that hedging can mitigate. Mian (1996) finds no significant relationship between risk management and possible financial distress. Our firms are not financially constrained and should therefore hold higher levels of cash as their likelihood to face financial distress increase.

As problems with managerial risk aversion increase, firms are expected to hold more cash to lower the riskiness of new investments (Culp, 2001). However, we find that managerial risk aversion has a strong negative effect on cash holdings. This might be explained by firms wanting to avoid excessive spending, a view supported by previous research (Harford, 1999; Dittmar and Thakor, 2007). In fear of excessive spending and empire building, firms hold lower cash levels to limit bad investments. Mikkelson and Partch (2003) contradict this reasoning, arguing that cash hoarding might instead be essential for operations and find no support that high cash holdings lower firm performance. However, since good investments are of high importance to our sample firms, and investing in pet projects might get severe consequences, they may want to limit problems with excessive spending as managerial risk aversion increase.

The last opportunity for risk management to create value is by decreasing the tax liability. As large cash reserves is a disadvantage seen from a tax perspective, we expect our firms to have lower cash holdings when they have a tax advantage. However, our results imply that as tax

benefits increase, firms hold more cash. This indicates that our sample firms do not base their cash management decisions on possible tax benefits. Holding costly cash reserves to be able to move on good investments is probably more important for our firms than a potential tax benefit. However, the results also indicate that these firms decrease their cash levels when having a tax advantage. Higher cash levels increase the tax liability and should therefore be avoided when a possible tax benefit exists (Opler et al, 1999). Also, firms that have a possible tax benefit should prefer hedging over holding cash, since it increases the post-tax firm value (Smith & Stulz, 1985).

Firm size has a negative effect on cash holdings, which can be explained by a greater access to capital markets. Also, larger firms have a lower risk of facing financial distress, which reduces the need to hold cash reserves (Kim et al, 1998; Opler et al, 1999; Gill, 2012). Some empirical findings have shown a positive relationship between these firm aspects and changes in cash holdings (Almeida et al, 2004; Denis and Sibilkov, 2010). Their results support the pecking order theory since firms will always prefer internal funding to external (Myers & Majluf, 1984). However, our sample firms are dependent on good investments to be able to compete in their industries, and may therefore lower their cash levels to mitigate poor investments by managers in favor for an optimal cash level.

The negative relationship between dividends and cash holdings is supported by the fact that firms with good access to capital markets reduce the need to hold costly cash reserves. The results also show that profitable firms hold more cash. This is not in line with our expectations, but can be explained by the precautionary motive as firms want to make sure to have easy access to internal funds when good investment opportunities appear.

5.5 Limitations

Our sample consists of data from a five year period between 2009-2013. Since this period might include time-specific events, the results may be relevant only for these years. The recent financial crisis may have affected our results as firms might have had limited ability to choose optimal cash management and hedging strategies. As the economy has stabilized, firms may have begun to operate differently. Now firms might be more aware of financial risks and act according to this. Our results may therefore only be applicable for periods following a recession.

Although we have managed to include a dynamic sample by covering firms from all market capitalizations, our results may not replicate the entire market as we only include firms from S&P 1500. The study is limited to public companies, meaning that the results are not applicable to private firms. However, the differences among private and public companies might be large in the context of risk management and meaningless to examine together. Also, private companies do not follow as strict disclosure practices, making it difficult to collect data on these companies.

Another limitation that might affect the results is that we use a binomial variable for hedging. This limits our ability to find out whether firms that hedge more relative to other firms hold different cash levels, which would be interesting to examine as well as it could have given more significant results. The availability of such information is limited and is rarely disclosed in databases and annual reports, which is why we focused on a binomial variable. To retrieve the information needed for a relative hedging measure, a survey could have been carried out. Though, this is not realistic for our study, as it would probably have resulted in a low response rate.

The proxies for several of our variables might capture other aspects than the ones we are interested in examining, and may thereby distort our results. One way to address this potential problem is to test different proxies for the variables as robustness. We do this with the proxy for underinvestment, by also testing Market-to-Book (Appendix 5). The test shows that we get significant results between cash holdings and hedging for firms with high investment opportunities, also when using a different proxy. This means that our results are not dependent on the choice of variable.

6. CONCLUSION

The final chapter presents concluding remarks on our findings and suggestions for further research within the area of study.

6.1 Concluding remarks

This study has two main purposes. First, investigate whether hedging and cash holdings can be seen as substitutive risk management tools in the manner that hedgers can hold lower cash reserves. Second, examine if the relationship between hedging and cash holdings is strengthened under possible underinvestment problems.

Our findings show that US firms with high investment opportunities hold significantly lower cash reserves compared to non-hedgers. Our results indicate that they hold much less cash, and that they lower their cash reserves with approximately 8%. It is important for firms with substantial growth opportunities and high investment rates to ensure a safe and stable access to capital. Firms whose operations rely on R&D and high improvement expenditures can use liquid resources to invest in value enhancing projects when they hedge, and do not have to hoard cash for risk reducing purposes. We show that hedging as a risk management tool has grown in importance over the years. Our results indicate that firms hedge more than earlier, but we also find that firms rarely change their hedging activity. It therefore becomes difficult to examine the effect implementation of a hedging program would have within a company.

The risk of underinvestment problems is imminent for investment intensive companies. We find that hedging firms can lower their cash reserves as investment opportunities increase, and our results suggest that firms in this case reduce their cash levels with as much as 34%. This means that the overall results support the theory on risk management. It also supports hedging and cash reserves as alternative risk management tools.

As our results indicate, determining an optimal cash level is a complex decision that is influenced by many different factors. We conclude that firms with substantial investment opportunities have a reason to hedge so that cash reserves can be used for investments. This allows them to use their liquidity on value-enhancing projects. Non-hedgers must instead hold cash reserves for risk reducing purposes. Hedging and cash holdings can thereby be seen as alternative risk management tools.

6.2 Suggestions for further research

Our focus is directed towards the relationship between hedging and cash management in the presence of potential underinvestment problems. There are several other firm aspects that may affect this relationship that can be examined. For example, it would be interesting to test the relationship between cash and hedging in the presence of either managerial risk aversion, likelihood of financial distress or tax convexity. The importance of risk reducing activities differs between industries and sectors and it can therefore be interesting to examine other firms. Further, this research area can be examined over a longer period to mitigate potential biases from specific events. Including a longer time period might capture variation in the hedging variable, thereby making it possible to examine the effect on cash levels when hedging strategies change. Intuitively, the relationship between hedging and cash holdings should be strongest when a firm chooses to change their risk management programs and implements hedging in their strategy.

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8. APPENDICES

Appendix 1 - List of companies included in sample

Large Cap

1.	Agilent Technologies Inc	Large Cap	Biotech & Pharmaceuticals
2.	AbbVie	Large Cap	Biotech & Pharmaceuticals
3.	AmerisourceBergen Corp	Large Cap	Biotech & Pharmaceuticals
4.	Abbott Laboratories	Large Cap	Biotech & Pharmaceuticals
5.	Actavis plc	Large Cap	Biotech & Pharmaceuticals
6.	Allergan Inc	Large Cap	Biotech & Pharmaceuticals
7.	Alexion Pharmaceuticals	Large Cap	Biotech & Pharmaceuticals
8.	Amgen Inc	Large Cap	Biotech & Pharmaceuticals
9.	Baxter International Inc.	Large Cap	Medical Equipments & Devices
10.	Bard (C.R.) Inc.	Large Cap	Medical Equipments & Devices
11.	Becton Dickinson	Large Cap	Medical Equipments & Devices
12.	BIOGEN IDEC Inc.	Large Cap	Biotech & Pharmaceuticals
13.	Bristol-Myers Squibb	Large Cap	Biotech & Pharmaceuticals
14.	Boston Scientific	Large Cap	Medical Equipments & Devices
15.	Celgene Corp.	Large Cap	Biotech & Pharmaceuticals
16.	Dentsply International	Large Cap	Medical Equipments & Devices
17.	Endo International	Large Cap	Biotech & Pharmaceuticals
18.	Edwards Lifesciences	Large Cap	Medical Equipments & Devices
19.	Gilead Sciences	Large Cap	Biotech & Pharmaceuticals
20.	Hospira Inc.	Large Cap	Medical Equipments & Devices
21.	Intuitive Surgical Inc.	Large Cap	Medical Equipments & Devices
22.	Johnson & Johnson	Large Cap	Medical Equipments & Devices
23.	Lilly (Eli) & Co.	Large Cap	Biotech & Pharmaceuticals
24.	McKesson Corp.	Large Cap	Biotech & Pharmaceuticals
25.	Medtronic Inc.	Large Cap	Medical Equipments & Devices
26.	Merck & Co.	Large Cap	Biotech & Pharmaceuticals
27.	Mylan Inc.	Large Cap	Biotech & Pharmaceuticals
28.	Patterson Companies	Large Cap	Medical Equipments & Devices
29.	Pfizer Inc.	Large Cap	Biotech & Pharmaceuticals
30.	PerkinElmer	Large Cap	Biotech & Pharmaceuticals
31.	Perrigo	Large Cap	Biotech & Pharmaceuticals
32.	Quest Diagnostics	Large Cap	Biotech & Pharmaceuticals
33.	Regeneron	Large Cap	Biotech & Pharmaceuticals
34.	St Jude Medical	Large Cap	Medical Equipments & Devices
35.	Thermo Fisher Scientific	Large Cap	Medical Equipments & Devices
36.	Vertex Pharmaceuticals Inc	Large Cap	Biotech & Pharmaceuticals

37.	Waters Corporation	Large Cap	Biotech & Pharmaceuticals
38.	Zimmer Holdings	Large Cap	Medical Equipments & Devices
39.	Zoetis	Large Cap	Medical Equipments & Devices

Mid Cap

1.	Bio-Rad Laboratories-A	Mid Cap	Biotech & Pharmaceuticals
2.	Cooper Companies Inc	Mid Cap	Medical Equipments & Devices
3.	Charles River Laboratories	Mid Cap	Medical Equipments & Devices
4.	Covance Inc	Mid Cap	Biotech & Pharmaceuticals
5.	Hologic Inc	Mid Cap	Medical Equipments & Devices
6.	Hill-Rom Holdings Inc	Mid Cap	Medical Equipments & Devices
7.	IDEXX Laboratories Inc	Mid Cap	Medical Equipments & Devices
8.	Masimo Corp	Mid Cap	Medical Equipments & Devices
9.	Mallinckrodt plc	Mid Cap	Biotech & Pharmaceuticals
10.	ResMed Inc	Mid Cap	Medical Equipments & Devices
11.	Salix Pharmaceuticals Ltd	Mid Cap	Biotech & Pharmaceuticals
12.	Steris Corp	Mid Cap	Biotech & Pharmaceuticals
13.	Techne Corp	Mid Cap	Biotech & Pharmaceuticals
14.	Teleflex Inc	Mid Cap	Medical Equipments & Devices
15.	Thoratec Corp	Mid Cap	Medical Equipments & Devices
16.	United Therapeutics Corp	Mid Cap	Biotech & Pharmaceuticals

Small Cap

1.	Abaxis Inc	Small Cap	Medical Equipment & Devices
2.	Abiomed Inc.	Small Cap	Medical Equipment & Devices
3.	Affymetrix Inc	Small Cap	Medical Equipment & Devices
4.	Akorn, Inc.	Small Cap	Biotech & Pharmaceuticals
5.	Analogic Corp	Small Cap	Medical Equipment & Devices
6.	Albany Molecular Research	Small Cap	Biotech & Pharmaceuticals
7.	Anika Therapeutics Inc.	Small Cap	Biotech & Pharmaceuticals
8.	Cambrex Corp	Small Cap	Biotech & Pharmaceuticals
9.	Conmed Corp	Small Cap	Medical Equipment & Devices
10.	Cryolife Inc	Small Cap	Medical Equipment & Devices
11.	Cyberonics Inc	Small Cap	Medical Equipment & Devices
12.	Cynosure	Small Cap	Medical Equipment & Devices
13.	Emergent Biosolutions Inc	Small Cap	Biotech & Pharmaceuticals
14.	Greatbatch Inc	Small Cap	Medical Equipment & Devices
15.	Haemonetics Corp	Small Cap	Medical Equipment & Devices
16.	Integra Lifesciences Hldg	Small Cap	Medical Equipment & Devices
17.	ICU Medical Inc	Small Cap	Medical Equipment & Devices
18.	Impax Laboratories	Small Cap	Biotech & Pharmaceuticals
19.	Invacare Corp	Small Cap	Medical Equipment & Devices

20. Lannett Company Inc.	Small Cap	Biotech & Pharmaceuticals
21. Landauer Inc	Small Cap	Medical Equipment & Devices
22. Ligand Pharmaceuticals Inc.	Small Cap	Biotech & Pharmaceuticals
23. Luminex Corp.	Small Cap	Medical Equipment & Devices
24. The Medicines Company	Small Cap	Biotech & Pharmaceuticals
25. Meridian Bioscience Inc	Small Cap	Medical Equipment & Devices
26. Merit Medical Systems Inc	Small Cap	Medical Equipment & Devices
27. Momenta Pharmaceuticals	Small Cap	Biotech & Pharmaceuticals
28. Natus Medical Inc	Small Cap	Medical Equipment & Devices
29. Neogen Corp	Small Cap	Medical Equipment & Devices
30. NuVasive Inc.	Small Cap	Medical Equipment & Devices
31. Questcor Pharmaceuticals	Small Cap	Biotech & Pharmaceuticals
32. Repligen Corporation	Small Cap	Biotech & Pharmaceuticals
33. Symmetry Medical	Small Cap	Medical Equipment & Devices
34. Spectrum Pharmaceuticals	Small Cap	Biotech & Pharmaceuticals
35. SurModics Inc	Small Cap	Medical Equipment & Devices

Appendix 2 - Eviews Outputs 2SLS and Hausman test

Reduced form equation

Dependent Variable: DUMMY_HEDGING
Method: Panel Least Squares
Date: 05/16/15 Time: 18:57
Sample: 2009 2013
Periods included: 5
Cross-sections included: 77
Total panel (unbalanced) observations: 275
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_STOPTIONS	0.003375	0.141903	0.080544	0.0935
INVOP	0.007688	0.003820	2.012586	0.0456
TAX	0.020572	0.009020	2.280596	0.0237
LFD	0.011210	0.004960	2.260104	0.0249
MRA	1.121821	0.823687	1.361950	0.1748
DUMMY_DIVIDEND	-0.015047	0.012192	-1.234199	0.2187
SIZE	0.084423	0.039517	2.136405	0.0339
ROA	-0.264227	0.175815	-1.502866	0.1345
C	-0.089620	0.330509	-0.271157	0.7866

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.967677	Mean dependent var	0.629091
Adjusted R-squared	0.953386	S.D. dependent var	0.483929
S.E. of regression	0.104481	Akaike info criterion	-1.431183
Sum squared resid	2.074103	Schwarz criterion	-0.313272
Log likelihood	281.7877	Hannan-Quinn criter.	-0.982534
F-statistic	67.71545	Durbin-Watson stat	1.606264
Prob(F-statistic)	0.000000		

2SLS – *CH* as dependent variable

Dependent Variable: LOG_CASH
Method: Two-Stage Least Squares
Date: 05/16/15 Time: 19:15
Sample: 1 450
Included observations: 275
White heteroskedasticity-consistent standard errors & covariance
Instrument specification: MRA SIZE ROA INVOP TAX
DUMMY_DIVIDEND LFD C LOG_STOPTIONS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MRA	-13.30587	58.34356	-0.228061	0.8198
SIZE	0.415179	1.272648	0.326232	0.7445
INVOP	-0.009301	0.193274	-0.048125	0.9617
ROA	6.716253	9.891892	0.678966	0.4978
DUMMY_DIVIDEND	0.322669	1.519941	0.212291	0.8320
DUMMY_HEDGING	-3.870381	11.81704	-0.327526	0.7435
LFD	-0.009734	0.104887	-0.092803	0.9261
TAX	0.113649	0.107026	1.061883	0.2893
C	-3.293049	2.189673	-1.503900	0.1338

R-squared	-1.490077	Mean dependent var	-2.128354
Adjusted R-squared	-1.564966	S.D. dependent var	0.929274
S.E. of regression	1.488279	Sum squared resid	589.1836
F-statistic	2.691442	Durbin-Watson stat	0.671066
Prob(F-statistic)	0.007320	Second-Stage SSR	188.9208
J-statistic	6.92E-37	Instrument rank	9

J-stat from Hausman Test

Endogenous variables to treat as exogenous: DUMMY_HEDGING

	Value	df	Probability
Difference in J-stats	3.022441	1	0.2206

2SLS – Δ*CH* as dependent variable

Dependent Variable: CHANGE_CH
Method: Two-Stage Least Squares
Date: 05/16/15 Time: 19:43
Sample (adjusted): 2 450
Included observations: 224 after adjustments
Instrument specification: MANAGERIAL_RISK_AVERSION SIZE UNDERINVESTMENT ROA DUMMY_DIVIDEND LIKELIHOOD_OF_FD_ _ZSCORE CONCAVE_TAX_CURVE LOG_STOCK_OPTIONS_ C

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MANAGERIAL_RISK_AVERSION	-1.281531	0.685190	-1.870331	0.0628
SIZE	-0.011578	0.010626	-1.089519	0.2771
UNDERINVESTMENT	-0.006853	0.007735	-0.885951	0.3766
ROA	-0.477102	0.267078	-1.786376	0.1754
DUMMY_DIVIDEND	-0.026304	0.032531	-0.808577	0.4197
DUMMY_HEDGING	-0.097354	0.036443	-2.671404	0.1181
LIKELIHOOD_OF_FD__ZSCORE	0.002580	0.002130	1.210886	0.2273
CONCAVE_TAX_CURVE	-0.196271	0.006570	-29.87304	0.0000
C	0.265970	0.079312	3.353458	0.0009

R-squared	0.888694	Mean dependent var	-0.011530
Adjusted R-squared	0.884552	S.D. dependent var	0.578504
S.E. of regression	0.196562	Sum squared resid	8.306875
F-statistic	214.5756	Durbin-Watson stat	1.114891
Prob(F-statistic)	0.000000	Second-Stage SSR	8.306875
J-statistic	8.763602	Instrument rank	9
Prob(J-statistic)	0.003073		

J-stat from Hausman Test

Endogenous variables to treat as exogenous: DUMMY_HEDGING

	Value	df	Probability
Difference in J-stats	0.137997	1	0.7103

Appendix 3 – Eviews outputs from testing

Redundant fixed effects likelihood ratio test

Model 1

Redundant Fixed Effects Tests
Equation: LOG_CH_1
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	10.301233	(86,261)	0.0000
Cross-section Chi-square	526.987779	86	0.0000

Redundant Fixed Effects Tests
Equation: LOG_CH_1
Test period fixed effects

Effects Test	Statistic	d.f.	Prob.
Period F	0.144981	(4,343)	0.9651
Period Chi-square	0.601397	4	0.9629

Model 2

Redundant Fixed Effects Tests
Equation: LOG_CH_2
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	9.785469	(86,260)	0.0000
Cross-section Chi-square	513.990034	86	0.0000

Redundant Fixed Effects Tests
Equation: LOG_CH_2
Test period fixed effects

Effects Test	Statistic	d.f.	Prob.
Period F	0.228888	(4,342)	0.9221
Period Chi-square	0.951756	4	0.9170

Model 3

Redundant Fixed Effects Tests
Equation: CHANGE_CH_3
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	2.607660	(86,195)	0.0000
Cross-section Chi-square	221.991746	86	0.0000

Redundant Fixed Effects Tests
Equation: CHANGE_CH_3
Test period fixed effects

Effects Test	Statistic	d.f.	Prob.
Period F	0.783072	(3,278)	0.5042
Period Chi-square	2.440326	3	0.4862

Model 4

Redundant Fixed Effects Tests
Equation: CHANGE_CH_4
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	1.988741	(86,194)	0.0000
Cross-section Chi-square	183.316594	86	0.0000

Redundant Fixed Effects Tests
Equation: CHANGE_CH_4
Test period fixed effects

Effects Test	Statistic	d.f.	Prob.
Period F	0.624220	(3,277)	0.5999
Period Chi-square	1.953948	3	0.5820

Hausman specification test for random effects in cross-section

Model 1

Correlated Random Effects - Hausman Test
Equation: LOG_CH_1
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	18.809921	8	0.0159

Model 2

Correlated Random Effects - Hausman Test
Equation: LOG_CH_2
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	24.952683	9	0.0030

Model 3

Correlated Random Effects - Hausman Test
Equation: CHANGE_CH_3
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	25.014546	8	0.0015

Model 4

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	27.254103	9	0.0013

Correlation Matrix

Covariance Analysis: Ordinary
Date: 05/18/15 Time: 10:24
Sample: 2009 2013
Included observations: 356
Balanced sample (listwise missing value deletion)

Correlation Probability	D_HEDGING	D_DIVIDEND	INVOP	SIZE	ROA	MRA	LFD	HEDGE_INVOP	TAX
D_HEDGING	1.000000								

D_DIVIDEND	0.340209	1.000000							
	0.0000	-----							
INVOP	-0.132740	-0.109557	1.000000						
	0.0122	0.0388	-----						
SIZE	0.575688	0.470267	-0.098920	1.000000					
	0.0000	0.0000	0.0623	-----					
ROA	0.098107	0.104385	-0.288235	0.127636	1.000000				
	0.0645	0.0491	0.0000	0.0160	-----				
MRA	-0.324400	-0.218416	0.037250	-0.309841	0.020241	1.000000			
	0.0000	0.0000	0.4835	0.0000	0.7035	-----			
LFD	-0.262690	-0.113923	-0.129461	-0.232576	0.392663	0.106667	1.000000		
	0.0000	0.0316	0.0145	0.0000	0.0000	0.0443	-----		
HEDGE_INVOP	0.194483	-0.035236	0.192135	-0.084099	-0.055425	-0.063779	-0.437453	1.000000	
	0.0002	0.5075	0.0003	0.1132	0.0970	0.2300	0.0000	-----	
TAX	-0.036000	-0.106615	0.235499	-0.254367	-0.151779	-0.031848	-0.413803	0.580161	1.000000
	0.4984	0.0444	0.0000	0.0000	0.0041	0.0492	0.0000	0.0000	-----

Appendix 4 - Descriptive Statistics

Large Cap n=184

Ratio	Mean	Median	Std.Dev	Minimum	Maximum
Hedging Dummy	0.863	1	0.35	0	1
Cash/Total Assets	0.15	0.13	0.13	0.012	1.11
Total Assets	23972	9616	38038	741	212949
Total Sales	15955	5580	24922	18.4	122734
Market Value of Equity	31936	15610	42993	1961	212543
Return on Asset	0.08	0.09	0.05	(0.11)	0.27
Dividend Dummy	0.56	1	0.50	0	1
R&D/Sales	0.41	0.092	2.28	0.0	21.67

Note: The table displays the mean, median and standard deviations of all Large Cap firms for important firm aspects. The numbers are in million dollars and contains values from 184 observations.

Mid Cap n=66

Ratio	Mean	Median	Std.Dev	Minimum	Maximum
Hedging Dummy	0.66	1	0.48	0	1
Cash/Total Assets	0.169	0.149	0.12	0.001	0.61
Total Assets	2139	1572	1898	310	10477
Total Sales	1134	1190	583	233	2492
Market Value of Equity	2989	2545	1380	1112	6685
Return on Asset	0.084	0.071	0.05	(0.05)	0.20
Dividend Dummy	0.42	0	0.049	0	1
R&D/Sales	0.09	0.065	0.08	0.0	0.38

Note: The table displays the mean, median and standard deviations of all Mid Cap firms for important firm aspects. The numbers are in million dollars and contains values from 66 observations.

Small Cap n=156

Ratio	Mean	Median	Std.Dev	Minimum	Maximum
Hedging Dummy	0.34	0.0	0.47	0	1
Cash/Total Assets	0.212	0.14	0.39	0.01	4.11
Total Assets	437.9	308	361	7.4	1741
Total Sales	319	218	314	1.4	1722
Market Value of Equity	694	576	490.6	89.4	2644
Return on Asset	0.066	0.058	0.10	(0.32)	0.70
Dividend Dummy	0.124	0	0.36	0.0	1
R&D/Sales	0.305	0.08	0.91	0.0	8.5

Note: The table displays the mean, median and standard deviations of all Small Cap firms for important firm aspects. The numbers are in million dollars and contains values from 156 observations.

Appendix 5 - Robustness tests

Robustness Test with MtB as proxy for Investment Opportunities

Model 1

Dependent Variable: LOG_CASH_TA
Method: Panel Least Squares
Date: 05/16/15 Time: 20:21
Sample: 2009 2013
Periods included: 5
Cross-sections included: 87
Total panel (unbalanced) observations: 358
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MANAGERIAL_RISK_AVERSION	0.974475	1.330408	0.732463	0.4644
MARKET_TO_BOOK	0.000938	0.006865	0.136576	0.8914
SIZE	0.051263	0.040594	1.262820	0.2075
ROA	3.171133	0.942524	3.364511	0.0009
LIKELIHOOD_OF_FD__ZSCORE	0.023412	0.006806	3.439643	0.0007
DUMMY_HEDGING	-0.549872	0.132718	-4.143167	0.0000
DUMMY_DIVIDEND	-0.160633	0.116082	-1.383781	0.1673
CONCAVE_TAX_CURVE	0.105317	0.040282	2.614518	0.0093
C	-2.590021	0.292055	-8.868259	0.0000

R-squared	0.196641	Mean dependent var	-2.157391
Adjusted R-squared	0.178226	S.D. dependent var	0.983067
S.E. of regression	0.891167	Akaike info criterion	2.632249
Sum squared resid	277.1686	Schwarz criterion	2.729805
Log likelihood	-462.1726	Hannan-Quinn criter.	2.671047
F-statistic	10.67827	Durbin-Watson stat	0.845337
Prob(F-statistic)	0.000000		

Model 2

Dependent Variable: LOG_CASH_TA
Method: Panel Least Squares
Date: 05/16/15 Time: 20:22
Sample: 2009 2013
Periods included: 5
Cross-sections included: 87
Total panel (unbalanced) observations: 358
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MANAGERIAL_RISK_AVERSION	0.755824	1.378261	0.548389	0.5838
MARKET_TO_BOOK	-0.048938	0.017077	-2.865701	0.0044
SIZE	0.058162	0.039320	1.479173	0.1400
ROA	3.701889	0.990015	3.739226	0.0002
LIKELIHOOD_OF_FD__ZSCORE	0.022514	0.006496	3.465933	0.0006
DUMMY_HEDGING	-0.869059	0.167162	-5.198919	0.0000
DUMMY_DIVIDEND	-0.111304	0.114845	-0.969170	0.3331
CONCAVE_TAX_CURVE	0.278857	0.080243	3.475173	0.0006
MTB_INTERACTION	0.079705	0.028333	2.813199	0.0052
C	-2.510623	0.281485	-8.919199	0.0000

R-squared	0.216548	Mean dependent var	-2.157391
Adjusted R-squared	0.196286	S.D. dependent var	0.983067
S.E. of regression	0.881320	Akaike info criterion	2.612744
Sum squared resid	270.3005	Schwarz criterion	2.721139
Log likelihood	-457.6812	Hannan-Quinn criter.	2.655853
F-statistic	10.68757	Durbin-Watson stat	0.854173
Prob(F-statistic)	0.000000		

Model 3

Dependent Variable: CHANGE_CH
Method: Panel Least Squares
Date: 05/16/15 Time: 20:20
Sample (adjusted): 2010 2013
Periods included: 4
Cross-sections included: 87
Total panel (unbalanced) observations: 291
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONCAVE_TAX_CURVE	-0.101564	0.013360	-7.602140	0.0000
DUMMY_DIVIDEND	-0.027792	0.018972	-1.464930	0.1441
DUMMY_HEDGING	-0.035512	0.026199	-1.355452	0.1764
LIKELIHOOD_OF_FD__ZSCORE	0.002003	0.002774	0.721852	0.4710
MANAGERIAL_RISK_AVERSION	-0.337535	0.319104	-1.057757	0.2911
MARKET_TO_BOOK	0.018778	0.002466	7.615761	0.0000
ROA	-0.479529	0.239987	-1.998148	0.0467
SIZE	-0.010553	0.007407	-1.424709	0.1553
C	0.119023	0.069044	1.723881	0.0858

R-squared	0.805766	Mean dependent var	0.002411
Adjusted R-squared	0.800256	S.D. dependent var	0.554323
S.E. of regression	0.247742	Akaike info criterion	0.077583
Sum squared resid	17.30807	Schwarz criterion	0.191191
Log likelihood	-2.288270	Hannan-Quinn criter.	0.123094
F-statistic	146.2325	Durbin-Watson stat	0.600342
Prob(F-statistic)	0.000000		

Model 4

Dependent Variable: CHANGE_CH
Method: Panel Least Squares
Date: 05/16/15 Time: 20:21
Sample (adjusted): 2010 2013
Periods included: 4
Cross-sections included: 87
Total panel (unbalanced) observations: 291
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONCAVE_TAX_CURVE	-0.064929	0.020139	-3.224097	0.0014
DUMMY_DIVIDEND	-0.016195	0.020885	-0.775401	0.4388
DUMMY_HEDGING	-0.106571	0.026506	-4.020602	0.0001
LIKELIHOOD_OF_FD__ZSCORE	0.002022	0.002722	0.742949	0.4581
MANAGERIAL_RISK_AVERSION	-0.396533	0.315396	-1.257256	0.2097
MARKET_TO_BOOK	0.008037	0.005438	1.477947	0.1405
ROA	-0.412517	0.233938	-1.763357	0.0789
SIZE	-0.008499	0.007140	-1.190335	0.2349
MTB_INTERACTION	0.016951	0.008418	2.013567	0.0450
C	0.135635	0.069309	1.956957	0.0513

R-squared	0.808795	Mean dependent var	0.002411
Adjusted R-squared	0.802671	S.D. dependent var	0.554323
S.E. of regression	0.246240	Akaike info criterion	0.068738
Sum squared resid	17.03816	Schwarz criterion	0.194969
Log likelihood	-0.001319	Hannan-Quinn criter.	0.119306
F-statistic	132.0701	Durbin-Watson stat	0.573964
Prob(F-statistic)	0.000000		

Hedging allows firms to use their cash reserves on investments

Capital requirements and funding needs is a constant concern for companies with large investment opportunities. Two master students from Lund University have studied cash management from a risk point of view. Few researchers have focused on corporate liquidity from this perspective, and the new findings constitute a major breakthrough in the corporate world.

The findings reveal that hedging and cash holdings are used as substitutive risk management tools. We meet with Andrea Bjørndalen and Johanna Nilsson for an exclusive interview. They are both graduating in June 2015 and have spent their last semester researching the connection between hedging and cash management. "High growth companies, especially those who rely on heavy R&D investments, struggle to avoid underinvestment problems," Andrea Bjørndalen begins, "and a critical factor to prevent such problems is reliable availability of cash." Lack of sufficient funds means that firms must refrain from pursuing value-enhancing investment. Engaging in risk management can reduce the need to turn to capital markets and creditors for expensive funding, which reduces the risk of expropriating wealth at the expense of creditors. Instead, hedging helps stabilize cash inflows and lets firms use their liquidity for other purposes.

Johanna Nilsson states that hedging has increased both in popularity and in importance in later years, and can be explained by a more globalized market place. While a study conducted in the beginning of the 90s found that around 30% hedged their risk exposures, Bjørndalen and Nilsson find that as many as 61% of the firms in their study hedge. The study reveals that hedgers in fact hold less cash compared to non-hedgers. "Firms that do not hedge must reserve some of their cash holdings to be able to deal with unforeseen events, which might be a costly strategy for high investment firms" Nilsson explains.

The study also reveals that firms with high investments in R&D, and firms that face an increased risk of underinvestment, have even more to gain from hedging than the average firm. By hedging, these firms have the opportunity to use internal capital for funding investment opportunities and still have the ability to deal with unforeseen events. However, even if the substitutive relationship between hedging and cash has now been proven, determining an optimal cash level is still a complex decision.

Bjørndalen and Nilsson emphasize executives to look over their cash management strategies from a risk perspective, as this may add value to more stakeholders. "There may be major saving potentials through lowering cash holdings to an optimal level without compromising the management of risks", Bjørndalen concludes. "But also, the area has not yet been studied to a great extent, and we are sure that we will be able to examine the relationship between cash holdings and hedging closer in the future."