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Is Cash King or Dead Money?

An Empirical Study of Norwegian Firms and the Effect of Cash on Firm Performance

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Abstract

This thesis explores the relationship between cash and firm performance. Additionally, the thesis provides insight into how this relationship varies across different time periods and industries. Using instrumental variable multiple regression analysis, the thesis analyzes accounting data for a sample of Norwegian firms from 2005-2015. After correcting for a non-linear relationship between cash and firm performance we find that i) firm performance for our sample of Norwegian firms is less affected by cash than US manufacturing firms, ii) cash has a positive, but weakly diminishing effect on firm performance throughout the entire sample period, iii) the relationship between cash and firm performance is most pronounced pre-recession, iv) firms with high knowledge intensity have higher cash ratios than firms with lower knowledge intensity, v) cash has less effect on firm performance for firms with high knowledge intensity compared to firms with low knowledge intensity for cash ratios up to 0.4, and vi) cash has a greater effect on firm performance for firms in labor intensive industries than in capital intensive industries.

In addition to our analysis results, we provide a thorough discussion of potential pitfalls of OLS regression and how we account for these. We also attempt to explain all our results in great detail, focusing on understanding the underlying causality behind the regression estimates. We conclude that cash indeed has a substantial impact on firm performance and that the importance of cash is understated in much of the current strategy and finance theory.

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1. Introduction

Understanding why some firms fail while others succeed is one of the key issues strategy researchers are trying to explain. Over time there has been several different views and theories attempting to determine why performance differs between firms. As potential sources of performance heterogeneity, many resources have been analyzed and rated based on their potential to create competitive advantages. Within the strategy field, financing, and cash in particular, has been discarded as a source of competitive advantage for decades. In recent times however, the interest in cash has increased.

The effect of cash on firm performance is widely debated. Based on the contributions from the resource-based view (Barney, 1991), cash is considered as a homogeneous resource and consequently discarded as a potential driver of competitive advantage. From a finance perspective, high cash levels have traditionally been interpreted by market forces as negative, signaling a lack of profitable investment opportunities or managerial issues (Jensen, 1986). Nevertheless, recent studies have found a positive relationship between cash and firm performance, and pointed out several beneficial effects of cash (Kim and Bettis, 2014; Nason and Patel, 2016). Consequently, there are arguably both benefits and costs to hoarding cash with regards to firm performance. Whether the strategy field is correct to discard cash as uninteresting in terms of performance and competitive advantages, is currently an unsolved conundrum.

In addition to studying the effect of cash on firm performance in normal times, it is of interest to understand how this effect changes in the event of economic downturns. The majority of studies on firm performance have focused on companies in normal times, while strategy literature has been virtually silent on the issue of recessions (Knudsen and Lien, 2014). During recessions, firms typically experience changes in investment opportunities, reductions in cash flow, as well as reduced access to credit. These distinct effects could heavily impact firms' performance. Hence, financing is probably never more relevant as a strategic asset than during recessions. Since economic crisis brings both threats and opportunities, it creates a dilemma for managers to either hoard cash as a buffer against threats or to expend cash to exploit emerging opportunities (Nason and Patel, 2016).

The financial crisis of 2008 caused wide-spread economic uncertainty and instability. Therefore,

understanding how firms used their resources to overcome the downturn and its challenges is valuable. Little research has been dedicated to focusing on the effect of firms' cash holdings during recessions and this research is, to our knowledge, non-existing for Norwegian firms. During the financial crisis more than two thirds of Norwegian firms experienced a decline in demand (Løken et al., 2012). Studying the link between Norwegian firms' performance and level of cash holdings before, during and after the recession, could provide valuable information on both the advantages and disadvantages of hoarding cash. More importantly, it could provide insight on whether cash could be a source for competitive advantage during recessions.

The purpose of this thesis is to bridge a gap in the strategy and finance literature by providing empirical research on how a firm's level of cash impact performance outcomes in normal times and in recessions. Therefore, we explore the connection between cash holdings and firm performance using quantitative data and empirical research methods. On this basis, we formulate the following research questions:

How does cash affect firm performance for Norwegian firms and how does this effect vary pre-, during- and after the financial crisis of 2008-2009?

Our main contribution to the strategy and finance field is to prove that cash cannot be discarded as a useful resource, and emphasize that cash could in fact be a determinant in explaining firm performance. To answer our research question we will combine findings from the field of strategy, competitive analysis, finance, as well as innovation and recession economics. We use accounting data on Norwegian firms from 2005 to 2015. The analysis compares firms' performance before, during and after the financial crisis. We will firstly investigate the relationship between cash and firm performance by using a similar model as the study conducted by Nason and Patel (2016). After providing evidence of a positive relationship between firm performance and cash holdings both in normal times and in recessions, we expand the model in order to take other factors into account. Additionally, we investigate a selection of sub-hypothesis' regarding industry decompositions.

2. Theoretical Backdrop

The main purpose of this thesis is to investigate the relationship between cash levels and firm performance. To lay the theoretical foundation we elaborate on the determinants of performance differences, before going deeper into strategy and finance theories concerning competitive advantage, firm performance and cash. Additionally, we discuss theory of business cycles and recessions, and how this affects the relationship between cash and firm performance. Lastly, we narrow the focus to how cash and performance varies across industries.

2.1 Determinants of performance differences

Understanding the determinants of corporate performance have long been of interest for researchers in the economics and strategy field. Most of the notable empirical literature on firm performance emerged during the 1960s and 1970s, and generated important insights about the variation in firm profitability (Mcgahan and Porter, 2002). Responding to the limits of the early research, Schmalensee (1985) pioneered in this field by introducing the decomposition of variance in firm performance into year, corporate, industry, and firm-specific effects. Year effects account for how yearly macroeconomic fluctuations and factors with broader economic significance impact firms. Corporate effects denote variation stemming from differences between corporations who owns and operates one or more business-units, typically across several industries. Schmalansee reported that industry factors were the most important determinants of profitability, but this finding was refuted by Rumelt (1991). He distinguished between stable and fluctuating effects, and found that the most important sources of economic profitability are firm-specific. However, both researchers agreed that industry- and firm-specific factors are the key determinants of firm performance differences, and that the corporate and year effects are less important. Therefore, we further describe the theoretical background for both industry- and firm-specific factors.

2.1.1 Industry factors

The industry a firm operates in could determine the potential of gaining competitive advantages and profits (Porter, 1980). There are different opportunities with regards to achieving sustained competitive advantage for each industry; a realization which made industry factors popular to research in terms of performance differences among firms (Teece et al., 1997). Porter (1985) defines competitive advantage as a firm's ability to create abnormal returns in the industry it operates in or superior performance compared to an industry average. Some industries become more attractive because they have structural impediments to competitive forces (Teece et al., 1997). As an example, entry barriers can prevent potential entrants from increasing competition or capture market shares, and consequently reducing profitability for incumbents.

A central argument within the strategic management research has been that the structural characteristics of industries are the primary determinants of performance. The dominant paradigm in the 1980s was the competitive forces approach (Teece et al., 1997) pioneered by Porter (1980). According to Porter, analyzing the industry's underlying structure in terms of five competitive forces could help firms find the best positioning in an industry to defend against these forces and shape them in a company's favor (Porter, 1980). The forces are threat of new entrants, bargaining power of buyers and suppliers, threat of substitute products or services and rivalry among existing competitors. Firms who are able to manage their competitive environment can generate economic profits superior to that of their competitors (Teece et al., 1997) and obtain competitive advantages.

The competitive forces approach emphasizes industry factors rather than idiosyncratic firm characteristics when trying to explain the determinants of profitability. Taking this model into account, sustainable competitive advantages can be generated even if the resources firms possess are homogeneous.

2.1.2 Firm-specific factors

Originally, industry factors received most attention, but in more recent years researchers have focused on firm-specific effects as the main driver of firm performance (Hawawini et al., 2003). The main reason for this change of interest was the inability to provide a rigorous explanation for why firms within an industry facing identical conditions and operating under the same market structure perform differently from each other. Hawawini et al. (2003) report that whilst

industry factors may have a large impact on performance for average performing firms, firm-specific factors dominate for the best and worst firms in an industry.

Firm-specific effects focuses on characteristics of the firm's internal environment. They emphasize how firm-specific factors such as tangible and intangible resources and capabilities could be sources of sustained competitive advantages (Barney, 1986). Heterogeneity among firms in terms of these firm-specific resources have received a lot of attention, and has been explained by differences in reputation, operational effectiveness, organizational processes, and managerial skills (Hawawini et al., 2003). In an attempt to understand the inter-industry heterogeneity, Barney (1991) introduced the resource-based view of the firm. This view proposes that firm-specific idiosyncrasies in the accumulation and leverage of unique and durable resources are the main sources of sustainable competitive advantage. The resource-based view will be more thoroughly presented in section 2.2.

Findings from a study conducted by Mcgahan and Porter (2002) indicate that industry and corporate-parent effects are important, explaining 10.3 percent and 11.6 percent of profitability variance between firms respectively. Firm-specific effects have an even larger influence on performance with 36 percent. The remaining roughly 40 percent is unexplained variation and is normally assumed to stem from short-term differences in profitability, methodological issues or inaccuracies in data sets, as well as luck or coincidences.

Based on what researchers have succeeded in explaining of performance variation among firms, firm-specific effects are the dominating determinant. Our main focus moving forward will be on firm-specific effects and how they account for performance differences. More specifically, the importance of cash as a firm-specific resource will be investigated based on fundamental theories and studies within both strategy and finance.

2.2 Firm-specific effects and performance

As mentioned, our aim is to investigate how firm cash levels can affect firm performance. It is therefore relevant to go more in depth on firm-specific effects in order to investigate the importance of cash as a strategic asset. First, we will elaborate on theory from strategy and finance which indicates that cash should be discarded as an important strategic asset. Secondly, we will provide contradicting theoretical grounds for why cash is in fact important from both a finance and strategy perspective. Finally, we weigh the opposing arguments against each other.

2.2.1 The irrelevance of cash in strategy and finance

We will now discuss how theories from both the strategy and finance field constitute the foundation of why cash has been discarded as a determinant of firm performance and competitive advantage. The main focus will be on the resource-based view and the Modigliani-Miller theorem.

2.2.1.1 Resource-Based View

For decades strategy literature focused on privileged product market positions and industry level factors as a basis for competitive advantage and above-normal returns (Dierickx and Cool, 1989). This view, first introduced by Porter (1980), was criticized for overlooking the fact that resources need to be deployed to achieve or protect such privileged product market positions. This in turn, implies a cost of implementing product market strategies that needs to be accounted for. In response, Barney (1986) introduced the concept of a strategic factor market, defined as a market where the resources necessary to implement a strategy are acquired. He argues that without imperfections in these strategic factor markets, buyers will not be able to extract superior economic performance from any factor since the cost of acquiring the strategic resource will approximately equal the economic value once the resource is used. The imperfections exist if the buyer has superior information, is lucky, or both. The managerial implications of this is that firms should focus their analysis mainly on their "unique" skills and resources rather than on the competitive environment in an industry (Dierickx and Cool, 1989). This acknowledgement drives the theoretical foundation away from industry effects and more towards a firm-specific view of performance variation.

Resource-based theory emerged in the 1990's as a key perspective of the determinants of firm performance (Crook et al., 2008). Rather than focusing on industry level characteristics, Barney (1991) introduced a model of firm performance which focus on the resources and capabilities controlled by firms. In this model he specifies which attributes resources must possess in order to be potential sources of competitive advantage.

According to Barney (1991), resources can be defined as all assets, capabilities, organizational processes, firm attributes, information, knowledge etc. controlled by a firm that enable the firm to conceive of and implement strategies to improve its efficiency and effectiveness. Resources are further divided in tangible and intangible assets which can be used to implement its strategies,

where intangible assets include resources such as human capital and organizational capital while tangible assets consist of financial and physical capital. Financial resources include all the money firms use to conceive or implement strategies, independent of the source. It could include cash from entrepreneurs, equity holders, bondholders, banks, and retained earnings (Barney and Hesterly, 2015). Capabilities are a subset of a firm's resources and are defined as the tangible and intangible assets that enable a firm to take full advantage of the other resources it controls.

Regarding the resources and capabilities a firm might possess, the resource-based view is based on two assumptions (Barney, 1991). The first assumption concerns firm resource heterogeneity, which points out that firms within the same or different industries might possess different bundles of resources and capabilities. This assumption implies that some firms will be more skilled in accomplishing certain business activities than other firms, even within the same industry, and is critical to the argument that firm-level factors do have an impact on firm performance (Barney and Hesterly, 2015). The second assumption relates to resource immobility. The resource-based view assumes that resources are not perfectly mobile across firms, meaning that they cannot be easily bought and sold in factor markets (Barney, 1986), and thus the heterogeneity of resources may be long lasting (Barney, 1991). If a firm possess resources and capabilities that other firms find too costly or difficult to acquire, accumulate or imitate, the heterogeneity of that particular resource or capability will be long lasting (Barney and Hesterly, 2015). Together, these two assumptions can be an important contribution in the attempt of explaining why some firms outperform others, even within the same industry.

Barney (1991) suggests that a firm's resource must meet four criteria in order to be a potential source for sustained competitive advantage: (a) it must be valuable, in the sense that it exploit opportunities and/or neutralizes threats in a firm's environment, (b) it must be rare among a firm's current and potential competition, (c) it must be imperfectly imitable and (d) there cannot be strategically equivalent substitutes for this resource that are valuable but neither rare or imperfectly imitable. Based on these attributes, Barney introduced the VRIO framework where he also added organization as a criterion. If a resource or a capability is valuable, rare and non-imitable, it is also critical that the firm is organized in such a way that it is ready and capable to exploit the resource at hand. The VRIO framework has been widely used in the field of strategy and management for analyzing firms' resources and the potential for these resources to generate competitive advantages (Barney and Hesterly, 2015).

2.2.1.2 Finance in the resource-based view

According to the two assumptions of the resource-based view, financing, and hence cash, is discarded as an important resource. Cash could be considered a homogeneous resource that all firms to some extent are in possession of and that can easily be accumulated through financial markets or liquidation of assets. It is also in violation with key requirements of the VRIO framework because cash is neither rare nor imperfectly imitable to competitors. This entails that cash cannot be the source of a sustained competitive advantage for firms.

Overall, it is an underlying assumption in the resource-based view and in strategy theory that capital markets are efficient. The efficient market hypothesis (Fama, 1970) is a fundamental financial market theory as well as an important link between strategy and finance. This theory has opened up a whole new research field within strategy. The core of the efficient market hypothesis is that a market is efficient if the prices always fully reflect all available information. In the strategic factor market presented by Barney (1986), under perfect factor market conditions, resources will never be sold if the full value of the resource is not reflected in the price. In such markets all pure profits of implementing a certain strategy will be anticipated and competed away. These conditions could imply that the level of cash a firm has is irrelevant in terms of creating profitability or above normal returns.

2.2.1.3 The Modigliani-Miller theorem

Capital structure has been a profoundly researched area for decades, first introduced by Modigliani and Miller (1958). Their view was that a firm's value is independent of the choice of capital structure, with a precondition of perfect capital markets where no information asymmetries or transaction costs exist. Capital structures are limited to being viewed as different ways of allocating cash flows. It has no impact on the size of the total cash flow and is therefore irrelevant to a firm's value.

The theorem states that the amount and structure of debt taken up by a company does not affect its value if the following conditions are fulfilled: 1) there are no taxes, 2) bankruptcy does not entail any real liquidation costs for the company nor any reputation costs for its directors, and as already mentioned (3) financial markets are perfect, meaning that they are competitive, frictionless and free of any informational asymmetry (Pagano, 2005).

Modigliani and Miller (1958) produced two basic propositions with respect to the valuation of securities in companies with different capital structures. The first proposition states that the market value of any firm is independent of its capital structure. In the second proposition Modigliani and Miller claim that the weighted cost of capital (WACC) of a firm is unaffected by its leverage ratio. Even though debt may appear cheaper than equity, due to the absence of a risk premium, increasing leverage does not reduce the average cost of capital to the firm (Pagano, 2005). The total effect would be precisely offset by the greater cost of equity capital.

The Modigliani-Miller theorem concludes that value creation is independent of financing decisions and capital structure. This further supports the arguments on the irrelevance of finance in strategy and the discarding of cash as an important resource. However, there are several flawed aspects of these arguments which needs to be evaluated.

2.2.2 The importance of cash in strategy and finance

In the following section the presented arguments from the strategy and finance field will be challenged in order to establish whether there are theoretical grounds to believe that cash can have a positive effect on firm performance. Whether or not the underlying assumptions from strategy and the resource-based view in particular hold will be discussed. Furthermore, critique of the Modigilani-Miller theorem combined with a review of pecking-order theory and trade-off theory will be presented, in order to find theoretical evidence suggesting that cash is in fact important.

2.2.2.1 Do the assumptions on financing from the strategy field hold?

As the previous section confirms, there are theories advocating that financing and cash as strategic assets are uninteresting in terms of firm performance and competitive advantage. There is however little doubt that financing is closely related to the acquisition and accumulation of resources. In the field of strategy, a fundamental assumption is that financial markets are well functioning, leading to the financing of all positive NPV-investments (Knudsen and Lien, 2014). As a consequence, all firms should in theory have no difficulties acquiring financing for their investments, given that the corresponding return is positive after adjusting for the discount factor. Finance literature on the other hand, shows that this assumption is violated often, particularly during a recession. Financing of assets is also typically even more difficult

to obtain for the type or resources strategists view as the most important in creating economic returns and competitive advantages (Knudsen and Lien, 2014).

The theory of the resource-based view is built upon the two assumptions of heterogeneity and immobility as critical attributes a resource must have in order to be a source of competitive advantage. In combination with the VRIO framework, cash is rejected as an explanatory factor of firm performance. However, discarding the importance of cash based on these assumptions alone is questionable, particularly if we consider that the importance of cash might vary over time periods as the efficiency of capital markets changes. When credit constraints tighten and demand falls during recessions, the access to financing might be more important than in a stable economy.

When it comes to the notion that cash as a resource is irrelevant because of perfectly competitive strategic factor markets, there are several competitive imperfections that reduces how efficient and perfect markets are. The imperfection of heterogeneity between firms' financial strength is key to explaining differences in times of inefficient markets (Barney, 1986). This type of imperfection exists when only a few firms have enough financial backing to enter a strategic factor market and attempt to acquire the resources needed to implement a product market strategy. Because only a few firms are competing for the same resources, perfect competition dynamics are less likely to unfold. In this situation, having large cash reserves could lead to above normal returns and might potentially be a source of competitive advantage. Generally, firms differ in their financing abilities. Having a high level of cash could therefore be a beneficial advantage over firms who lack financial strength (Gamba and Triantis, 2008). It provides higher flexibility to respond to changes in the operating environment and improves the ability to seize profitable investment opportunities.

2.2.2.2 Critique of the Modigliani-Miller theorem

Since Modigliani & Miller's publication in 1958, the corporate finance field has challenged their contribution, mainly focusing on the assumptions which the proposition is based upon. The first assumption to be modified was the one concerning taxes, which was changed by Modigliani and Miller (1963) themselves when they incorporated the effect of tax on capital and firm value. When faced with corporate taxes, firm value increases with the leverage due to the tax shield. Interest on debt capital is an acceptable deduction from the firm's income and thus decreases

the net tax payment of the firm (Abeywardhana, 2017). This would result in an added benefit of using debt capital, thus lowering the capital cost of the firm.

Acknowledging tax benefits of debt challenges Modigliani and Miller's initial irrelevance theorem. It was only the beginning of criticism of the unrealistic conditions which Modigliani and Miller based their propositions on. Drawbacks in their theory stimulated decades of research on capital structure, and researchers have been split in their focus and discussions on factors such as taxes, agency costs and financial distress. However, there seems to be an agreement in literature that the choice of capital structure is influenced by a trade-off between tax benefits of debt and the need to keep a liquid position.

When considering the connection between how a firm is financed and the firm's respective business choices, it is convenient to generally categorize a firm's decisions into one of two broad categories - investment activity and corporate strategy (Parsons and Titman, 2008). Capital structure can affect what type of investments a firm choose or how investments are financed (Myers and Majluf, 1984). A firm's choice of capital structure also affects its strategic decisions and relationship with both its non-financial stakeholders and competitors (Parsons and Titman, 2008). Non-financial stakeholders have either a direct or indirect interest in the firm's long-term viability. Different stakeholders may demand different compensation for the costs they will bear if the firm goes out of business, by imposing financial distress costs. Financial distress costs can increase for firms with capital structures that enhance the likelihood of bankruptcy, such as high debt-levels. They can also increase with costs that arise from the actions of competitors; if a firm is financially weak relative to its competitors, rivals might choose to compete more aggressively, thus increasing the financial distress costs. Hence, the choice of capital structure is clearly important for both strategic and competitive reasons. Firms have incentives to choose a capital structure which minimizes financial distress costs. Furthermore, their choice of capital structure might impact decisions such as whether to stockpile cash rather than paying out dividends (Parsons and Titman, 2008).

There are two main theories that further challenge the Modigliani-Miller theorem: Pecking-order theory and Trade-off theory. These theories both imply that capital structure does influence firm value, hence cash might in fact be of relevance as a resource due to increased firm operational flexibility.

Pecking order theory

Pecking order theory is a highly acknowledged theory within corporate finance and is an important contribution on how firms finance investments. According to the theory, there is an order of priority with regards to how a firm chooses what type of financial capital to use. Donaldson (1961) found that management prefer internally generated funds rather than using external funds, a discovery which was further popularized by Myers and Majluf (1984).

Pecking order theory is based on the concept of information asymmetry between firm management and external investors (Myers and Majluf, 1984). It also acknowledges the existence of transaction costs, and ranks investment options according to the minimum amount of transaction costs. Taking these effects into account violates Modigliani and Miller's proposition that firm value is independent of capital structure. According to the pecking order theory, firms choose their financing options in the following order: (1) internal financing, (2) issuing debt and (3) issuing equity (Chen and Chen, 2011). Assuming that firms' managers know more about the value of its assets and investment opportunities than external investors do, the preferred financing option would be internally generated funds. This way option problems related to asymmetric information would be avoided. If external financing is required, the firm would prefer debt to equity.

The model developed by Myers and Majluf (1984) convey that given asymmetric information, a firm with insufficient financial slack may not undertake all valuable investment opportunities. It would rather withdraw from investing than issue new equity. Thus, a firm that has too little financial slack increases its value by accumulating more cash. Studies have also found a negative relationship between debt financing and firm performance (Chen and Chen, 2011). Profitable firms are likely to have more retained earnings, making them less dependent on external financing. The pecking order theory is clearly an important contribution in proving the importance of capital structure and how the choice of financing can impact firm value. Furthermore, it supports research indicating that internal financing and cash levels have a positive effect on firm performance.

Trade-off theory

Trade-off theory was presented by Kraus and Litzenberger (1973) and builds on the foundation provided by Modigliani and Miller. Kraus and Litzenberger criticized the assumption of complete and perfect capital markets in the Modigliani-Miller irrelevance theorem. The theory

is based on a trade-off between the tax advantages of using debt and the potential financial distress costs incurred on the firm when increasing the debt level. Taxation of corporate profits and the existence of bankruptcy penalties are important market imperfections that are central to a theory of the effect of capital structure on valuation (Kraus and Litzenberger, 1973). The theory highlights the benefits and costs of increasing debt in the financing mix and how a trade-off between these would generate an optimal capital structure.

The benefits of increasing a firm's debt-ratio is connected to the presence of tax-deductible interest rates, enabling the WACC to be reduced by increasing debt. This tax shield implies that in a friction-less capital market, firms would prefer to be fully leveraged. However, there are also costs associated with debt. If a firm cannot meet its debt obligation, it is forced to bankruptcy and incurs the associated costs (Kraus and Litzenberger, 1973). Bankruptcy costs increase with debt as the firm have to pay a higher compensation to its creditors. The risk of bankruptcy does not necessarily only create bankruptcy costs, but other financial distress costs as well. Parsons and Titman (2008) address how debt levels can influence firms' relationship with stakeholders such as suppliers and customers. Firms' relationship with non-financial stakeholders could be disrupted by concerns over the firm's long-term viability if debt levels are too high. Non-financial stakeholders are defined as parties that have either a direct or indirect interest in the firm's long-term viability (Parsons and Titman, 2008). Each of these parties may demand compensation for the costs they would bear if the firm goes bankrupt. These compensations impose financial distress costs for firms whose capital structure increases the possibility of bankruptcy.

A key implication from the trade-off theory is that leverage can have a positive effect on profits due to the tax benefits of debt. However, cash is important in order to reduce the financial distress costs of high debt levels, and the corresponding negative effects on stakeholders. What defines the optimal capital structure varies between firms and industries, but one thing is clear; capital structure and cash levels can have an impact on firm performance.

2.3 Cash and firm performance

The discussion above opens up for the fact that cash potentially could affect firm value and performance. We will now investigate existing literature and perspectives from studies that have specifically researched the effects of cash holdings on firm performance. The first section will focus on the costs and benefits of hoarding cash. In the second section we will describe theory on business cycles and recessions, before closing in on cash and firm performance in recessions.

2.3.1 Hoarding of cash

In the field of corporate strategy, cash holdings have for decades been considered negative for firm performance (Fresard, 2010). Companies that hoarded large cash positions were viewed with great skepticism. However, after the financial crisis, and as a result of increasing uncertainty and market turmoil in general, researchers have rapidly changed their perspective. Empirical evidence show that firms have been increasing their cash holdings steadily for the last decades (Sánchez and Yurdagul, 2013), which could confirm that firms are realizing not only the necessity of cash, but the importance of cash as a strategic asset.

Fresard (2010) points out that prior empirical work has devoted little attention to potential effects of firms' cash holdings on their actions and performance in the product market. Holding high cash levels clearly has both benefits and costs to firm performance - these will be highlighted in the following sections.

2.3.1.1 Benefits

One of the benefits of holding cash is the increased flexibility in strategic responses, which enable firms to pursue multiple strategic alternatives (Nason and Patel, 2016). It gives leeway for quick decision-making and implementation of strategies, allowing firms to benefit from profitable opportunities before their competitors can. As an example, a firm can respond to, and secure a profitable acquisition before its competitors get the opportunity to bid, by paying cash instead of waiting for financing. Firms with excess cash can also endure the option value of waiting longer than firms with cash restrictions. Therefore, they can evaluate credible threats and delay making irreversible resource commitments, until key uncertainties have been resolved and the scenario that will prevail in the future is more certain (Ghemawat and Del Sol, 1998).

Cash allows firms to capitalize on investment opportunities and reduces the corresponding risk of under-investing in these opportunities, which is a particular problem when external financing is too costly. The benefits of cash can be especially distinct for certain periods of the business cycle and for some industries more than others. Firms in innovative, fast-moving industries are more exposed to external uncertainties (Kim and Bettis, 2014). Because of lower asset tangibility and uncertainty, investment opportunities in R&D are costlier to finance using external capital. Consequently, greater R&D intensity relative to capital expenditures increases the benefits for firms to hold a greater cash buffer against future shocks (Bates et al., 2009). Reviewing the adaptive benefits of holding cash for R&D intensive firms, O'Brien and Folta (2009) find that they can be high if proper governance mechanisms are present. The benefits of having high cash levels will be discussed in greater detail in section 2.3.2, when we turn the discussion more specifically towards recessions and knowledge intensive industries.

Cash also holds a substantial strategic value because it could influence the product market choices of other firms (Fresard, 2010). For instance, cash-rich firms can use its war chest to finance competitive strategies and influence competitors' choices. Competitive strategies could include increasing entry barriers, such as signaling the ability to behave or respond aggressively to entrants by for example initiating price wars, and thereby influence rivals' choices. By providing competitive deterrence (Kim and Bettis, 2014) excess cash could distort rivals' investment or expansion decisions and ultimately serve as a barrier to entry for potential competitors (Fresard, 2010).

2.3.1.2 Costs

The economic approach regarding costs of holding cash views excess cash as financially wasteful since it earns very low measurable returns and incurs large opportunity costs (Kim and Bettis, 2014). Consequently, cash should either be invested or paid out to shareholders. This approach leads to the two major concerns regarding cash holdings; over-investments and managerial inefficiencies. One of the major costs associated with cash holdings is that excess cash leads to over-investing in less profitable opportunities, increases entrenchment and results in poor governance (Nason and Patel, 2016). A study by Richardson (2006) investigate investment decisions in the presence of free cash flow. When firms internally generate cash flows in excess of that required to maintain existing assets in place and finance new positive NPV projects, free cash flow is obtained. Even though finance theory denies a relation between firm level

investment and internally generated cash flows (Modigliani and Miller, 1958), Richardson finds evidence that over-investment is concentrated in firms with the highest level of free cash flow.

Richardson's study emphasizes the over-investing aspect of high cash holdings. Jensen (1986) on the other hand, argues that entrenched managers in firms with high free cash flow might lack investment opportunities. Furthermore, high cash holdings might signal that the managers are reluctant to pay out cash to shareholders. Following Jensen's research, we would expect firms with agency problems to hoard cash if they do not have good investment opportunities and/or their management does not want to return cash to shareholders. This view is one of the reasons why excess cash has been considered a negative factor for firm performance for decades.

In sum, cash holdings can have both benefits and costs, but the evidence of studies are pointing towards benefits outweighing the costs. As first highlighted by Jensen, cash hoarding could have negative signaling effects in terms of lacking good investment opportunities or managerial issues. On the other hand, there are also positive signaling effects associated with cash hoarding which could offer a highly beneficial strategic dimension to a firm. In combination with the flexibility effect that allows firms to fight against threats and take advantage of opportunities, cash is assumed to have a positive effect on firm performance. Based on this theoretical review we put forward the following hypothesis:

Hypothesis 1: *Cash has a pronounced curvilinear relationship to firm performance, with a positive linear term and a negative quadratic term*

2.3.2 Recessions and firm performance

Throughout modern times, economies have constantly been dynamic with regards to development and growth. This means that the competitive environments firms operate in are continuously changing, creating new challenges each firm have to overcome. The term *business cycles* covers economic fluctuations which can be caused by a multitude of factors. These factors and their economic impact will not be discussed further in this thesis, instead we refer to general macroeconomic theory and literature. In this chapter, we will provide a brief overview of business cycle and recessionary theory. Additionally, we will discuss existing literature on the effect of cash in recessions.

2.3.2.1 Business Cycle Theory

Business cycles can be defined as fluctuations of income relative to potential income where booms occur when income rise above potential, whilst recessions take place when income declines relative to its potential level (Gärtner (2006) in Knudsen (2018)). In line with this, Benedictow and Johansen (2005) argue that it is common to define business cycles depending on how GDP growth varies relative to the current growth trend. Further, they add to the definition of recessions by underlining that booms and recessions peak and bottom out respectively, when the actual income is parallel to potential income regardless of the distance discrepancy. There are several different classifications of the different stages of business cycles; what remains constant is the shared understanding of that economic variation relative to potential development will be present in all modern economies worldwide.

Based on academic literature (Gärtner, 2006; Benedictow and Johansen, 2005), Bolle and Kårbø (2015) generically illustrated business cycle development. As discussed above the difference between GDP level (actual income) and long-term GDP trend (potential income) determines whether the given economy is experiencing a boom or a recession.

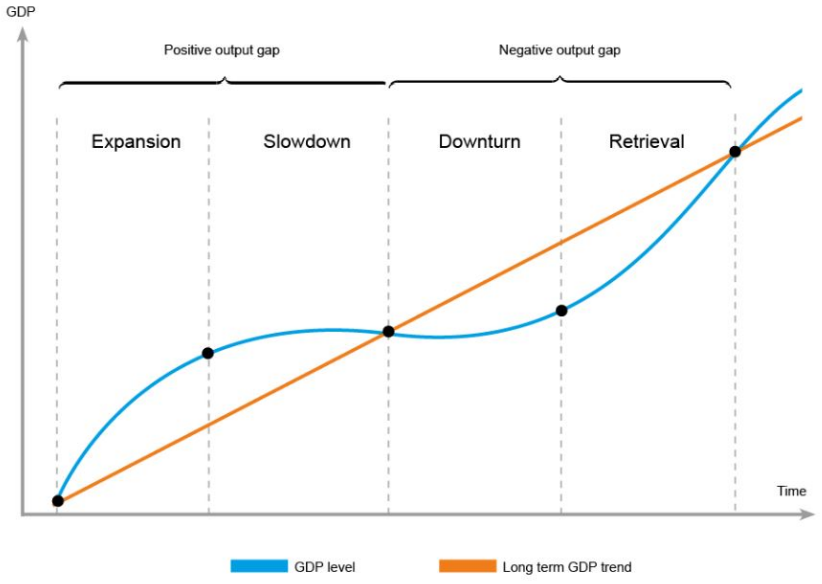

Figure 2.1: Business cycles (Benedictow and Johansen (2005) in Bolle and Kårbø (2015))

Figure 2.1 shows a generic display of business cycles in an economy over time. In expansions, the actual income is above its potential resulting in a positive output gap. The expansion phase lasts until the GDP level reaches the maximum distance from the long-term GDP trend, after

which the economy enters the slowdown phase as the GDP growth abates. Once the GDP level fall below potential, the economy is in a period of downturn. The downturn phase is characterized by reduced spending, lower investment levels and higher unemployment rates. Lastly, after the economy has bottomed out relative to potential income, the retrieval phase towards the long-term GDP trend begins.

2.3.2.2 Recessions

The definition of a recession varies among scholars and the key variable here is severity. In the previous section, we mentioned that Gärtner (2006) defined recessions as periods were actual income was below potential income. We believe this application of the phenomenon of recessions is too wide and narrow the scope accordingly. The National Bureau of Economic Research (NBER) concluded that a recession occurs when an economy experiences two or more quarters of decreasing GDP-levels (Benedictow and Johansen, 2005). Claessens et al. (2009) presents evidence that a typical recession lasts for four quarters. Further, they classify severe recessions as when the peak-to-trough (top to bottom) decline is below -3,15 %. In line with this statement we argue that there should be an additional section in figure 2.1 from the peak of the positive output gap to the bottom of the negative output gap indicating a recession. Additionally, we stress the requirement for severity; as a qualitative benchmark, an economic downturn can be classified as a recession if the decline is significantly visible in GDP levels, interest rates and unemployment levels.

There are multiple ways individual firms are affected by recessions. During the financial crisis of 2008, two thirds of Norwegian firms experienced drops in demand (Lien and Knudsen, 2012). In times of recession, overall spending levels are reduced by both consumers and firms which equates to lower business activity. Another notable effect many firms experience is a reduction in access to finance. Investors want to reduce risk and prefer solid firms over firms with higher uncertainty causing what can be labeled a "flight to quality" (Lang and Nakamura, 1995). Overall, the competitive scene becomes less lenient which causes bankruptcies to increase.

The last aspect of recessions we will discuss here is essential to understand how the effect of cash on firm performance and recessions are connected. Knudsen and Lien (2014) illustrates how firm performance before and after a recession are determined by three factors. In the event of a recession, both the exogenous impact of the recession (i.e. reduced demand and access

to capital) and how a given firm responds to the changing market dynamics will influence the performance in the next period. The remaining determinant of firm performance in period T=1 is given by the error term. This error term contains all factors that, given no recession, influence firm performance.

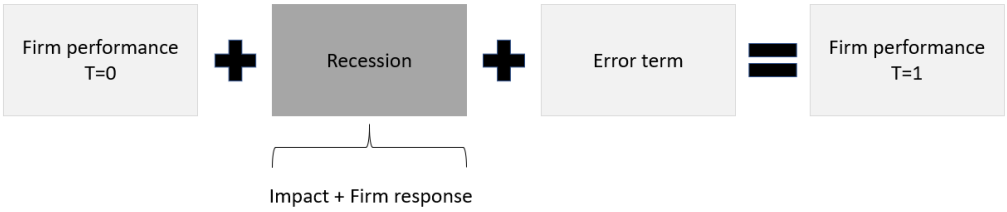

Figure 2.2: Impact of recessions

2.3.2.3 Cash in recessions

As the theoretical backdrop indicates, cash can have an impact on firm performance in general. We have also discussed how market efficiency can vary over time and especially in recessions. In this section the focus is narrowed to whether recessions can increase the effect of cash on firm performance. Economic crisis brings both threats and opportunities, enhancing the dilemma for managers to either hold cash to buffer against threats or to expand cash to exploit emerging opportunities (Nason and Patel, 2016). Two key aspects of recessions which affect firms' investment opportunities are demand reductions and reductions in credit availability (Knudsen and Lien, 2014). Capital markets are less efficient when recessions hit, which can cause serious distortions in both the level and composition of investments - factors that are important to competitive behavior and outcomes.

A study by Campello et al. (2009) finds that firms had to pass on profitable investment opportunities during the 2008 financial crisis due to binding external financing constraints. 90 percent of financially constrained firms reported that the constraints restrict their pursuit of attractive projects during the crisis and more than half of these firms were forced to cancel valuable investments. Constrained firms also displayed a much higher propensity to sell off productive assets as a way to generate funds and were also forced to burn a sizable portion of their cash savings during the crisis. These findings clearly support the importance of cash on firm performance.

The findings of Campello et al. (2009) are supported by Duchin et al. (2010) who show that the tightened supply of external financing following the crisis, mainly hurt investment levels in firms with small cash reserves. Firms with low cash levels had to cut R&D, employees and capital spending to cope with the tightened credit conditions (Fresard, 2010), and the buy-passing of positive NPV projects reduced the strength of future economic recovery (Campello et al., 2009). On the other hand, US firms that managed to hoard cash before the 2008 crisis might have benefited from the financial downturn by gaining a leading position in the market (Fresard, 2010).

In recessions, capital markets are less efficient and firms face credit constraints and reduced investment opportunities. Partly as a result of the last decades market turmoil, researchers have recognized the advantage of hoarding cash in order to avoid cash squeeze. On one side, cash can have substantial positive effects on firm performance, since firms in recession are more dependent on internal financing. On the other hand, excess cash can reduce firm performance due to increased opportunity costs of not investing. In the event of recessions, we expect the positive effects of cash to be amplified due to the reductions in demand and tightening of credit constraints compared to pre- and post-recession. We also expect the negative effects of too much cash to increase due to the opportunity costs of not investing the excess cash holdings. Hence, we formulate the following hypothesis:

Hypothesis 2: *Cash has a more pronounced curve-linear relationship to firm performance during recessions compared to pre- and post-recessions, with a positive linear term and a negative quadratic term*

2.3.3 Performance differences across industries

Shocks to investment opportunities and cash flows vary considerably across firms and industries (Knudsen and Lien, 2014). It is also likely that the effect of cash on firm performance can vary between industries. Therefore, we find it interesting to decompose our analysis by looking specifically at certain industries. We will firstly compare relatively knowledge intensive industries to less knowledge intensive industries with the intention of explaining how typically innovative and R&D focused firms' performance are impacted by cash holdings. Secondly, we compare capital intensive industries to labor intensive industries.

2.3.3.1 Knowledge intensity and innovation

In this section we elaborate on the relationship between innovation and cash. Since knowledge is an underlying factor of innovation, firms with a high innovation focus cold be viewed as knowledge intensive (Bergmann and N. Betten, 2016). We therefore use knowledge intensity as a proxy of firm innovation[1]. Under the precautionary motive for cash theory, an increase in cash holdings could be explained by firms buffering to protect themselves against uncertainty and cash flow shocks. Consistent with this perspective, Bates et al. (2009) show that corporate liquidity is empirically associated with business risk by documenting that firms with riskier cash flow and limited access to external capital typically hold more cash. R&D intensity and corresponding spending is widely used as proxies for risk taking in academic studies (Bromiley et al., 2017). According to Bates et al. (2009) firms have increased R&D expenses over time, and firms with higher R&D expenditures hold more cash. This characteristic is consistent with the evidence of a positive relationship between risk and cash holdings. The arguments above are supported by Lyandres and Palazzo (2016). They present evidence that cash holdings of innovative firms are far greater than what they define as "old-economy" firms. This includes firms in industries such as manufacturing and low-technology production, typically less knowledge intensive firms. Furthermore, they conclude that firm cash holdings are related to the competitive interaction in future output markets. The fiercer the competition, the lower the firm's optimal cash holdings. On this basis we form the following hypothesis:

Hypothesis 3: *Firms with high relative cash share compete in more innovative industries*

The economic downturn and uncertainty that comes with a recession reduces credit availability since credit providers demand larger compensation for providing external funds (Knudsen and Lien, 2014). The implications of this effect are more immediate for physical investments, while the corresponding effects for R&D investments are somewhat different.

Bernanke (1983) argues that firms have different option values of waiting depending on their activities. In the ever-changing business cycles, firms which undertake mainly physical investments have low option values of waiting for new information. This is caused by the fact that the cost of scaling production up or down is comparably low to research activities, hence firms are less willing to sacrifice current profits for future information. On the other hand, firms with

[1]This approximation is discussed further in section 3.4.6

high knowledge intensity, which generally entails more R&D activities, have higher adjustment costs. These projects are often more risky and new information might drastically change the projected outcome. When cutting investments in R&D, it could be very difficult to scale investments back up (Knudsen and Lien, 2014). According to Ghemawat (2009), the time span needed to activate R&D investments is four to six years on average. This is a relatively long time span, which reduces their sensitivity to demand fluctuations (Knudsen and Lien, 2014). Consequently, knowledge intensive firms have incentives to try to smooth their investment levels over time.

In order to stabilize their investments activities, internal cash buffers are vital for knowledge intensive firms. R&D investments are costlier to finance externally due to the uncertainty related to the output of investments (Knudsen and Lien, 2014). The cost of external capital will increase further in recessions, making a high share of internal finance even more important for maintaining the investment level. Furthermore, since the output from investments in new knowledge often is both intangible and of high specificity, the salvage value is low if the project should fail. Hence, such investments will primarily be financed internally. The implications of this discussion are that we would expect to see higher effects of cash on firm performance in highly knowledge intensive industries, since excess cash can enable knowledge intensive firms to avoid unprofitable investments and high adjustment costs.

Hypothesis 4: *Cash has a bigger impact on firm performance as knowledge intensity of firms increase*

When a recession hits, firms have both strategic and financial incentives to shield R&D investments, but the ability to do so depends on financing constraints (Knudsen and Lien, 2014). Those who are able to finance R&D and innovation internally will tend to maintain these investments, while firms that are unable to do so must either face serious cost increases from external finance or cut investments. Because of the high adjustment costs this could create a lasting negative effect on firm competitiveness. Another aspect that affects investments in innovation activities is the fact that the pay-back duration is long (Sood and Tellis, 2009). This entails that the impact of cash on firm performance might be low during recessions despite firms maintaining investment levels. Returning to Knudsen and Lien (2014), investment reductions will be the greatest in industries that focus on physical investments. As mentioned, the cost of scaling down production for goods and services that produce physical goods is lower than

for innovation activities. If a firm is experiences financing constraints that prevents them from producing to demand, the marginal benefit of cash is high. Braun and Larrain (2005) study how recessions impact manufacturing industries and find that the industries that are highly dependent on external financing are hit harder in the event of demand drops and capital access limitations. This implicitly leads to the next hypothesis:

Hypothesis 5: *Cash has a greater impact on firm performance in recessions for firms with low knowledge intensity*

Braun and Larrain (2005) also argues that R&D investments have high adjustment costs since they are expensive to reverse. Therefore, investment levels of firms with high R&D levels are less responsive to business cycle fluctuations. Recalling Knudsen and Lien (2014), innovative activities are much more expensive to finance externally compared to physical investments. It seems reasonable to believe that, if firms with high knowledge intensity are aware of this, managers will take this into account and build up an internal financing buffer. Hence, the next hypothesis:

Hypothesis 6: *The effect of cash on firm performance deviates less through business cycles for firms with high knowledge intensity compared to firms with low knowledge intensity*

2.3.3.2 Capital intensive versus labor intensive industries

A second industry decomposition we focus on is capital intensive versus labor intensive industries. Capital intensive industries require large amounts of capital investments to produce its goods and services, and includes industries such as automobile manufacturing, oil production and refining, steel production, telecommunication and transportation sectors. Labor intensive industries require high levels of labor in order to produce its goods and services, such as restaurants, agriculture, hotels and personal care.

Investments that are typical for capital intensive industries are infrastructural components. Typically, this includes physical buildings, equipment, material and machines (Lee, 2010). Capital intensive businesses tend to have more fixed assets and are therefore committed to a high level of operating leverage. As noted in Shapiro and Titman (1986), referenced by Lee (2010), capital intensity might therefore increase firm risk as the high volume of fixed costs will not vary according to instability in demand, sales or volume and thus cause higher fluctuations in

profitability. In face of recessions, capital intensive industries might be more vulnerable compared to labor intensive industries because they still have to pay the fixed costs associated with capital investments, such as depreciation on equipment.

There are however split views when it comes to the implications of cash holdings on firm performance for labor and capital intensive firms. The other perspective that has been highlighted by researchers emphasize that labor intensive industries are more exposed to market risk than capital intensive firms, largely due to wage rigidity (Knesl, 2018). For labor intensive firms, wages typically account for a large share of variable costs. Wage rigidity exposes labor intensive firms to market fluctuations to a greater extent than capital intensive firms. Lubatkin and Chatterjee (1994) further argue that capital intensity may reduce business risk, because firms with high capital intensity may have already allocated a great amount of cash on fixed assets. Thus, the firm may incur cost savings through subsequent, normal operations. Risk reduction may be more pronounced during uncertain economic environments or economic downturns, because of the ability to reduce some of the fixed costs. Lubatkin and Chatterjee (1994) find evidence indicating that capital intensity may be negatively correlated with risk. This is to the extent that capital intensity represents a proxy for a firm's ability to minimize costs.

There are clearly two conflicting views, and it is difficult to establish which one is the most valid. When evaluating how industry structures can affect firm performance in light of cash holdings however, the first argument introduced by Shapiro and Titman (1986) seems to be most relevant. Following this argument, capital intensity tends to increase firms' risk, because firms' cost structures remains fixed even when sales levels fluctuates. In order to pay the fixed costs when revenues decline, firms' cash holdings could be a crucial asset. Therefore, we expect to find evidence confirming the following hypothesis:

Hypothesis 7: *Cash has a greater effect on firm performance in capital intensive industries than in labor intensive industries*

2.3.4 Summary of hypotheses

Before we move on to the analysis, we summarize the overall research topics we identified based on our theoretical backdrop. Our first hypothesis relates to the general effects of cash on firm performance. Academic literature outlines both benefits and costs of holding cash and we consequently expect this trade-off to be reflected in a positive, but diminishing relationship between cash and firm performance.

Secondly, we provided a theoretical backdrop for how recessions affect firms, specifically focusing on demand changes, reductions in access to financing and the subsequent increased external financing cost. In the event of recessions, we believe the marginal benefits of cash will be higher up to a certain point. Above this point, we expect the negative effects of cash to be amplified, hence creating a more pronounced curvilinear relationship during the recession compared to the other time periods.

Lastly, we turned our focus to studying how the effect of cash on firm performance varies for different industry sub-samples. First, we provided a theoretical background for how cash effect firm performance in innovative industries, and determined knowledge intensity as a proxy for innovation. Due to differences in firm attributes based on knowledge intensity level, we hypothesize that cash will have a greater effect on firm performance for firms with high knowledge intensity. Additionally, we expect knowledge intensive firms to have higher cash levels and less inter-period cash variation than firms with low knowledge intensity. After this, we showed that there is basis to believe that the effect of cash will differ for labor intensive and capital intensive industries. Lastly, the discussed theory laid the foundation for our final hypothesis that this effect will be greater for firms in capital intensive industries.

3. Research design and methodology

The previous chapter have focused on laying the foundation for the empirical research that will answer our hypotheses and thesis question. The following chapter will firstly explain the research design, before we move on to the data set used and the different filtering options we applied. Secondly, we discuss the theoretical aspects in light of our regression model and describe how we set up the empirical analysis. Thirdly, the different variables and the complete regression models will be presented. Lastly, we shed light on our main concerns with the empirical analysis and factors that may reduce the validity of our conclusions.

3.1 Research design

As stated in the preliminary sections of our thesis, our goal is to explore the relationship between cash holdings and firm performance using quantitative data and empirical research methods. We use the framework developed by Saunders et al. (2009) as a guide in our research. In light of this framework, it is slightly unclear which category our research purpose falls into; not only do we intend to evaluate the causal relationship between cash holdings and firm performance which pulls towards an explanatory research purpose, we will also attempt to provide descriptive data and results in order to portray firms in Norway and the importance of cash. In addition, it is reasonable to argue that our research purpose might also be exploratory given the fact that the link between cash holdings and firm performance has never been examined using Norwegian firm accounting data. Overall however, it seems fair to believe that our research falls in line with what Saunders et al. (2009) describe as "if the project utilizes description it is likely to be the precursor to explanation" and should therefore be classified as a descripto-explanatory study.

The second step is to determine the research approach to the thesis. With this, Saunders et al. (2009) states that research can either be inductive or deductive. It is clear that we use the deductive research approach in this thesis.

The final aspect that affects the research design is whether the data used is qualitative or quantitative. Since our thesis question is based on accounting data it is obvious that quantitative

data is the best approach to answering our hypotheses. Collecting and analyzing accounting data qualitatively is a rigorous task and does simply not give the same opportunity to provide objective, accurate results.

The framework and our highlighted research design can be seen in figure 7.1 in the Appendix.

3.2 Data

We used the data base created by the Institute for Research in Economics (SNF) (Berner et al., 2016) in our thesis. The data base contains accounting data for all Norwegian firms from 1992-2015. The fact that all Norwegian firms are present in this database reduces the chance of drawing conclusions based on sampling errors.

All observations are adjusted for inflation in the given time period, see figure 7.2 in the Appendix for specific inflation rates. 2015 has been set as the base year and accounting data for earlier years have been inflated to represent 2015 values.

3.2.1 Data Selection

Due to the fact that the fundamental research question relates to understanding the effect of cash on firm performance, it is essential to focus on firms operating in a competitive environment. Firms such as charities, public firms and non-profit organizations do not have profit-maximization as an objective and therefore cannot be expected to behave accordingly. Inclusion of such firms in the data sample would create unexplained noise and reduce the statistical inference drawn from our analysis.

A major issue with the data selection was that many of the firms are too small to provide any real causal significance. Additionally, many of these firms have incomplete or inaccurate accounting data. The main purposes of filtering out certain firms are to increase the internal validity of conclusions drawn and reduce the size of the data set. On the other hand, reducing the sample size is generally not ideal since the external validity decreases.

3.2.1.1 Selection criteria

Below we will provide an overview of the selection criteria we have used in the preliminary data treatment of the SNF data set. We have chosen the following criteria in order to ensure that firms with abnormal characteristics or missing information are removed. It is especially important to exclude non-profit maximizing firms. By combining the selection criteria presented below, we reduce the chance of including firms which are irrelevant to study, and also minimizing unfortunate interference and skewed results. A thorough, qualitative filtering of the data set will increase the validity of our study.

Criterion 1: Time period

The observations extracted from the database are from the time period 2004-2015. It should be noted that the year 2004 has only been included in order not to lose observations from 2005 when using lagged variables. We use accounting data to analyze the effect of cash on corporate performance before, during and after the recession. Year 2005-2007 are considered as pre-recession, whilst years 2008-2009 are defined as the recession period, and the years 2010-2015 as post-recession. The remaining data set contained 2 839 655 observations.

Since our main thesis question is focused on the effect of cash, we define the 11-year period in focus as a period of overall neutral economic growth. The idea behind this is that we want to examine the effect on cash as generally as possible, hence the need for including both periods of economic booms and downturns so that the different periods more or less cancel each other out. Therefore, we can view the regression outputs and variable coefficients for the entire period as indicators of how each respective variable affects firm performance during times of neutral economic growth. Additionally, we also focus specifically on cash in recessions to see how the effects of cash differentiates during economic downturn compared to pre- and post-recession periods.

Criterion 2: Sales revenue $>$ 10 MNOK

Firms with sales revenues less than this minimum condition are assumed to have a slower growth rate than bigger and more established firms, which could create a weak basis for comparisons and provide skewed results. Removing these firms also insure a certain minimum size on the firms included in the sample. It is also reasonable to exclude firms with low revenues as they could be non-profit maximizing firms.

Criterion 3: Personnel costs > 3 MNOK

The selection criteria of removing all firms with personnel and social costs less than NOK 3 million provides an extra confirmation that small firms are excluded. Firms with low personnel costs are assumed to have few employees. It also ensures that legal entities such as holding companies are removed from the sample. This is beneficial because these firms are likely to have different competitive behaviors and strategic responses than commercial firms.

Criterion 4: Missing NACE codes

We noted that several observations were missing NACE codes from 2007 and decided to remove these. Including these observations would create difficulties with regards to the industry specific research in our thesis. Overall, these observations constitute roughly 9 000 observations.

Criterion 5: Legal form

All firms that do not have the following legal form are also excluded: AS, ASA, ANS or DA. We find it interesting to study both public and privately owned firms separately and together. By only allowing the mentioned legal forms, we ensure that all firms who are not obligated to perform financial statements and annual reports are excluded. Small enterprises might be relieved of the annual financial report obligation, but because of the criteria presented above this is not a concern, as small firms are excluded from the sample anyway.

Criterion 6: Competitive, profit-maximizing industries

In addition to the criteria above, it is also necessary to exclude certain industries which could of different reasons have a misconceiving effect on the results. This includes industries which tend to have non-profit maximizing firms or exhibit non-competitive behaviors. Industries that typically are heavily subsidized by the government, have abnormal market conditions or high tariff barriers are removed, as well as industries which tend to be inelastic to macroeconomic fluctuations. In addition, the banking, finance and insurance industries are also dropped due to their reporting practices and distinctive capital structure. Based on these considerations, the following industries are excluded:

Table 3.1: Industry exclusion

Industry Name	NACE Code
Crop and animal production, hunting and related service activities	1
Forestry and logging	2
Insurance, reinsurance and pension funding, except compusory social security	65
Activities auxiliary to financial services and insurance activities	66
Retail estate activities	68
Veterinary activities	75
Security and investigation activities	80
Services to buildings and landscape activities	81
Education	85
Creative, arts and entertainment activities	90
Libraries, archives, museums, and other cultural activities	91
Gambling and betting activities	92
Activities of extraterritorial organizations and bodies	99

Criterion 7: Missing geographical information

Lastly, firms with incomplete geographical information has also been removed. We have assumed that missing geographical information weakens the validity of the observation. Some observations have *0* or *NULL* as values and have therefore been removed. Firms with *UTLANDET* have also been excluded since we are focusing on firms located in Norway. Firms with missing information for the variables *LANDSDEL* have had the correct location generated based on municipality information.

3.2.2 Sample outliers

The definition of an outlier is an observation that has an abnormal distance to the mean and whose omission would significantly influence regression results (Chatterjee and Hadi, 1986). Despite being an abnormal observation, an outlier should not be considered a negative factor without further inspection as it may provide valuable insight. Therefore, our overall goal with regards to treatment of our data sample is to remove as few outliers as possible. This way we maximize the external validity of our results. The outlier dilemma therefore becomes a trade-off between including observations that should not be in the data set or removing observations that

potentially provide valuable input to our regression model. In other words, we have to decide between risking potential estimator bias or reducing the external validity.

An outlier can be caused by one of two things; either the observation is extraordinary due to data errors or it is simply a legitimate extreme value (Williams, 2016). When deciding how to account for outliers there are two possible approaches we need to consider. Firstly, we can use qualitative boundaries for certain key variables. These limits will have to be based on best knowledge and relevant academic literature. The second approach is to apply objective, statistical techniques to remove observations that are deemed to be an outlier. There are both positive and negative aspects with both approaches. One might think that the second method is the most appropriate, however the risk of accidentally removing observations that should be included is certainly present. On the other hand, the qualitative method requires more effort if conducted appropriately. One cannot simply set a variable limit without manually checking the potential outliers. Ideally, since we want to remove as few observations as possible in order to maximize external validity, we inspect scatter plots for all variables and look further into relevant observations both when qualitative and statistical data removal methods are applied.

As mentioned, we apply both qualitative methods and statistical techniques when we identify and remove outliers in our data set. It is however necessary to underline the fact that the order in which these approaches are applied will affect the total sample size in the end. This is due to the fact that the statistical methods use weighted values that will be affected if the qualitative data removal is completed beforehand. We invested a significant amount of time evaluating different methods to deal with outliers and had numerous iterations in our analysis due to encountering different issues with sample outliers. In the end, we found combining both Cook's Distance and qualitative variables to be the best way of remove outliers that negatively affected the inference of our results. At the same time, we attempted to stay in line with our data treatment strategy of removing as few observations as possible. After manually reviewing scatter plots of key variables when using Cook's D first and vice versa, we conclude that we run the qualitative filtering method first.

Extreme values for key variables

Our main purpose of using qualitative cut-offs for certain key variables is to ensure that we remove highly irregular observations that unproportionally skew the interpretation of coefficients. Here, we focus on four key variables: ROA, EBITDA margin, debt ratio and cash ratio. The

first three contain a high relative number of extreme values, whilst we also focus on cash ratio since this is our explanatory variable. After producing multiple scatter plots and gradually increasing the cut-offs, the final qualitative criteria can be seen in table 3.2 below. Additionally, we have included the before and after distribution scatter plots of the four variables in the Appendix (see figure 7.3 & 7.4)

Table 3.2: Removing extreme values for independent variables

Return on Assets	<	-100 %
Return on Assets	>	500 %
EBITDA margin	<	-200 %
EBITDA margin	>	100 %
Debt ratio	>	150 %
Cash ratio	>	100%
Cash ratio	<	0 %

Cook's Distance outlier identification

Cook's Distance is a measure that combines the residual and leverage of an observation to indicate the influence the omission of a given observation will have on the regression estimates (Statistical Consulting Group, 2016). As mentioned above, an outlier is an observation with a large residual that may be a peculiarity or a data error. Leverage on the other hand, shows how far an independent variable deviate from its mean. The higher the leverage, the greater the effect on regression coefficient estimates. Applying Cook's D generates a single metric based on the formula below (Pennsylvania State University, 2018):

$$\mathrm{D}_i = \frac{\sum_{j=1}^{n}(\hat{Y_j} - \hat{Y_{ji}})^2}{\rho * MSE} * \frac{h_{ii}}{(1-h_{ii})^2},$$

where

- the numerator in the first term equals the residual of observation i
- ρ = number of coefficients
- MSE = mean squared error
- h_{ii}= leverage value

The first term represents the observation residual, whilst the second term captures the leverage (significance) of the observation. The results of performing Cook's D indicates how much the model's fitted values are influenced by deleting an observation; the greater the value of D_i, the greater the influence of the given observation.

When it comes to using Cook's D as not only a tool for outlier identification, but also a method to remove outliers, a cut-off has to be set based on both the observation distance and leverage. Even though an observation has a high residual, the leverage, and thereby the effect of its omission, may be very small. In this case we believe it makes sense to include the observation as this is in line with our overall data treatment strategy of removing as few observations as possible. Since calculating Cook's D in STATA is based on the last regression results in memory, Cook's D should ideally be run after every regression. However, we believe that since we only make small alterations to each regression model, applying Cook's D to the base model with all control variables is an acceptable approximation.

There is some variation in the academic literature with regards to the cut-off limit for Cook's D. Mcdonald (2002) argues that the numerical indicator should be dependent on the number of independent variables in the regression. In our case, since we have more than 3 independent variables and $n>15$, we should apply 0.85 as our cut-off for Cook's D values. Chatterjee and Hadi (2015) on the other hand, presents a more practical operational rule of classifying observations with Cook's D values above 1 as influential. The latter aligns well with our data treatment purpose of a conservative approach and we therefore set our cut-off to 1. In addition, since Chatterjee and Hadi (2015) also states observations should be analyzed graphically, we generate Cook's D values each year and inspect the corresponding scatter plots manually.

3.2.3 Data treatment - Concluding remarks

Ideally, we wanted to not use qualitative criteria as this is not an objective statistical filtering technique. However, we discovered that some extreme observations were not removed by Cook's D due to low leverage. The main issue with these left-over observations was that they significantly influenced the Altman's Z variable, since this variable is a non-discriminative function of multiple accounting variables. When not applying qualitative filtering, we saw that the Altman's Z variable became hugely inflated and the explanatory power of the regression models

became unrealistically high.

Overall, there are many different methods to adapt to outliers. It is important not to directly associate an outlier with a negative effect on regression validity; if observations that should be included are removed, the results will be of less statistical value. Williams (2016) presents opinions that claim there is no single perfect way to deal with outliers, instead the most important factor to remember is to remain critical to simple cut-offs and that subjective decisions may be just as valuable as objective statistical techniques. Therefore, in light of the fact that we have roughly 240 000 observations, we emphasize the trade-off between internal and external validity. We believe the cost of potentially removing observations that in fact should have been included is much lower than what we gain from removing extreme observations.

Additionally, we note that due to the size of our data set, it would be extremely time consuming to manually check accounting data and firm specific information for each suggested outlier in order to determine whether the observation should be included or not. As stated, we use graphical plots as tools to inspect potential outliers, but we do not dive deeper into each individual outlier. This is obviously a weakness with our data treatment. Table 3.3 below shows the sample selection that remains after implementing the different filtering choices we have made.

Table 3.3: Data removal

	Observations	Share of remaining sample
All observations of Norwegian firms from 2004-2015	2 839 655	100 %
Removing firms with revenue with less than 10 MNOK	2 438 045	85,86 %
Removing firms with salary costs less than 3 MNOK	107 523	26,77 %
Removing firms in selected industries*	32 616	11,09 %
Removing firms with missing NACE codes	9 256	3,54 %
Removing firms based on legal form**	6 926	2,75 %
Removing firms with extreme performance indicator values	3 592	1,46 %
Removing firms with missing geographical information	180	0,07 %
Remaining data sample	241 517	8,5 %

*See table 7.4 for details of which industries that have been removed

**See Criterion 4, chapter 3.2.2

3.3 Empirical methodology

In order to provide a transparent basis of the analytic techniques we have applied in our analysis, we dedicate space to elaborate on how we have set up our regression models to examine the effect of cash on firm performance. This section will cover the fundamental theoretical aspects of OLS regression and the other statistical tools we have used in our thesis. The statistical theory is provided by Wooldridge (2012) and the Econometric Techniques empirical course.

3.3.1 Fundamentals of OLS regression analysis

Ordinary Least Squares (OLS) is the simplest form of statistical regression analysis. Essentially, OLS, without taking non-linearities into account, draws a linear line through all observations that minimizes the sum of the squared residuals. A residual represents the difference between sample observations (Y) and the estimated OLS regression line ($\bar{Y}$). The simplest for of an OLS regression model can be expressed by the general form:

$$Y = \beta_0 + \beta_1 X + \epsilon,$$

where the purpose is to:

$$\min = \sum_{i=0}^{n} (Y_i - \bar{Y})^2$$

In the simple OLS regression model Y is the dependent variable that is estimated, β_0 is the regression constant, β_1 is the independent variable coefficient which states the effect of X on Y and ϵ is the error term. The error term equates to the sum of changes in Y that is not explained by the independent variable(s) in the regression model.

Generally, using simple OLS regression will be futile with regards to explaining complex statistical questions. Often, there are multiple factors that explain variation in the dependent variable which means that having a single explanatory variable is not sufficient. Instead, multiple regression analysis can be applied to account for having several influential independent variables. The multiple regression model is expressed below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \epsilon,$$

Using multiple regression analysis is almost always preferred to simple regression analysis due to the possibility of including several explanatory variables and improve the chances of explaining more of variation in Y. In our analysis we will introduce multiple variables in order to isolate the effect of cash on firm performance. There are however multiple factors that must be taking into account when using OLS regression and this will be discussed in the following section.

3.3.2 Quadratic variables

Quadratic variables can be included in regressions when we want to examine non-linear relationships that may exist in our models. The basic intuition of squared terms is that if the coefficient is negative, the effect on the dependent variable is reduced as the explanatory variable increases and vice versa (Wooldridge, 2012).

In their paper, Nason and Patel (2016) squares the predicted value of cash to generate the quadratic variable. The reason why we instead will square the cash ratio directly is because unlike Nason and Patel, we do not use the step-wise method of 2SLS IV regression (discussed in section 3.6.4). Instead, we run the regression directly using a specific STATA command that requires the endogenous variable(s) to be specified, in this case cash ratio and non-linear versions of cash ratio.

3.3.3 Dummy interaction terms

The purpose of interaction dummy variables with independent variables is to test whether the effect of the variable in focus is greater for one group of observations compared to another (Wooldridge, 2012). If an independent variable is included both as a separate variable and an interaction term, the interpretation of this variable changes. Given that the dummy variable = 1, the combined effect of the variable is equal to the sum of both the separate coefficient and the interaction coefficient. The separate coefficient represents the effect of the independent variable if the dummy variable = 0. If the coefficient for the interaction term is greater than the coefficient for the independent variable, the effect is correspondingly greater for observations included in the dummy category.

Our main objective is to study the effect of cash on firm performance. However, in our literary review, we also open up for examining this effect prior, during and after a recession. In order to analyze the effect of cash in the event of a recession, we include interaction terms for both the linear and quadratic explanatory variable cash ratio. This way we can capture the performance differences of holding cash that may arise in a recession.

3.3.4 Gauss-Markov assumptions for OLS

The application of regression analysis does not introduce strict requirements with regards to what or how it is used. On the other hand, the validity and accuracy of the results is highly dependent on whether certain statistical conditions are met. Potentially, the regression results can contain significant bias which in turn means that the estimated coefficients will provide misleading information. In order for an OLS regression to be unbiased, there are multiple assumptions (Gauss-Markov assumptions) that have to hold. The assumptions below are based on the use of cross-sectional data, where all observations are in the same time period.

Assumption 1: Linearity in parameters

Assumption 2: Random sampling

Assumption 3: Sample variation in X - no perfect collinearity between independent variables

Assumption 4: Zero conditional mean - the expected value of the error term is 0 for any independent variable, $\mathrm{E}(\epsilon|\mathrm{x}) = 0$

In order for the OLS estimates to be unbiased the four assumptions above must hold. Having an unbiased estimator means that the probability distribution of an explanatory coefficient has an expected value true to the population parameter - $(\mathrm{E}(\beta) = \hat{\beta})$.

Assumption 5: Homoskedasticity - the error term has equal variance for any independent variable, $\mathrm{Var}(\epsilon|\mathrm{x}) = \sigma^2$

If the assumption of homoskedasticity does not hold, the regression estimates exhibit heteroskedasticity. Heteroskedasticity does not affect the biasedness of the estimators, but reduces their efficiency which is determined by the standard errors of the coefficients.

The Gauss-Markov assumptions above determine whether the OLS estimator is BLUE (Best Linear Unbiased Estimator), which only occurs if all the assumptions hold. So far, the discussion

of OLS regressions have been based on the fact that all observations are time-independent. Once time becomes a factor in the data set, the requirements change slightly. Our data set has accounting information for several years which means that it is defined as panel data. It is therefore necessary to introduce two additional assumptions that are required to hold if our OLS estimates still are to be considered unbiased and efficient. Additionally, it should be noted that *Assumption 2* is no longer needed to ensure that the estimates are BLUE.

Assumption 6*: No autocorrelation - no correlation in error terms between time periods

With the introduction of the time dimension to the regression model the assumption of no autocorrelation becomes relevant. This assumptions states that the error term of different time periods should not be correlated and can be expressed accordingly:

$$corr(u_t, u_s|X) = 0,$$

where t and s represent different time periods. If autocorrelation is present for a variable, the standard deviation of this given variable will be biased which in turn affects the efficiency of the entire model. It should be noted that the potential efficiency issues that may arise from heteroskedasticity and autocorrelation will have greater effect for smaller data samples since standard deviations of coefficients will be higher.

Assumption 7*: Normality in errors

The second assumption that becomes relevant once observations are time-dependent is normality in errors. This assumption does not affect whether the estimates are BLUE, but instead influences the inference the results provide. If the error terms meet the requirement of normality, they are independent of all independent variables for any given time period t and independent and identically distributed as n goes to infinity.

Based on the assumptions required to be fulfilled in order for OLS to be BLUE, there are several potential problematic factors that may arise when we analyze our model. In section 3.6 we discuss the most probable and serious issues that often are present in regression model analysis.

3.4 Regression structure

The base regression model used in this thesis is based on Nason and Patel's (2016) article on the effect of cash on firm's stock performance. The purpose of replicating their methods is to provide comparable research using Norwegian firm data and to explore how the results coincide with those of Nason and Patel. In this section we will present and discuss the variables used in our regression models. Multiple control variables are calculated using industry averages. Consequently, all variables denoted with i, are calculated at the 2-digit NACE code level. All variables without the industry notation are calculated on a firm basis. We only deviate from the 2-digit level when grouping firms based on knowledge intensity.

3.4.1 Dependent variable

In their paper, Nason and Patel use Tobin's Q as their measure of firm performance. Tobin's Q is the share of total market value of a firm to the firm's total asset base. Since we do not have stock information in our data set and most of the firms are not listed, we have to use an alternative measure of firm performance. Nason and Patel also ran their model using return on assets (ROA); they did not include their complete results in their paper, but we gained access to their findings through e-mail correspondence with Robert Nason.

We have also used EBITDA margin as a measure of operational efficiency as a dependent variable in our models, but have decided not to include these results in our thesis. Overall, the results are very similar; both coefficient signs and significance are nearly identical, though their absolute values are lower. This however, might be reasonable to suspect as EBIDTA margin is a more decomposed accounting measure.

Return on Assets

Return on Assets (ROA) is a measure of the profitability of a firm relative to its total assets. ROA captures the fundamentals of firm performance by evaluating income to the assets required to run a business (Hagel et al., 2018). Hagel et al. (2018) also argues that unlike ROA, other popular performance metrics such as return on equity and return to shareholders can be heavily influenced by debt leverage. This type of financial engineering will provide misleading information and obscure how a firm is actually doing. ROA can be calculated with or without interest expense depending on whether it is of interest to correct for cost of debt. By including interest

expense the ROA measures a firm's success in using assets to generate earnings independently of the financing of those assets (Selling and Stickney, 1989).

A potential weakness of using ROA as the dependent variable is that ROA can be heavily influenced by investments the same year. Even though the costs of these investments are immediately present in the accounting data, the potential return of an investment might not materialize for quite some time. In addition, the general belief that there is a link between firm performance over different time periods introduces the need to perhaps control for previous firm performance. For our purpose it may seem sensible to control for prior firm performance. A detailed discussion on controlling for prior performance can be found in section 3.6.5.

3.4.2 Explanatory variables

In line with our research question and hypotheses, we use firm cash holding (cash ratio) as the main explanatory variable in our regression model. Naturally, since absolute values would highly skew the results, this variable is specified as the ratio of cash to total assets. As mentioned earlier, the main goal of our regression model is to isolate the effect of cash on firm performance by removing as much as possible of unexplained errors. Hopefully, our results will be an approximation of the true value of firm cash holdings. However, like with any empirical analysis, it is highly unlikely that we will be able to accurately identify a causal effect with complete certainty.

$$\text{Firm cash holdings}_t = \frac{\text{Cash}_t}{\text{Total assets}_t}$$

3.4.3 Instrumental variable

If endogeneity is present in our regression model, the validity of the inference drawn can be significantly reduced and the estimates of our explanatory variables will be biased and inconsistent as n increases. Nason and Patel (2016) argues that the relationship between cash and market performance may be endogenous and presents *peer cash holdings* as an instrumental variable (IV) to correct for potential endogeneity between these two variables. Peer cash holdings are a function of the average cash holdings in an industry. In order to calculate peer cash holdings,

we first aggregate yearly total cash holdings and total asset values in each industry group. From these values we calculate peer cash holdings for each industry i in each year t:

$$\text{Peer cash holdings}_{it} = \frac{\text{Total cash}_{it}}{\text{Total assets}_{it}}$$

After having calculating peer cash holdings, we subtract peer cash holdings from the cash ratio for all observations which results in the final IV value.

The requirements for using an IV as a method to reduce endogeneity problems are the following:

1. The effect of the IV (z) has to be exogenous to the structural equation (u)

   - COV(z,u) = 0

2. The IV has to have an effect on the endogenous variable x

   -COV(z,x) $\neq$ 0

Essentially, the IV does not affect the dependent variable directly, but only through the explanatory variable. Using peer cash holdings as an instrument sees to fulfill both these requirements; the industry cash average will most likely explain a significant amount of a firm's given cash level, but not necessarily the performance of the same firm. It seems reasonable to argue that the average cash ratio in an industry will not directly affect a specific firm's performance. First stage tests of peer cash holdings clearly reject the null-hypothesis of a weak instrument and supports the decision of including this variable as an IV.

3.4.4 Base model control variables

Control variables are included to reduce the unexplained variation that may alter the true effect of cash on firm performance. Firms will have individual traits that in turn uniquely affect performance and this might hide the true causal effect of holding cash. The section below will outline the control variables used by Nason and Patel (2016) to suppress these effects and any alterations we have done to these variables.

We note here that we do not lag any of the independent variables in our regression models. The reason behind this is the argument that the effect of a firm's actions will be incorporated in year t and not year *t+1*, which in turn means that the independent variables do not need to

be lagged (Nason and Patel, 2016). We recognize that this may be something that should be researched further and we include a short discussion on this topic in section 5.2.

Absorbed slack

Absorbed slack is a measure of how much of unaccounted costs or reduced income a firm has included in their financial reporting. Generally, absorbed slack is reported as the ratio between selling, general and administrative costs and sales income (SG&A) (Kim and Bettis, 2014). In Norway however, these costs are not reported directly in the income statement. Therefore, we have to generate an approximate variable in order to be able to measure absorbed slack.

According to Investopedia (2018), SG&A costs include all costs that not directly linked to product development or service costs. In order to create an appropriate proxy variable, we therefore include the following expenses: personnel expenses, loss on receivables and other operating expenses.

$$\text{Absorbed slack}_t = \frac{\text{Personnel expenses}_t + \text{loss on receivables}_t + \text{other operating expenses}_t}{\text{Sales}_t}$$

Debt ratio

Debt ratio is included to control for performance effects stemming from debt levels of firms. The academic literature's perspective of the effect of debt on firm performance has changed over time. Initially, Modigliani and Miller (1958) argued that the value of a firm is unaffected by capital structure. By concluding that firm value is unrelated to capital structure, it can indirectly be interpreted that Miller & Modigliani believe firm performance is unaffected by debt levels. However, more recent research argue that capital structure indeed is a relevant factor with regards to affecting firm profitability (Killi et al., 2011). An important argument that supports the relevance of debt is that the profitability of firms is dependent on capital structure since this directly determines whether projects with positive NPV can be accepted or not (Myers and Majluf, 1984). Moreover, Fresard (2010) argues that firms with low debt levels experience stronger product market performance compared to firms with higher debt ratios. Debt ratio is calculated by scaling the sum of long-term and short-term debt on total assets.

$$\text{Debt ratio}_t = \frac{\text{Debt}_t}{\text{Total assets}_t}$$

Capital intensity

Many firms require significant investments to reach operational capacity. There are several ways in which capital intensity can be measured; Lee (2010) defines this as a ratio of total assets scaled by sales, whilst Nason and Patel (2016) divides capital expenditure (CAPEX) by sales to obtain the ratio. CAPEX is the sum of the difference between fixed assets in two periods t and *t-1* plus depreciation. Since we are intending to follow Nason and Patel (2016), the latter alternative has been chosen to calculate capital intensity.

$$\text{CAPEX}_t = \text{Fixed assets}_t - \text{Fixed assets}_{t-1} + \text{Depreciation}_t$$

$$\text{Capital Intensity}_t = \frac{\text{CAPEX}_t}{\text{Sales}_t}$$

Altman's Z

Altman's Z is a score developed by Altman (1968) as an indicator of the probability that a firm will go bankrupt. The score is derived from using multiple accounting values from both corporate income and balance sheets. Throughout several validating tests, the Z-score model has shown a high Type I bankruptcy accuracy of 95 %, one financial statement prior to distress. Additionally, the model predicts bankruptcy with 72 % accuracy two years in advance. The original model, which has been multiplied by 100 for practicality reasons, is shown below:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

$$X_1 = \frac{\text{Working Capital}_t}{\text{Total Assets}_t}$$

$$X_2 = \frac{\text{Retained Earnings}_t}{\text{Total Assets}_t}$$

$$X_3 = \frac{\text{EBIT}_t}{\text{Total Assets}_t}$$

$$X_4 = \frac{\text{Market value of Equity}_t}{\text{Book value of Total liabilities}_t}$$

$$X_5 = \frac{\text{Sales}_t}{\text{Total Assets}_t}$$

The main issue that arose from this model was the fact that the market value of equity can only be calculated from listed firms by multiplying the number of outstanding shares and the current share price. Since the majority of firms in our sample are private firms, we needed to find an alternative measure to market value of equity. Fortunately, Altman has developed a revised Z-score model (we call this model Z') which instead uses book values of equity (Altman, 2013).

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.42X_4 + 0.998X_5, where$$

$$X_4 = \frac{\text{Book value of Equity}_t}{\text{Book value of Total liabilities}_t}$$

It is clear that the constant terms for some of the variables have changed, however Altman provides proof that the Z-score method is still valid. The revised model has only a slight reduction in Type I accuracy (91 % vs 95 %) and is therefore fully applicable for our use as an alternative method of calculating bankruptcy risk. It should be noted that Z-score models are calculated on industry basis. The above model has been based on manufacturing firms in the US and can therefore be slightly inaccurate for Norwegian firms. Still, due to a lack of alternatives, we have to use the above model.

Firm size

In order to control for firm size, Nason and Patel (2016) use the natural log of employees as a proxy variable. Due to the fact that most of our firms are unlisted and that these firms are not required to report changes in the number of employees, we have to find an alternate variable to control for size effects. There are other accounting measures that may also seem useful in order

to control for firm size, such as sales or total assets, however this might open up for endogeneity issues in our model. Kim and Bettis (2014) argues that since the dependent variable ROA is already scaled on total assets and is significantly impacted by income, the relationship between the dependent variable and the control variable for firm size may be spurious. Still, the majority of academic literature we have read on the subject of size effects on firm performance conclude that using sales or total assets as proxies works fine (Titman and Wessels, 1988). We generate the proxy for size by taking the natural logarithm of sales.

$$\text{Size}_t = \log(\text{Sales}_t)$$

3.4.5 Expanded model control variables

Lagged Return on Assets

According to economic theory, above average returns should diminish over time (Birer and Weichselbaumer, 2005). Goddard and Wilson (1999) argues that successful firms with advantages that enable them to earn current profits above norm can be expected to try to retain these advantages over time. At the same time, it should be expected that competitors will try to imitate the successful firms, thus affecting the profitability of the currently successful firms. Goddard and Wilson (1999) then presents the phenomenon of "Persistence of Profits" in which they conclude that firm profitability in the future is partially explained by current profitability. Therefore, in order to control for past profitability, we include the lagged variable of ROA in our model. We test the model using different lags (from 1 to 4), but only include the first lag. The reason for this is that last year's ROA seems to be highly significant for next year's ROA, but this effect quickly diminishes for lags greater than 1.

$$\text{Lagged ROA}_t = \text{ROA}_{t-1}$$

Due to the uncertain statistical validity of including a lagged dependent variable in our regression model, we refer to chapter 3.6.5 for a more extensive discussion of this variable.

Market share

In their article in the Harvard Business Review, Buzzell et al. (1975) presents evidence that market share has a strong, positive impact on firm profitability. They argue that factors such as economies of scale, market power and quality of management as reasons as to why firms with higher market shares will outperform firms with lower market share. Hence, we control for market share in our expanded model. Market share is calculated as the share of firm sales to the total sales of the respective industry for each firm each year. Industry sales are based on 2-digit NACE code levels.

$$\text{Firm market share}_t = \frac{\text{Firm sales}_t}{\text{Total industry sales}_t}$$

Sales growth

Sales growth is included mainly to capture the effect of firm growth on firm performance, but also to account for sensitivity to changes in market dynamics. Firms that experience high growth prior to a recession, will be more severely hit in the event of a economic downturn (Geroski and Gregg, 1996).

When contemplating using sales growth as a control variable, we carefully considered potential simultaneity issues due to the link between ROA and sales growth. Even though sales ultimately affect ROA, there are several cost factors that intervene in between. Despite an ROA increase, the actual cause might not be related to increased sales. Instead, there might have been a significant cost or debt reduction that instead drives ROA up. Hence, we conclude that sales growth is a valid control variable for our model.

$$\text{Sales growth}_t = \frac{\text{Firm sales}_t - \text{Firm sales}_{t-1}}{\text{Firm sales}_t}$$

3.4.6 Knowledge intensity sub-samples

In order to investigate whether the effect of cash on firm performance is higher for knowledge intensive industries than less knowledge intensive industries, we need to define which industries are knowledge intensive. In a master thesis conducted by Bergmann and N. Betten (2016), knowledge intensity is defined on the basis of three different factors of a firm that could be

assumed to indicate knowledge intensity. R&D-intensity, average personnel costs and share of employees with higher education are combined into one continuous explanatory variable for knowledge intensity (KI), where each NACE code in the selection is connected to a value of KI between 1 and 10. This variable is constructed in order to group firms according to their knowledge intensity, into one of four groups representing either a low, medium low, medium high or high degree of knowledge intensity. We use the same division of industry codes in our analysis of the effect of cash on firm performance for knowledge intensive industries. See table 7.4 in appendix for a full overview of the industry classifications on knowledge intensity.

3.5 Model specification

We now present the different regression models we will examine in an attempt to validate or reject our hypotheses. For an extensive description of each variable, we refer to chapter 3.4 as we do not elaborate on the different variables included in our models in this section.

As previously discussed we first examine the regression model from Nason and Patel (2016) as our base model. The model below includes the control variables that will be present throughout all regressions.

$$\begin{aligned} \textit{Firm performance}_t &= \beta_0 + \beta_1 \textit{Absorbed slack}_t + \beta_2 \textit{Debt ratio} + \beta_3 \textit{Capital Intensity} \\ &\quad + \beta_4 \textit{Altman's Z} + \beta_4 \textit{Size} + \textit{Industry dummies} + \epsilon \end{aligned}$$

For practicality reasons we define $\beta_1 - \beta_6$ as control variables (Nason and Patel - NP) to avoid unnecessary model specification complexity. Below we show the complete regression model based on Nason and Patel (2016) that we have replicated and adapted to our data set.

$$\begin{aligned} \textit{Firm performance}_t &= \beta_0 + \beta_1 \textit{Cash ratio}_t + \beta_2 \textit{Cash ratio}^2 + \beta_3 \textit{Recession dummy} \\ &\quad + \beta_4 \textit{Cash ratio * Recession dummy} + \beta_4 \textit{Cash ratio}^2 \textit{ * Recession dummy} \\ &\quad + \textit{[Control variables (NP)]} + \epsilon \end{aligned}$$

In order to improve the model, we introduce additional variables to control for more of the unexplained variation. The independent variables above are now grouped as focus variables to simplify the regression model expressions. Below is the expanded regression model we have developed; this model will be used throughout the analysis except for the initial section where we replicate the model used by Nason and Patel. We note that this expanded model is applied for separate time periods and industries. This entails that recession interaction terms and industry dummies are removed in respective regressions.

$$\begin{aligned} \textit{Firm performance}_t &= \beta_0 + \beta_1 \textit{L.Firm performance} + \beta_2 \textit{Market share} + \beta_3 \textit{Sales growth} \\ &\quad + \textit{[Focus variables (NP)]} + \textit{[Control variables (NP)]} + \epsilon \end{aligned}$$

3.6 Data concerns and validity

In the section below, we will discuss some of the key concerns that arise in our regression model. First, we cover the less serious concepts of heteroskedasticity and multicollinearity. After that, we move on to the potentially more serious issues of endogeneity and the inclusion of the lagged dependent variable.

3.6.1 Heteroskedasticity

As mentioned earlier, the presence of heteroskedasticity in our regression model will not affect the biasedness of our estimates, but instead reduce the efficiency of our model. In order to determine whether heteroskedasticity is present in our model, we consider both informal residual and scatter plots in addition to the more accurate formal Breusch-Pagan and White test for heteroskedasticity. The different plots are sometimes difficult to interpret accurately so we turned to the formal tests to determine the cause of action.

The Breusch-Pagan (BP) test is focused on detecting heteroskedasticity in linear regression models. Hence, we apply this test to our simplest regression without any non-linear terms. The BP test regresses the squared residuals on all independent variables and concludes that the null-hypothesis of homoskedasticity holds unless the p-value is below a critical level.

$$\hat{u}^2 = \delta_0 + \delta_1 X_1 + \delta_2 X_2 + ... + \delta_k X_k + \epsilon$$

where

$$H_0 : \delta_0 = \delta_1 = \delta_2 = ... = \delta_k = 0$$

The purpose of also applying the White test is to account for possible heteroskedasticity arising from the non-linear and interaction terms in our model. Unlike the BP test, the White test includes both squared and interaction terms when regressing the residuals on the independent variables as shown below. The null-hypothesis is the same as for the BP test; all deltas are equal to zero if we are to assume homoskedasticity.

$$\hat{u}^2 = \delta_0 + \delta_1 X_1 + \delta_2 X_2 + \delta_3 X_1^2 + \delta_4 X_2^2 + \delta_5 X_1 X_2 + ... + \delta_k X_k + \epsilon$$

The tests both provide a p-value of 0.000 and clear indication that the model exhibits heteroskedastic errors for both linear and non-linear relationships. As a result, we conclude that the standard errors of our estimates are likely biased. Williams (2015a) argues that OLS is not optimal when heteroskedastic errors are present since it gives equal weight to all observations when, in fact, observations with larger disturbance variance contain less information than observations with low disturbance variance. Another issue might be that the significance of independent variables can be affected, however this is not likely to happen unless the model suffers from severe heteroskedasticity.

With regards to the causes of heteroskedastic errors, Williams (2015a) presents multiple reasons. Firstly, the fact that we are using IVs in our regression entail that heteroskedasticity is more likely to be an issue than if we had no IVs. Williams argue that errors may increase as the value of the IV increases; this would be a problem if we had an IV that was size dependent. However, since peer cash holdings is not directly determined by the size of firms, this is not likely to be the cause of the heteroskedastic errors in our model. Another reason is that the regression model is misspecified. Misspecification of a regression model can be caused by both incorrect function form and/or omission of important variables.

In order to correct for heteroskedasticity we apply robust standard errors in accordance with Wooldridge (2012). Using robust standard errors normally increases the standard errors which is the cause of the reduced model efficiency. Robust standard errors will not affect the estimated coefficients unless the sample size is small (Wooldridge, 2012), which this not an issues in our model. Followingly, all our regression models are estimated using robust standard errors.

3.6.2 Multicollinearity

Another statistical phenomenon that can cause problems with regards to drawing inference from the estimated independent variable coefficients is multicollinearity. It occurs when an independent variable can be linearly predicted by another independent variable. The main issue that arise due to multicollinearity is that it becomes impossible to tell which of the collinear independent variables that are actually of interest. If one of the collinear variables has a true effect on the dependent variable, it will be impossible to draw any inference from this variable due to multicollinearity. Still, in all regression models some degree of correlation between independent variables is expected (Wooldridge, 2012).

There are multiple ways to check for multicollinearity in our model. The easiest way to get an indication whether this is a problem or not is to examine our correlation matrix with all the independent variables. As shown in table 7.5, there are no independent variables that have a correlation above .4 except the squared term and the IV which means that even conservative thresholds for multicollinearity holds (Pallant (2013) in Bolle and Kårbø (2015)) and confirms our suspicion of no multicollinearity. Additionally, the strong correlation between firm cash ratio and our IV, indicates that peer cash holdings may be a very accurate indicator of a focal firm's cash holdings. The more formal test of multicollinearity we conduct is the *variance inflation factor* test (or VIF test). According to Williams (2015b), the VIF variable shows how much the variance of the coefficient estimate is being inflated by multicollinearity. Further, he argues that a general rule of thumb is that we should investigate variables with VIF greater than 10. We run the VIF test and find no independent variables with VIF value above 4 other than squared terms and interaction terms in addition to industry dummies. The high VIFs of the latter variables are expected and do not create a problem with our estimates.

3.6.3 Endogeneity issues

The potentially most serious issues that arise when performing regression analysis are related to endogeneity. Endogeneity is covered by assumption 4 in which exogeneity is present if the null-hypothesis holds and the independent variables are uncorrelated with the error term. Unlike the case of heteroskedasticity, endogeneity will affect the coefficient estimates creating positive or negative bias in our results. Due to this, endogeneity is considered a more serious issue and we therefore dedicate significant effort to minimize endogeneity problems in our model. The discussion below will cover some of the causes of endogeneity and how we adapt our model to these potential concerns.

One of the most frequent causes of endogeneity issues is omitted variable bias (Wooldridge, 2012). If there are omitted variables in the error term that should be included as an independent variable, assumption 4 is breached and the estimated model is no longer BLUE. In the worst case, the independent variable coefficients can be significantly biased and provide a completely wrong interpretation. The mathematical intuition of omitted variable bias is explained below.

If we have

$$Y = \tilde{\beta_0} + \tilde{\beta_1} X_1 + v$$

but the true model actually is

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u$$

then

$$v = \beta_2 X_2 + u$$

and the estimated bias becomes

$$bias(\tilde{\beta_1}) = E(\tilde{\beta_1}) - \beta_1 = \beta_2 * \tilde{\delta_1}$$

where $\tilde{\delta_1}$ is the slope coefficient from regression X_2 on X_1. Despite the potential bias that may exist because of omitted variables, it is generally accepted that it is not possible to account for all factors affecting ROA. We replicate and expand Nason and Patel's (2016) model of firm performance in order to include as many relevant control variables as possible in order to reduce potential omitted variable bias. Still, including too many or irrelevant variables introduces other potential issues, as mentioned in the discussion on multicollinearity, hence the need for a trade-off between risking bias and regression complexity.

Another potential source of endogeneity is reverse causality and/or simultaneity. Reverse causality occurs when an independent variable X_i is determined by the dependent variable. Simultaneity happens when both an independent variable and the dependent variable simultaneously affect each other, taking the causality complexity one step further. The main issue with simultaneity is that it is impossible to determine the causal effects between the two variables (Wooldridge, 2012). A good example of simultaneity is provided by Bolle and Kårbø (2015); they argue that the firm performance of a firm can be affected by the firm's capital structure. At the same time however, if a firm performs well it will be able to retain earnings and expand the capital base which in turn can lead to lower debt levels and thereby change the capital structure. In our situation the issue of simultaneity is less obvious, but still requires specific attention. It seems reasonable to believe that to some extent ROA might affect a firm's cash ratio in line with the argument above. If a firm performs well and chooses not to re-invest the profits or pay off debt, the cash levels of that firm will be affected which in turn might create bias in our estimates.

With regards to the potential of having simultaneity problems in our model, we flip the equations around to test for significance of ROA on cash ratio. We find that regardless of the regression structure, ROA is consistently highly significant. Additionally, the correlation matrix (see table 7.5) shows a correlation of roughly 0.3 between cash and ROA which is similar to the coefficient estimates from our regression tests. Still, we do not believe this to be a serious issue in our model.

Reed (2015) states that many research papers simply replaces simultaneity affected endogenous explanatory variables with a lagged value and claim that this solves the simultaneity problem. Reed then argues and presents theoretical evidence for the fact that the explanatory variable still will be endogenous, causing the estimates to be biased. In order to correctly use the lagged variables of a suspected endogenous explanatory variable, the lagged variables must be included

as instruments in IV regressions.

Before we move on to solving endogeneity issues, we perform the Durbin-Wu-Hausman test for endogeneity to test whether the assumed endogenous variable firm cash ratio actually could be treated as an exogenous variable. The reason why this test is important is that in the event of the variable being exogenous, OLS is preferred due to efficiency gains. If the null-hypothesis can be rejected, we have supporting evidence that we need to treat the variable as endogenous and that IV estimation is preferred over OLS. The conclusion of this test is a p-value of 0.000, giving clear indication that firm cash ratio should be treated as an endogenous variable and that IV analysis should be used.

3.6.4 Solving endogeneity

As mentioned in the regression variables section, we suspect, like Nason and Patel (2016), that the explanatory variable *firm cash holdings* may be endogenous due to omitted variable bias. If this is the case, the errors will be correlated with the endogenous variable which means our estimates are biased. We therefore apply Instrumental Variable analysis in order to correct for the possibility of endogeneity.

When contemplating using instrumental variables to correct for endogeneity, there are two different procedures that can be applied. The first option is to estimate the model using step-wise 2SLS. Here, the endogenous variable is regressed using the instruments and control variables to predict the value *Cash hat*. The problem with using this method is that the standard errors are inaccurate, causing the results to lose efficiency. Instead, STATA enables us to produce the same results with the correct standard errors using the *ivregress 2SLS* command. The difference between these two methods decreases as n increases, so due to our large sample size we do not suspect significant variation in the standard errors. Still, there is no reason not to use STATA's built in commands and the only purpose of using the step-wise procedure is to predict values of firm cash ratio to be used as instruments in 2SLS.

Another issue that arise with the assumption that firm cash ratio may be endogenous is the statistical aspect of variable interaction with endogenous variables. In line with Løken et al. (2012), any interaction with an endogenous variable should also be considered endogenous. Naturally, since we want to examine the non-linear effects of cash on firm performance, we have to find instruments to control for quadratic terms of firm cash ratio. Løken et al. (2012)

argues that there are two ways to solve such endogeneity problems. First, since we assume that the peer cash holdings is a valid instrument, any interaction with another independent variable will by definition also be exogenous and can be used as an instrument. The second method revolves around using predicted values of firm cash ratios as instruments instead of interacting independent variables. According to Carneiro et al. (2010) and Mogstad and Wiswall (2010), the second method is far superior when it comes to estimate efficiency and we therefore use this procedure to correctly instrument variations of firm cash ratio.

3.6.5 Autocorrelation and the lagged dependent variable

As discussed previously, the presence of autocorrelation in our regression model will cause our standard errors to be biased and reduce the efficiency of our estimates. However, autocorrelation can potentially also cause biased estimators if an autocorrelated variable is omitted from the regression model. If this is the case the errors will be persistently biased, which in turn will create serious estimate inconsistency. Earlier, we introduced the concept of "Persistence in Profits", where firms that perform well one period have a higher chance of performing well the next period. Based on this, we suspect that the dependent variable might be autocorrelated. To see whether this is the case we examine scatter plots of Y against Y_{t-1} (see Appendix figure 7.6). These plots indicate that autocorrelation most likely is present, which is supported by a correlation of 0.579 between these two variables. Additionally, we test for autocorrelation using *xtserial* on our OLS model with predicted values of cash (the test does not work on *ivregress 2SLS*). The conclusion is that autocorrelation is present. We strongly suspect that this serial correlation is caused by the dependent variable and in the current situation this entails that our estimates will be biased.

Before having decided to include prior profitability in our model, we spent a significant amount of time researching whether the inclusion of this variable creates problems in our regression model. In his study, Efthyvoulou (2012) argues, on the basis of Kiviet (1995), that including a lagged dependent variable in OLS regression creates significantly biased and inconsistent estimators. The mathematical approach to lagged dependent variables provides theoretical proof that estimators will be biased. Below we outline this approach[1] before we argue that estimators in fact still can be consistent despite the evident bias lagged dependent variables create.

[1] Based on Ben Lambert's instructional econometrics videos

The simplest form of a lagged dependent variable function is given by

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \epsilon_t$$

The strict exogeneity assumption requires the expectation of ϵ_t for all periods of Y_t since Y is included as an independent variable. This entails that the covariance between the error term and the dependent variable must equal 0.

$$\text{cov}(\epsilon_t, Y_t) = 0$$

By substitution we get

$$\text{cov}(\epsilon_t, \beta_0 + \beta_1 Y_{t-1} + \epsilon_t) = 0$$

β_0 can be removed since it is a constant (ϵ_t cannot be correlated with a constant). Additionally, we have no reason to believe $\beta_1 Y_{t-1}$ is correlated with the error term, hence we can also remove this term. This leaves:

$$\text{cov}(\epsilon_t, \epsilon_t) = 0$$

which equals

$$\text{var}(\epsilon_t) = \sigma^2 \neq 0$$

The above shows that in the event of OLS regression, the strict exogeneity assumption does not hold. Hence, the regression estimates are theoretically biased. However, Kiviet (1995) is more moderate in his paper, explaining that if the sample size is large, standard asymptotic approximations can still yield valid estimators. Since this is undoubtedly the case in our situation, his arguments support our choice. In the event that there is autocorrelation in the lagged return on assets variable, we believe estimated coefficients still will be close to their true values.

Keele and Kelly (2006) have written an excellent paper on the concept of using lagged dependent variables in regression models and we apply much of their theory in our variable decision making. They argue that if autocorrelation is present in the lagged dependent variable, our estimates will be downwards biased. This entails that our results might be somewhat conservative and should at least ensure that we do not overstate any variable effects. Keele and Kelly (2006) states that in order to use lagged dependent variable estimation the dependent variable must be stationary. If this is not the case, using a lagged dependent variable is statistically inappropriate. Due to the fact that we have an unbalanced data set with gaps [2], we cannot run any formal tests of stationarity and instead have to rely on our own intuition. Arguably, developments in firm performance should not display the same characteristics as a typical time series variable (GDP, population growth etc.). Therefore, even though our main reason for including lagged return on assets is the "Persistence of Profits" phenomenon, we find it very unlikely that ROA will display the characteristics of a highly persistent time trend. We do believe there is a relationship between firm performance from one period to the next, but that this relationship develops more or less statically over time. In other word we expect the development to be weakly stationary, which in turn means that the loosened criterion of stationarity holds. It should also be noted that using a lagged dependent variable can also be inappropriate if the assumed dynamic model is in fact static. That is, if there is no serial correlation between Y and Y_{t-1}, using a lagged dependent variable can cause serious bias.

The statistical post-estimations revealed that autocorrelation initially was a concern in our model. In order to correct for this, we included the lagged dependent variable as a control. Overall, we recognize that including this variable potentially opens up for methodological problems, but we argue that the economical reasoning, in addition to a large sample size, validates our choice.

[2]Gaps have been created since we remove single observations instead of entire firms if an observation meets filtering criterion. The upside is that we remove fewer observations, though the downside is that we cannot run tests that require no gaps

4. Analysis

This chapter will cover the results of our analysis. First, we devote quite some effort into presenting descriptive statistics of our data set focusing on time periods and industry differences. After that, we display and comment on our regression results to provide the basis for the discussion in chapter 6.

4.1 Descriptive statistics

We provide descriptive statistics in order to give a broad representation of how different trends developed for the firms in our data set. Since all observations affect the mean regardless of their size, we also include the median values in the descriptive plots to enrich the interpretation of which direction the most extreme values pull. In the section below, we show graphical outputs of the data. Full quantitative tables can be found in the Appendix.

4.1.1 Sample statistics

Figure 4.1 shows yearly mean and median values for both ROA and EBITDA margin for the entire time period from 2005-2015. It becomes obvious that there indeed are discrepancies between mean and median for both ROA and EBITDA margins, though these differences seem to be fairly cointegrated. The widespread economic impact of the recession in 2008-2009 also becomes highly visible; from a mean ROA of 12 % in 2007, the average firm performance (ROA) drops by 4 percentage points to 8 % in 2009. An interesting observation is that despite the economic recovery that followed in the years after the recession, average ROA has not returned to pre-recession values. It might be possible that the effects of the recession negatively affected future returns enough to suppress firm performance. On the other hand, it seems more likely that the pre-recession levels simply were extraordinarily high. Bolle and Kårbø (2015) presented similar statistics from year 2000 and their findings support that the latter argument is correct.

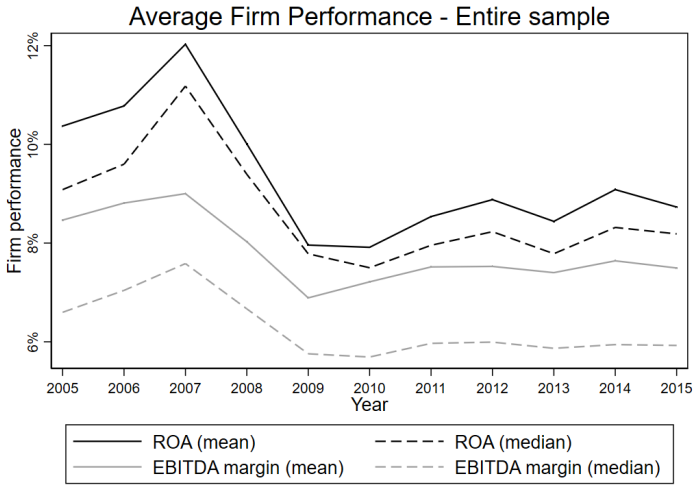

Figure 4.1: Average and median values for ROA and EBITDA margin 2005-2015

The impact of the recession also becomes visible when examining the Altman's Z statistic. Figure 4.2 shows the average values of Altman's Z for the entire time period. As mentioned earlier, the higher the Z-score, the less likely a firm is to go bankrupt in the near future. The financial crisis in 2008/2009 caused a sample average drop of 0.15 and increased the standard deviation by 89 %. Compared to figure 4.1, the recovery rate for the Altman's Z score seems to have been higher. In 2014, the average Z-score was 3.652, marginally above the 2007 score of 3.644. In combination with the fact that ROA did not have the same post-recession growth, it might be plausible to present the argument that firms took measures to become more financially robust in wake of the crisis.

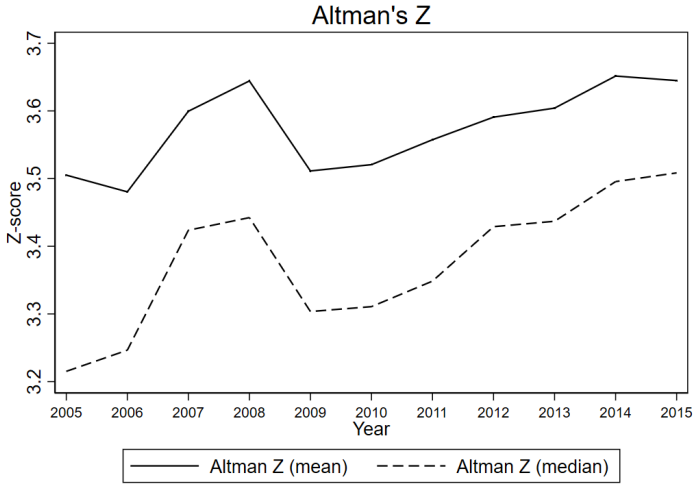

Figure 4.2: Average values for Altman's Z 2005-2015

We also categorize all firms into yearly size quartiles to see whether Altman's Z developed differently for each quartile during the time period (figure 4.3). We see that there is a clear correlation between firm size and Z-scores; the greater the firm size, the higher Z-scores. This indicates, not surprisingly, that large firms are less likely to go bankrupt than smaller firms.

Further, the graph gives evidence to believe that Altman's Z becomes more sensitive for smaller firms; the trend lines for the bottom two quartiles seems to be fluctuating more prior to and during the recession. It should also be noted that it is the third quartile that scores highest from 2005-2015 by roughly 0.2 points. This means that being a large firm size does not necessarily minimize risk of bankruptcy. Another observation we make here is that the quartiles seem to converge towards during the post-recession period. This convergence is largely caused by increased Z-scores for the 1st and 2nd quartile since the 3rd and 4th quartile remain fairly stable.

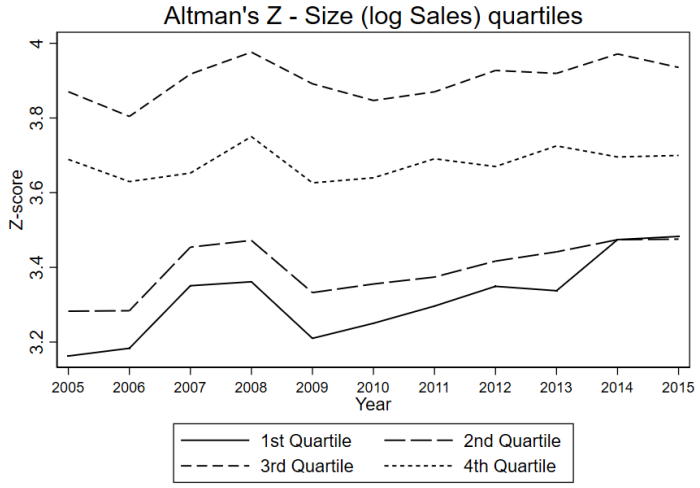

Figure 4.3: Average quartile values for Altman's Z 2005-2015 (lowest to highest quartile)

Another variable we will look into for the entire sample is sales growth (shown in figure 4.4). In line with the development of ROA and the EBITDA margin in figure 4.1, we see that the firms experience exceptionally high sales growth in the pre-recession period. The growth during these three years equates to a CAGR of 14 %. During the recession however, sales growth drops dramatically each year. From 2007-2008 the decline is almost 11 percentage points, whilst from 2008-2009 sales growth is reduced by roughly 8 percentage points. Even though the sales growth rate is only negative in 2009, the sudden drop clearly represents the effects of a recession. The sudden spike in 2010 and 2011 is likely caused by the economic recovery and the fact that sales growth rate is calculated on the previous year basis.

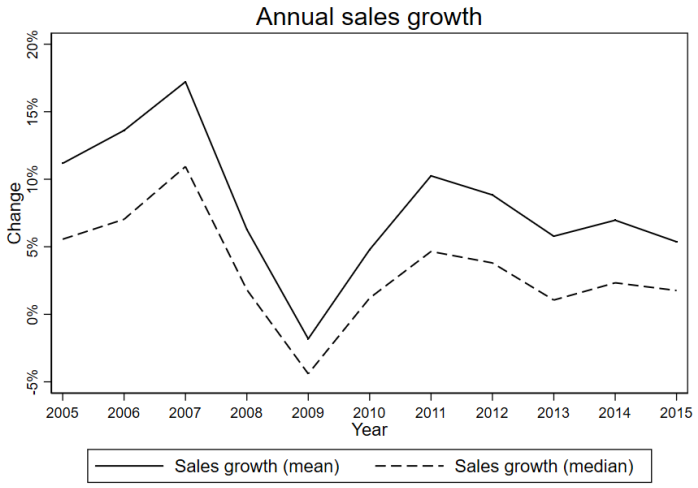

Figure 4.4: Average and median sales growth from 2005-2015

Finally, we also include the development for firm average cash holdings. According to figure 4.5, this trend seems to be steadily increasing throughout the entire period. This is in line with recent developments; as noted in a report by Sánchez and Yurdagul (2013), firms have been consistently hoarding more cash since the 1990s. Even though this report is based on firms in the US, we do not see any reason why average cash holdings for Norwegian firms may have developed differently.

Another interesting aspect that is visible here is that the increasing trend during the pre-recession phase stagnates during the financial crisis. The most logical explanation to this is that firms had to spend parts of their "war chests" or reduce cash accumulation in order to survive the recession. Another explanation though, may be that firms were faced with increased investment opportunities and exploited these. If this was the case however, we would expect to see a corresponding increase in firm profitability post-recession. As shown in figure 4.1 firm profitability averages increase slightly, but it is impossible to casually connect these observations by inspecting graphs.

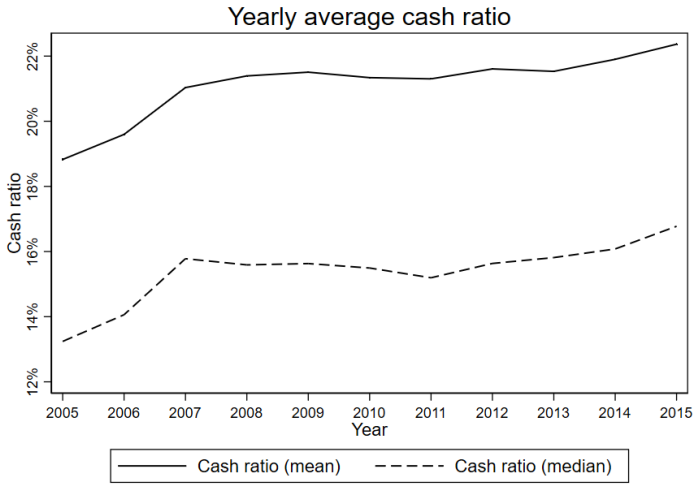

Figure 4.5: Average cash ratio for entire sample from 2005-2015

4.1.2 Industry statistics

We now move on to the descriptive statistics for our industry sub-samples. First, we present statistics for the different industry groups of knowledge intensity. Secondly, we present similar statistics for the wholesale industry and the manufacturing industry to highlight differences between labor intensive and capital intensive industries.

4.1.2.1 Knowledge intensive industries

We also differentiate between the different knowledge intensity groups when looking at firm profitability from 2005-2015. Figure 4.6 shows the average ROA for all four KI groups. At first glance it becomes clear that all four groups have fairly equal trend patterns, despite obvious level differences. KI group 1 seems to have the greatest average return variation across the time period, whilst firms in group 2 and 4 experienced less variation. Interestingly, there also looks to be an evident pattern that firms with high knowledge intensity outperform firms with lower knowledge intensity.

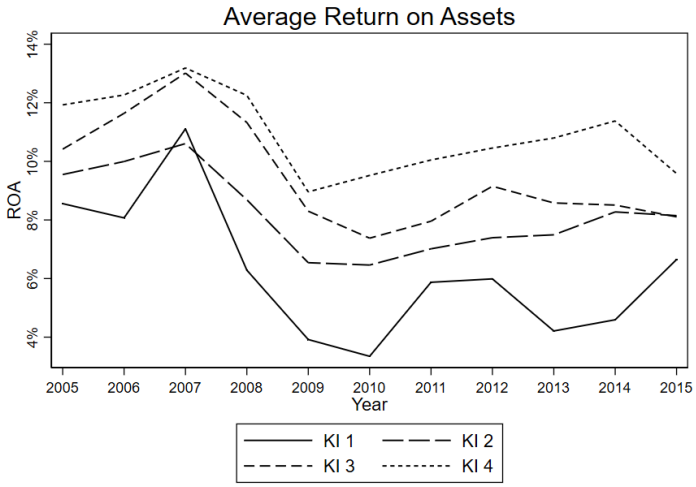

Figure 4.6: Average ROA for each KI group from 2005-2015

Figure 4.7 shows the average Altman's Z scores for each knowledge intensity group. Unlike firm performance, the interpretation of the relationship between knowledge intensity and Z-scores is more ambiguous. We see that group 1 and 4 are trending fairly closely throughout the 10 years. Group 1 however, experiences a much more significant decline in average Z-scores during the recession. This decline is also easily identifiable for group 2 and 3, but significantly smaller for group 4. In fact, the expected decline in Z-scores due to the recession is hardly noticeable for group 4. The interaction effect between group 4 and recession is specifically tested in our regression models, but the initial conclusion here is that firms in industries with very high knowledge intensity were less affected by the financial crisis in 2008/2009. This supports the average firm performance development of group 4 in figure 4.6. The overall conclusion is that the firms with the highest and lowest knowledge intensity are more prone to bankruptcy than firms which operate in industries with moderate levels of knowledge intensity.

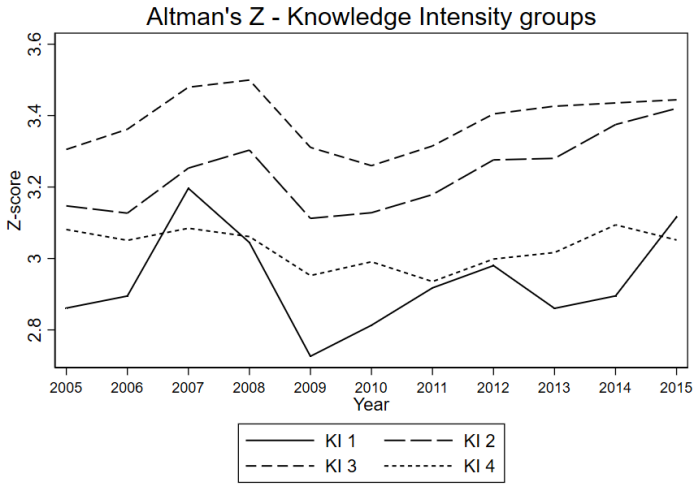

Figure 4.7: Average Altman's Z scores for each KI group from 2005-2015

The last descriptive statistic we provide here shows the average cash holdings for firms in each knowledge intensity group (figure 4.8). We see very little trend variation for all groups prior to, during and after the recession. It is however noteworthy that firms in group 4 on average has a cash ratio almost 10 percentage points higher than all the other three groups. An argument that may partially explain this is that firms in high knowledge intensity industries might be exposed to a greater need of internal financing due to high risk investments where less collateral value is available.

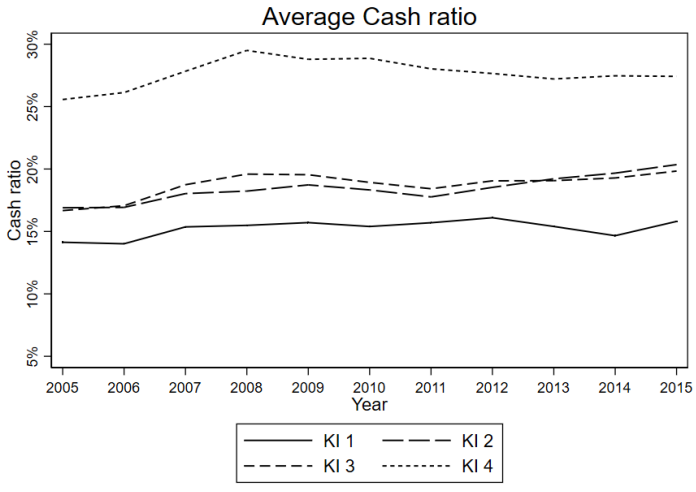

Figure 4.8: Average cash ratio for Knowledge Intensity groups from 2005-2015

4.1.2.2 Capital vs labour intensive industries

Referring to hypothesis 7), we investigate the relationship between cash and firm performance for specific industries. The purpose is to see whether the hypothesized effect differs between labor intensive and capital intensive industries. As proxies for these industry characteristics we choose to focus on the wholesale industry and the manufacturing industry. We stress that these industries are grouped at the 2-digit level according to the SSB NACE code standards[1] and that there might be significant within-industry firm variation. Below we provide descriptive statistics for firm performance and Altman's Z for both industries.

Figure 4.9 below shows the average return on assets for both industries throughout the 10-year period. Wholesale is the more profitable industry on average, continuously outperforming the manufacturing industry by roughly 2 percentage points. We note that this discrepancy is slightly larger just after the recession. A potential cause of this could be that the manufacturing industry is less responsive than the more consumer-oriented wholesale industry, hence the recovery after the financial crisis was slower.

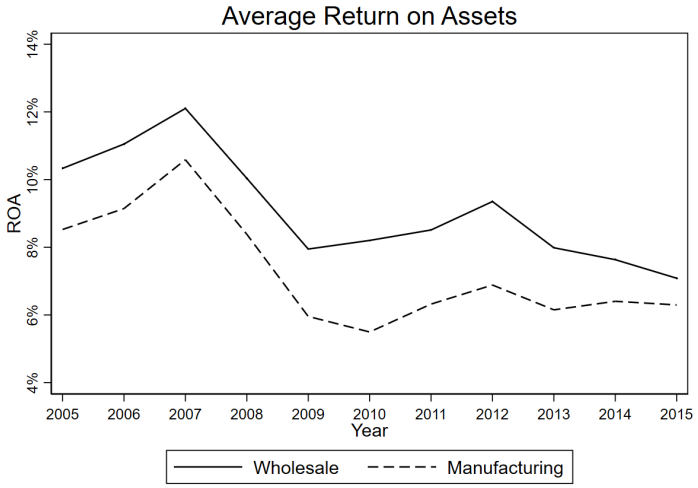

Figure 4.9: Average return on assets from 2005-2015 for selected industries

The other descriptive statistic we believe is important to investigate when looking at industries is the Altman Z-score illustrated in figure 4.10. The graph shows a massive difference in the average Z-scores; whilst the wholesale industry remains above 3.6 the entire period, the manufacturing industry fluctuates between 2.8-3. Whilst a Z-score of 3 is in the upper echelon of the gray area with regards to bankruptcy likelihood, a Z-score of 3.6 is well clear of bankruptcy. This

[1] See https://www.ssb.no/klass/klassifikasjoner/6

indicates that firms within the wholesale industry are much less likely to go bankrupt than firms in the manufacturing industry.

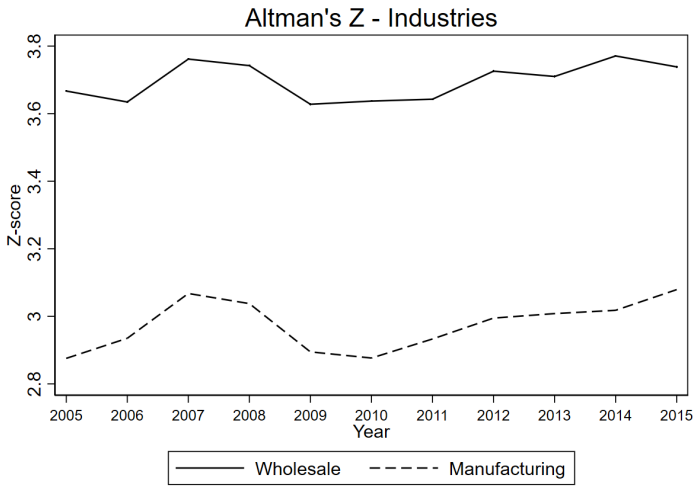

Figure 4.10: Average Z-scores from 2005-2015 for selected industries

We also include average cash ratios throughout the period for both of our selected industries. Figure 4.11 shows that even though the average cash ratio difference between the wholesale industry and the manufacturing industry is fairly low (1-2%), the wholesale industry has consistently higher average cash holdings. It does not seem to be any evident effect of the financial crisis with regards to cash holdings for these two industries. There is a slight decrease in average cash ratio for the manufacturing industry in 2008, but similar observations can be made post-recession. Therefore, we cannot contribute this cash reduction to the recession specifically.

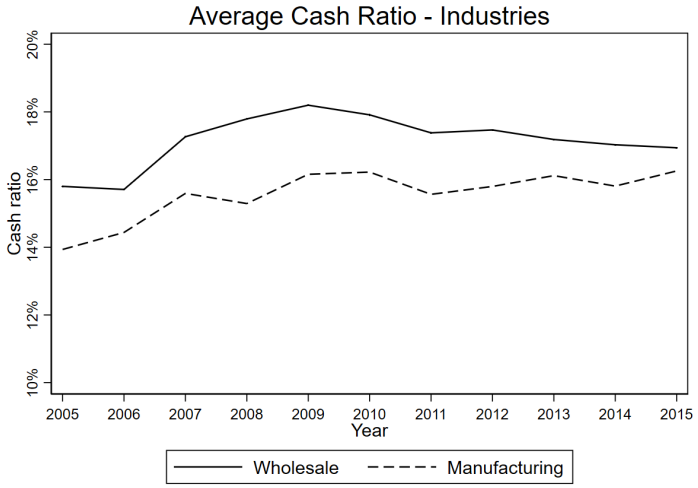

Figure 4.11: Average cash ratios from 2005-2015 for the wholesale and manufacturing industry

4.2 Results of analysis

In this section we provide the results of our regression models in order to lay the foundation for the discussion in chapter 5. We interpret relevant factors from the regression outputs, in addition to highlighting discrepancies from Nason and Patel (2016) and our own hypotheses.

The structure of the analysis results section will be as follows; first, we will present the replicated model from Nason and Patel (2016), before we include the results of the expanded model. After this, we turn our focus to the industry specific research. Here, we firstly look at different groups of knowledge intensity. Secondly, we examine the wholesale and manufacturing industry as proxies of labor intensive and capital intensive industries.

4.2.1 Generalized effect of cash on firm performance

Replicated regression model

The first and most important step in our research is to look at how cash affects firm performance for Norwegian firms. As previously discussed, we initially use the model by Nason and Patel (2016) to test for this. The results from the replica of the regression model is shown in table 4.1. We do not report regression results using EBITDA margin as the dependent variable since the results are highly consistent with ROA.

The first column in the regression table represents the results from solely applying the control variables to the regression model. The purpose of including only the control variables first, is to examine how much the model improves when subsequently adding the explanatory variables. As we can see, the control variables alone account for 13.8 % of all variation in ROA. Additionally, the coefficient signs are all as expected (see section 3.3.4).

When moving to the initial regression model (model 2), we switch from simple OLS regression to 2SLS using industry cash ratio as an instrument of firm cash ratio. Introducing cash ratio as an explanatory variable increases the explanatory power of the model from 13.8 % to 18.3 %. Further, the coefficient is rather large; since the model functionality form is linear (lin-lin), a one-unit increase in cash ratio will lead to a corresponding unit change in ROA determined by the variable coefficient. In this case, increasing cash ratio by one percent leads to an increase in ROA of 0.169 %.

Table 4.1: Base model

	OLS	2SLS			
	(1)	(2)	(3)	(4)	(5)
	ROA	ROA	ROA	ROA	ROA
Focus Variables					
Cash ratio		0.169***	0.217***	0.164***	0.206***
		(0.003)	(0.009)	(0.003)	(0.009)
Cash^2			-0.075***		-0.066***
			(0.011)		(0.012)
Recession				-0.007***	-0.009***
				(0.001)	(0.001)
Recession*Cash hat				0.026***	0.052***
				(0.004)	(0.012)
Recession*Cash hat^2					-0.042**
					(0.019)
Control variables					
Slack	-0.058***	-0.060***	-0.060***	-0.060***	-0.060***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Debt ratio	-0.108***	-0.081***	-0.080***	-0.081***	-0.080***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
C. Intensity	0.002***	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Altman's Z	0.019***	0.015***	0.015***	0.015***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size	-0.007***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.189***	0.095***	0.088***	0.096***	0.090***
	(0.010)	(0.007)	(0.006)	(0.007)	(0.006)
Industry effects	Yes	Yes	Yes	Yes	Yes
R^2	0.138	0.183	0.184	0.183	0.184
Observations	204283	204283	204283	204283	204283

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In model 3, the squared term of cash ratio is included to account for potential non-linear relationships between cash and ROA. We see that the coefficient for cash ratio squared is negative and highly significant, which gives support to hypothesis H1 of a curvilinear relationship. The positive linear term and the negative quadratic term dictates that this relationship is concave. With regards to the changes in the explanatory power, the increase is only 0.1 percentage points. In order to test whether this change is significant, we apply the *nestreg* command in STATA. The result of this test gives the inclusion of the quadratic term an F-value of 121.25, which clearly indicates that the increase in R^2 is significant.

Model 4 shows the regression results after the recession dummy and the linear interaction term have been included. The recession dummy represents the years 2008 and 2009 and indicates a -0.007% percentage point lower ROA. The interpretation of the interaction term is that for the years 2008 and 2009, the effect of cash is increased by 0.026% percentage points from 0.164% to 0.19%. We also see that the explanatory power is reduced 0.1% percentage points due to not including the quadratic term in this model.

The final regression model includes the interaction term between the squared cash ratio and the recession dummy. This variable capture whether the curvilinear relationship of cash is different in a recessionary environment compared to a non-recessionary environment. We find a coefficient of -0.042 which indicates that the effect of cash is more sensitive in recessions and diminishes at a higher rate. Again, we test for changes in explanatory power; including the recession dummy and the two cash interactions together have a significant impact on R^2 (F-value of 18.84), though this effect is too small to change the output with three decimal places. The focus variables cash ratio and the squared term of cash ratio are both highly significant and have positive and negative signs respectively. On this basis, we accept H1 that there is a curvilinear relationship between cash and firm performance with a positive linear term and a negative quadratic term. We note that we will test this hypothesis again after expanding the regression model.

Expanded regression model

In order to improve the initial model from Nason and Patel (2016), we introduce additional independent variables that we believe can contribute to explaining variation in ROA. The regression output is shown in table 4.2. The first column is the same as column 4 in table 4.1 and is included solely as a reference.

Table 4.2: Expanded regression model

	(1)	(2)	(3)	(4)
	Model 1	Model 2	Model 3	Model 4
Focus Variables				
Cash ratio	0.206***	0.103***	0.103***	0.093***
	(0.009)	(0.007)	(0.007)	(0.007)
$Cash^2$	-0.066***	-0.025***	-0.025***	-0.015
	(0.012)	(0.009)	(0.009)	(0.009)
Recession	-0.009***	-0.015***	-0.015***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Recession*Cash hat	0.052***	0.021**	0.021**	0.019**
	(0.012)	(0.010)	(0.010)	(0.010)
Recession*$Cash\ hat^2$	-0.042**	-0.014	-0.014	-0.015
	(0.019)	(0.015)	(0.015)	(0.015)
Added variables				
L.ROA		0.517***	0.517***	0.525***
		(0.005)	(0.005)	(0.005)
Market share			0.073***	0.090***
			(0.011)	(0.012)
Annual sales growth				0.056***
				(0.002)
Control variables				
Slack	-0.060***	-0.043***	-0.044***	-0.038***
	(0.003)	(0.003)	(0.003)	(0.002)
Debt ratio	-0.080***	-0.048***	-0.048***	-0.055***
	(0.002)	(0.002)	(0.002)	(0.002)
C. Intensity	0.004***	0.002***	0.002***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Altman's Z	0.015***	0.011***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Size	-0.002***	0.000	-0.000	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.090***	0.022***	0.027***	0.054***
	(0.006)	(0.005)	(0.005)	(0.005)
Industry effects	Yes	Yes	Yes	Yes
R^2	0.184	0.403	0.403	0.422
Observations	204283	196628	196628	196628

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The first variable we add is the lagged variable of ROA as shown in model 2. The immediate effect is a significant increase in explanatory power from 18.4 % to 40.3 %, indicating that ROA last period indeed is an important factor to explaining ROA at a given time. Further, we see that a one percent increase in ROA in period t-1 will lead to a 0.5 percentage point increase in ROA in period t. We also tested with increased lags, as mentioned in chapter 3, but as expected this effect drops off rather quickly.

The next variable we include is market share. The coefficient indicates a positive relationship to ROA, though the increase in explanatory power is not shown at the three-decimal level. Further testing shows that market share represents a statistically significant increase in R^2 of 0.01 percentage points.

The last variable we include is annual sales growth. Annual sales growth is also highly significant and has a positive impact on ROA. Including this variable increases the explanatory power of the entire model by 1.98 percentage points.

After adding all three variables to our regression model we see that the values of the focus variables have changed. All the cash variables and their interactions have either been significantly reduced or lost significance. This gives reason to believe that they were biased in the initial model given that all our added variables are correct. The linear effect of cash has dropped by roughly half, from 0.206 to 0.093. A similar, albeit more pronounced effect, can be found in the linear interaction term between cash and recession. An overwhelming majority of the changes in variable coefficients, both for focus and control variables, are due to correcting for firm profitability in the previous year. The curvilinear relationship that was present in the replicated model (table 4.1) is no longer statistically valid at the 10% level. However, after closer inspection of the quadratic term (cash ratio squared), we find a t-statistic of -1.64 and a corresponding p-value of 0.101. Since the significance stars have a cut-off at 10%, the output consequently presents the focus variable as not statistically significant. Since the focus variable is only 0.1 percentage points away from being labeled with a significance star, it seems reasonable to not completely disregard the nonlinear effect of cash on performance in the expanded model. Hence, we partly accept H1 that the relationship between cash and firm performance is curvilinear, with a positive linear term and a negative quadratic term. On the other hand, we reject the part of the hypothesis that claims a pronounced curvilinear relationship, and conclude that this relationship is instead weakly curvilinear.

Expanded model with time periods

Since the partial rejection of H1 above occurred when examining the entire time period as a whole, we now wish to see if this relationship is different for each time period. Therefore, the focus is now on understand how ROA and the explanatory variables vary depending on the three different time periods we have specified. Below we display the regression results of the expanded model for the time periods pre-recession (2005-2007), recession (2008-2009) and post-recession (2010-2015). The different periods are now investigated separately of each other and should highlight fundamental differences between the underlying characteristics of each period.

In order to add to the intuition provided by Nason and Patel (2016), we examine the expanded model for each of the three time periods. The results are shown in table 4.3. The first thing we note is that the explanatory power for all three time periods are fairly similar and within a 0.7 percentage point interval. That being said, these differences are highly significant despite low absolute values due to the sample size. Additionally, all the variables we added to improve the model are highly significant in each period. This supports their application regardless of the size of the coefficients. Still, the lagged term of ROA might introduce some issues with regards to its interpretation. Since the recession only lasted 2 years, only one lagged recessionary period is included. The same problem arises for the post-recession period as the lagged value from 2009 disappears. Though this might cause the lagged variable in table 4.3 to be slightly incorrect, we do not believe this problem causes any crucial issue in our model.

Recalling H2, we hypothesized that cash has a more pronounced curvilinear relationship to firm performance during recessions than pre- and post-recessions, with a positive linear term and a negative quadratic term. It is clear that the first part of this hypothesis does not hold; the curvilinear relationship is most pronounced during the pre-recession period since the value of the quadratic term is lower in the recession. Still, we see consistency in both cash ratio and the squared term of cash ratio, with a positive and negative sign respectively. Therefore, we partially reject H2 and conclude that the curvilinear relationship is not the most pronounced during recessions, but the positive linear term and the negative quadratic term remains. During the post-recession period the quadratic term becomes highly insignificant (t-value of 0.07). This implies that the relationship between cash and firm performance is no longer curvilinear and instead the effect of cash is linear. In theory, this entails that more cash is better and that firms ideally should have as much cash as possible.

Table 4.3: Expanded model - Time periods

	(1)	(2)	(3)
	Pre-recession	Recession	Post-recession
Focus Variables			
Cash ratio	0.120***	0.115***	0.085***
	(0.009)	(0.011)	(0.010)
Cash^2	-0.057***	-0.026*	0.001
	(0.014)	(0.015)	(0.012)
Added variables			
L.ROA	0.506***	0.510***	0.528***
	(0.008)	(0.012)	(0.007)
Market share	0.090***	0.052**	0.096***
	(0.022)	(0.026)	(0.016)
Annual sales growth	0.044***	0.063***	0.057***
	(0.003)	(0.005)	(0.003)
Control variables			
Slack	-0.034***	-0.047***	-0.035***
	(0.003)	(0.006)	(0.003)
Debt ratio	-0.078***	-0.067***	-0.052***
	(0.004)	(0.005)	(0.002)
C. Intensity	-0.000	0.002	0.001
	(0.001)	(0.002)	(0.001)
Altman's Z	0.011***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)
Size	-0.004***	-0.000	-0.002***
	(0.001)	(0.001)	(0.000)
Constant	0.096***	0.036***	0.045***
	(0.008)	(0.011)	(0.007)
Industry effects	Yes	Yes	Yes
Observations	44449	35673	116506
R^2	0.424	0.428	0.421

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 4.12 shows the marginal effects of cash for all three time periods. The margins have been calculated by adding cash ratios at an incremental of 0.1 from 0-1, whilst the coefficients for all other variables (in table 4.3) have been multiplied with the corresponding mean value for each period. We see that the curvilinear relationship is, as mentioned above, most pronounced for the pre-recession period and shows an inverse U-shaped curve. The margins in the recession are also diminishing, but at a much slower rate than pre-recession. This is the exact opposite of what Nason and Patel (2016) and Kim and Bettis (2014) find. For cash ratios < 0.3, firms benefit more from an additional unit of cash during the pre-recession period compared to the other two periods since the slope of the line is steeper. The post-recession curve is as close to perfectly linear as possible since the quadratic term is more or less equal to zero.

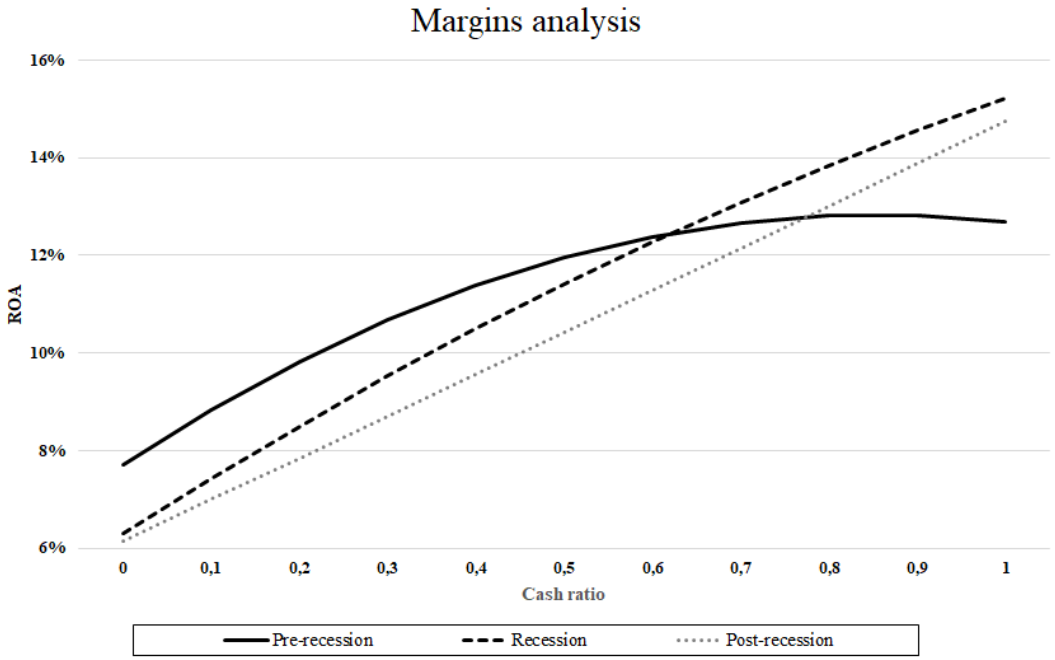

Figure 4.12: Margins analysis of the three time periods. The graph was generated by adding cash ratio levels from 0-1 whilst holding all other significant variables at mean levels for the corresponding time period.

4.2.2 Industry research

After expanding the replicated model from the study conducted by Nason and Patel (2016), we turn to researching differences within certain industries. We first divide our sample into different knowledge intensity groups based on the categorization by Bergmann and N. Betten (2016). Secondly, we select a labor intensive industry and a capital intensive industry to examine

whether differences arise for different types of industries.

4.2.2.1 Knowledge intensity

In order to answer the hypothesis on whether cash has a bigger effect on firm performance for knowledge intensive industries than for less knowledge intensive industries, we look at regression estimates for the four groups of knowledge intensity. First, we look at cash holdings for the different knowledge intensity groups. Then, we study the effects of knowledge intensity for all years by conducting one regression for each group. Finally, we compare the effect of cash on firm performance for industries within KI2 (medium low knowledge intensity) and KI4 (high knowledge intensity) over the three periods pre-recession, recession and post-recession.

Cash holdings

Our first hypothesis relating to knowledge intensity specific industries was H3; firms with higher cash shares compete in more innovative industries. As stated before, we use industry knowledge intensity as a proxy to degree of industry innovation. This hypothesis is not answered using a regression, instead we refer to figure 4.8 which shows annual average cash holdings for each KI group. As mentioned, the average cash holdings for firms in KI4 is significantly higher compared to the other knowledge intensity groups. On the basis of these descriptive statistics, we accept hypothesis 3.

Cash and firm performance

The regression models for the four different knowledge intensity groups are shown in table 4.4. The linear effect of cash ratio on ROA is highly statistically significant for all KI groups, but the effect does not increase proportionally with each Knowledge Intensity group. However, by comparing the group with lowest degree of knowledge intensity (KI1) with the group with highest intensity (KI4), we see an increase in the cash ratio coefficient from 0.081 to 0.103. For KI4 this means that a one percent increase in cash ratio will lead to an increase in ROA of 0.104 percentage points. Furthermore, the only KI group with a significant quadratic relationship between cash ratio and ROA is KI2, indicating that for the most part, there is a linear relationship between cash and firm performance across KI groups. The results also indicate that less knowledge intensive industries are hit harder by recessions than more knowledge intensive industries; for KI1, ROA declines by 0.017 percentage points in the face of recession while ROA for KI1 declines by 0.012 percentage points. Regarding the interaction effects between cash

and recessions, these are only statistically significant for KI3, with a positive linear term and a negative quadratic term. This entails that whilst the effect of cash is linear over the entire time period, the relationship becomes curvilinear during recessions. With regards to the explanatory power of the different models, R^2 is as high as 50% for KI1, but only 34.6% for KI2. KI3 and KI4 hover in between at 40.1% and 45.2% respectively.

The hypothesis that cash has a bigger impact on firm performance for firms with high knowledge intensity initially seems to hold based on our regression results. In the first regression model presented in table 4.4, we see that cash in KI1 has the smallest effect on ROA, and that it increases for the other knowledge intensity groups. However, we would expect to find the largest effect for KI4, but the coefficient of KI2 is in fact the highest. Due to the fact that KI1 consists of few observations (which potentially could amount to less than 400 firms), we exclude KI1 from our group of interest. Instead we turn our attention to KI2 which contains many more observations and still represent firms with relatively low knowledge intensity. Since the cash ratio coefficient is higher for KI2 than KI4, despite a significant quadratic term, we now reject H4.

Knowledge intensity and cash in recessions

According to hypothesis 5 we expect cash to have a greater effect on firm performance in recessions for firms with low knowledge intensity compared to firms with high knowledge intensity. Table 4.5 which shows the expanded regression model for KI2 and KI4 across the three time periods.

To answer the hypothesis we focus on column 2 and 5 in the regression table. We see that the linear cash variable is highly significant for KI2 and KI4, but the size of the coefficient is substantially higher for KI2. For KI2, an increase in cash ratio of one percent will linearly increase ROA by 0.181 percentage points. For KI4, a similar increase will increase ROA by 0.104 percentage points. Interpreted in isolation, this gives support to our hypothesis. The main difference between the two groups with regards to the effect of cash however, stems from the quadratic cash variable. We see that for KI2, there is a quite pronounced curvilinear relationship between cash and firm performance. For the high knowledge intensity group, this relationship is more or less linear due to a low and highly insignificant quadratic term. The corresponding margin curves are displayed in figure 4.13 in order to compare the cash effect for both knowledge intensity groups.

Table 4.4: Knowledge Intensity

	(1) KI1	(2) KI2	(3) KI3	(4) KI4
Focus Variables				
Cash ratio	0.081***	0.145***	0.101***	0.103***
	(0.025)	(0.018)	(0.013)	(0.018)
Cash^2	-0.024	-0.093***	0.001	-0.015
	(0.040)	(0.029)	(0.017)	(0.022)
Recession	-0.017**	-0.005*	-0.011***	-0.012**
	(0.007)	(0.003)	(0.002)	(0.005)
Recession*Cash hat	0.013	-0.011	0.059***	0.013
	(0.057)	(0.027)	(0.018)	(0.030)
Recession*Cash hat^2	-0.011	0.042	-0.059**	-0.004
	(0.093)	(0.048)	(0.029)	(0.039)
Added variables				
L.ROA	0.437***	0.311***	0.460***	0.471***
	(0.028)	(0.010)	(0.008)	(0.012)
Market share	0.032	0.132***	0.175***	0.162***
	(0.023)	(0.025)	(0.041)	(0.030)
Annual sales growth	0.069***	0.052***	0.057***	0.044***
	(0.014)	(0.004)	(0.004)	(0.005)
Control variables				
Slack	-0.090***	-0.047***	-0.053***	-0.058***
	(0.014)	(0.008)	(0.007)	(0.007)
Debt ratio	-0.006	-0.076***	-0.036***	0.008
	(0.011)	(0.005)	(0.004)	(0.006)
C. Intensity	0.031*	0.005**	0.001	0.005***
	(0.017)	(0.002)	(0.001)	(0.001)
Altman's Z	0.028***	0.023***	0.015***	0.026***
	(0.002)	(0.001)	(0.003)	(0.003)
Size	-0.001	0.002**	-0.004***	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.508	0.346	0.401	0.452
Observations	3589	31499	66880	23364

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.5: Knowledge Intensity - Time periods

	KI2			KI4		
	(1)	(2)	(3)	(4)	(5)	(6)
	Pre-recession	Recession	Post-recession	Pre-recession	Recession	Post-recession
Focus Variables						
Cash ratio	0.086***	0.181***	0.131***	0.137***	0.104***	0.085***
	(0.029)	(0.037)	(0.021)	(0.035)	(0.033)	(0.021)
$Cash^2$	0.003	-0.123**	-0.063*	-0.069	0.007	0.006
	(0.047)	(0.056)	(0.033)	(0.045)	(0.039)	(0.024)
Added variables						
L.ROA	0.358***	0.260***	0.293***	0.499***	0.428***	0.464***
	(0.018)	(0.019)	(0.013)	(0.022)	(0.026)	(0.013)
Market share	0.149***	0.118**	0.110***	0.169***	0.080	0.195***
	(0.034)	(0.055)	(0.038)	(0.051)	(0.062)	(0.041)
Annual sales growth	0.050***	0.052***	0.050***	0.032***	0.051***	0.045***
	(0.008)	(0.008)	(0.005)	(0.006)	(0.013)	(0.007)
Control variables						
Slack	-0.049***	-0.086***	-0.034***	-0.052***	-0.058***	-0.057***
	(0.008)	(0.011)	(0.010)	(0.011)	(0.012)	(0.009)
Debt ratio	-0.098***	-0.090***	-0.077***	0.000	0.021	0.012
	(0.009)	(0.012)	(0.006)	(0.012)	(0.013)	(0.007)
C. Intensity	0.005**	0.007	0.004	0.002	0.002	0.008***
	(0.002)	(0.010)	(0.003)	(0.002)	(0.002)	(0.002)
Altman's Z	0.022***	0.024***	0.023***	0.017***	0.029***	0.032***
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)
Size	-0.002*	0.003*	0.003***	-0.005***	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Constant	0.085***	0.015	-0.015	0.056*	-0.062*	-0.033
	(0.017)	(0.022)	(0.018)	(0.031)	(0.032)	(0.021)
R^2	0.401	0.371	0.325	0.439	0.459	0.461
Observations	7491	5721	18287	4988	4275	14101

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We see that the marginal cash effect on firm performance is higher for KI2 up to a cash ratio of 0.4. After that, the marginal effect diminishes and in fact starts to decrease for cash ratios greater than 0.7. We also note that the explanatory power is considerably higher in recession for KI4. Based on the regression output and the margin analysis plot above, we confirm hypothesis 5 that cash has a greater effect on firm performance for firms with lower knowledge intensity for cash ratios up to 0.4. However, for cash ratios above 0.4, we reject the hypothesis.

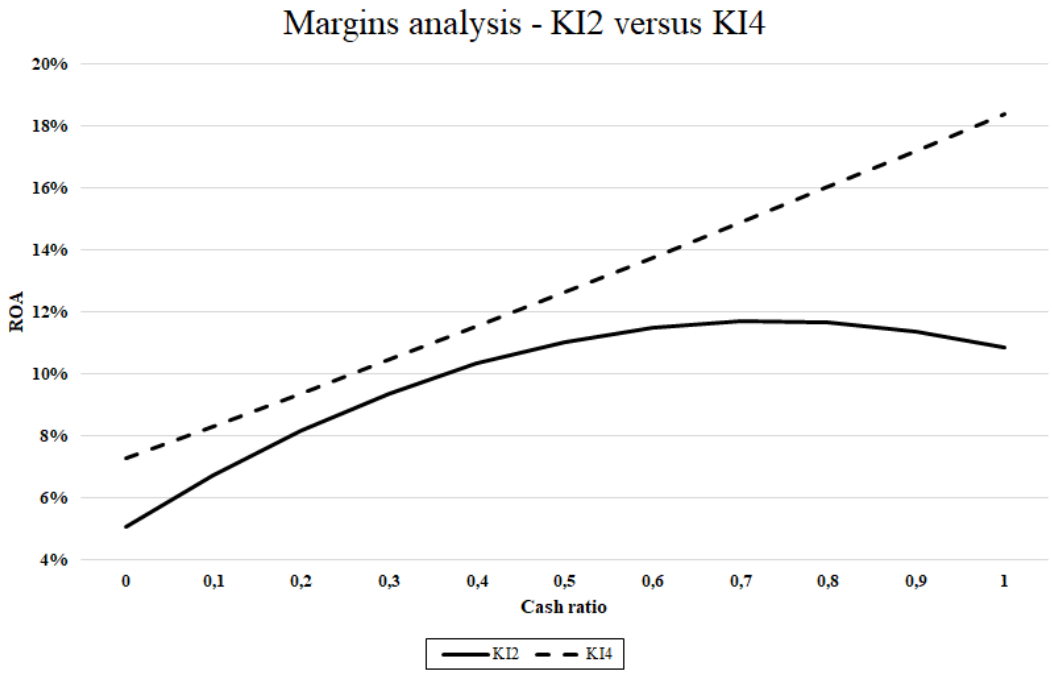

Figure 4.13: Margins analysis of the recession period for Knowledge Intensity group 2 & 4. The graph was generated by adding cash ratio levels from 0-1 whilst holding all other variables at mean levels for the corresponding time period.

Cash variation

Table 4.5 shows KI2 and KI4 over the three time periods pre-recession, recession and post-recession. The coefficient for the linear term of cash ratio is highly significant for both groups in all time periods. We see that for KI2 the cash ratio variable spikes (from 0.086 to 0.181) in the recession period compared to pre-recession. In the post-recession period, cash ratio drops rather significantly to 0.131. For KI4 however, we see a steady decrease in variable size from each time period to the next. In order to answer the hypothesis however, we also have to take the quadratic terms into account. Due to the inclusion of the quadratic terms, our conclusion is dependent on cash level. For example, if applying a cash ratio of 1, the total cash effect on firm

performance for KI2 would equal 0.089, 0.058 and 0.068 for each time period respectively. This entails that the effect of cash for KI2 varies considerably based on cash ratio due to the quadratic variables. As a result, we examine average cash levels for KI2 and KI4 in each time period. The average cash holdings across all time periods are 0.18 and 0.28 respectively. Therefore, we meet in the middle and use 0.23 as a representative cash ratio in each period to examine variation of cash.

The results show that the variation is greater for KI2 than KI4. Holding cash ratio at 23%, our results show that the isolated effect of cash on firm performance for KI2 is 1.99%, 3.51% and 2.68% in each time period. For KI4, the same results are 2.79%, 2.43% and 1.99%. The inter-period variation is therefore 1.52 and -0.83 percentage points for KI2 and -0.36 and -0.44 percentage points for KI4. On this basis, we accept H6 that the effect of cash on firm performance varies less for firms with high knowledge intensity.

4.2.2.2 Capital and labor intensive industries

In order to better understand how cash affects firm performance in different industries we select two of the most prominent industries to research further: wholesale and manufacturing. These industries have been categorized as labor intensive and capital intensive industries respectively. Table 4.6 shows the regression results using the expanded model. When testing hypothesis 7 that cash is more important for firm performance in capital intensive industries than in labor intensive industries, we do not regress separate time periods for each industry, but instead focus on the entire time period as a whole. The purpose behind this is that we believe the three time periods to an extent might cancel each other out, so that when viewed as a whole, the 10-year economic growth might be close to the actual GDP trend (see figure 2.1). The recession terms are not excluded even though we are looking at the whole 10-year period, but we see that they do not impact the dependent variable notably anyhow. As mentioned earlier, these industries are based on the 2-digit NACE codes. Therefore, we cannot assume a non-significant impact of within-industry variation.

Our first observation is that both the linear and the quadratic terms for cash are significant. Further, firm performance in both industries are weakly and negatively affected by the recession. The cash interaction terms are insignificant, indicating that the curvilinear relationship is not significantly different during recessions. For the models as a whole there is high consistency in

variable signs, except for the market share variable. Particularly interesting is the very high negative coefficient for the wholesale industry. The potential causes of this will be discussed further in chapter 5. With regards to the explanatory power, the regression models explain respectively 45.3 % and 43.2 % of total variation.

Below, we also show the margins analysis for both the wholesale and the manufacturing industry. We note that the margins analysis has been conducted for the entire time period, and not for each time period as previously done. The marginal development for both the wholesale and manufacturing industry is increasing with cash ratio, but the effect of additional cash is diminishing. We see that cash affects ROA the most for wholesale and also that the marginal benefit of increasing cash ratio is higher for wholesale than for manufacturing. This finding is consistent with the regression output, indicating that cash has a greater effect on firm performance in wholesale than in manufacturing. On this basis we reject H7 and conclude that cash has a bigger impact on firm performance for labor intensive industries.

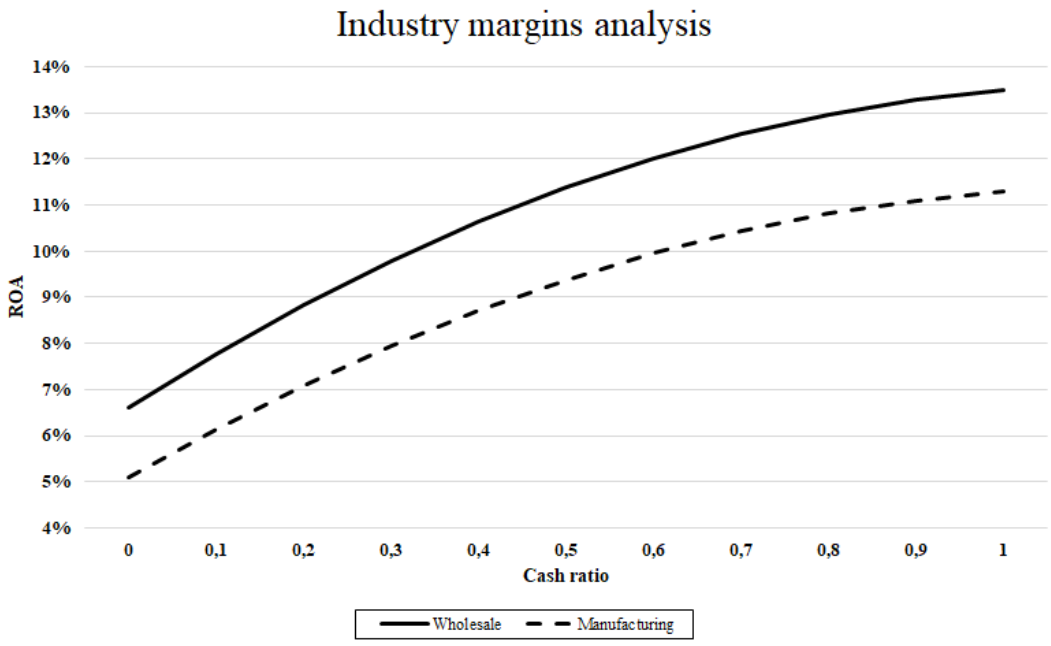

Figure 4.14: Margins analysis for the wholesale and manufacturing industry. The graph was generated by adding cash ratio levels from 0-1 whilst holding all other significant variables at mean levels for the corresponding time period.

Table 4.6: Industry regression

	Labor Intensive	Capital Intensive
	(1)	(2)
	Wholesale	Manufacturing
Focus Variables		
Cash ratio	0.122***	0.109***
	(0.015)	(0.014)
Cash^2	-0.053**	-0.047*
	(0.021)	(0.025)
Recession	-0.008***	-0.006**
	(0.003)	(0.003)
Recession*Cash hat	0.003	-0.005
	(0.023)	(0.026)
Recession*Cash hat^2	0.015	0.056
	(0.037)	(0.048)
Added variables		
L.ROA	0.561***	0.424***
	(0.012)	(0.009)
Market share	-0.665***	0.095***
	(0.238)	(0.017)
Annual sales growth	0.065***	0.060***
	(0.008)	(0.005)
Control variables		
Slack	-0.054***	-0.058***
	(0.011)	(0.009)
Debt ratio	-0.036***	-0.025***
	(0.006)	(0.004)
C. Intensity	0.003	0.002
	(0.003)	(0.002)
Altman's Z	0.009***	0.024***
	(0.003)	(0.001)
Size	-0.001	0.001*
	(0.001)	(0.001)
Constant	0.029**	-0.024*
	(0.014)	(0.013)
R^2	0.453	0.432
Observations	29107	32799

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.3 Summary of analysis results

In our regression analysis we first examined the relationship between cash and firm performance from 2005-2015, in order to analyze the effect of cash in times of neutral economic growth. Using the model from Nason and Patel (2016), our results show that there is a strong, curvilinear relationship between cash and firm performance with a positive linear term and a negative quadratic term. Additionally, the recession and cash ratio interaction terms show that this effect is stronger in recessions. The initial conclusion is therefore that H1 holds. However, after expanding the model with three additional independent variables, the curvilinear relationship is no longer statistically significant, though the positive linear term remains. We therefore partly accept H1 as the curvilinear relationship is no longer pronounced, but instead weakly diminishing.

After this, we divided the sample into three separate time periods in order to study how the effect of cash varied throughout the pre-recession, recession and post-recession period. Cash was still positively correlated with firm performance, but the curvilinear relationship only showed statistical significance during the pre-recession and recession time periods. On this basis we reject H2 and conclude that the curvilinear relationship in fact is more pronounced during pre-recession and non-existing post-recession. With regards to H3, we used the descriptive statistics to confirm this hypothesis. Since we assume knowledge intensity to be an approximation of innovation, it becomes clear that highly innovative firms indeed hold relatively more cash than less innovative firms.

Using the expanded model to also decompose our analysis on industries, we first tested the effect of cash on ROA for knowledge intensive industries. After regressing all the KI groups across time periods as well as comparing the focus variables for each group we find no evidence to support hypothesis 4.

Next, we looked further at how cash affects firm performance for KI group 2 and 4. We found that the focus variables were quite different; the linear term for KI2 was significantly higher than KI4, but the quadratic value for KI2 was also quite large whilst the corresponding value for KI4 was close to zero. Hence, there was a pronounced curvilinear relationship between cash and firm performance for KI2 and a more or less linear relationship for KI4. After studying the margins analysis, we rejected H5 for cash ratios < 0.4 and accept the hypothesis for cash ratios > 0.4.

The final hypothesis related to the different knowledge intensity groups looked at the variation of the effect of cash between the three time periods for KI2 and KI4. Since the total variation is affected by the given value of cash ratio due to the quadratic term, we used the average (23%) of KI2 and KI4 average cash holdings as representative cash ratio. Based on a cash ratio of 23%, we concluded the effect of cash varied less across time for KI4 and we accepted hypothesis 6.

The last hypothesis was directed at how cash affects firm performance in capital and labor intensive industries. We expected cash to have a greater impact on capital intensive industries based on theory put forward in chapter 2. We find that firm performance in both industries has a curvilinear relationship to cash, with a positive linear term and a negative quadratic term. The overall effect is greater for the labor intensive industry however, hence we reject H7.

5. Discussion

The purpose of this chapter is to discuss the results from the previous chapter in light of the strategic and financial theory presented in chapter 2. Secondly, we will outline potential weaknesses and critique the robustness of our thesis, in addition to discussing some of the specific choices we made prior to our analysis. The chapter will culminate in a short review of the theoretical implications of our findings, as well as practical implications for managers, before we discuss how future research can build on this.

5.1 Analysis discussion

5.1.1 The replicated regression model

The most important aspect that needs to be addressed when comparing the base model with the results from Nason and Patel (2016) is the different data samples that have been analyzed. Nason and Patel base their findings on roughly 8500 listed manufacturing firms in the US retrieved from the COMPUSTAT data base. Since this data base is renowned for research-friendly information, their sample is likely to consist only of "good" firms. By this, we mean that all the firms are listed, which ensures that the accounting data is of high quality and is up to date. Additionally, COMPUSTAT would have removed firms that displayed irregular behavior to such an extent that it could not be considered profit maximizing. Further, US manufacturing firms can be characterized as a "fitting" industry to research. This is due to the fact that there is little noise or unexplained variation since US manufacturing industry represent the core of generalized, profit maximizing firms. Many researches use this industry as their data sample because of the much simpler causality interpretation potential compared to other industries (Kotha and Swamidass, 2000; Vogt, 1994; Mabert et.al, 2000).

Our data sample is arguably narrow since the Norwegian economy is heavily influenced by the energy sector and overall less diversified than many other national economies (Madslien, 2016). On the other hand, it is more reasonably to argue that our data is representative of a generalized economic situation since we include a wide selection of industries. Compared to Nason and Patel's sample of US manufacturing firms, our sample is clearly more generalized. Instead of

focusing on firms in a specific industry, where behavior and results can be significantly skewed from other cross-industry averages, we examine, to a large extent, the Norwegian economy as a whole. This might entail that causal effects will be harder to identify, however the "area of effect" is much greater for the conclusions that are drawn. As shown in table 4.1, we find similar relationships between firm performance and cash terms both for the entire sample and recession interaction terms, except for the interaction term in model 4. Nason and Patel (2016) have a negative interaction term when not accounting for polynomial effects, whilst this same term is positive in our replicated model. This indicates that despite the differences in sample data, much of the inference pulls in the same direction.

Another factor that differentiates Nason and Patel's results and our own is the economic impact of the recession. According to Trading Economics, the US economy experienced negative GDP growth from mid-2008 until 2010 with the growth rate falling as low as -4%[1]. In Norway, whilst the growth rate also falls to -4% at one point in 2009, the recession is much shorter and not nearly as comprehensive when compared to the US[2]. It is a common assertion that the impact of the recession in Norway hit later than other countries and especially compared to the US. As mentioned, much of the Norwegian economy is based on the oil sector and the increasing oil price from 2008 to 2010 undoubtedly negated the recessionary impact significantly.

5.1.1.1 Implications of the dependent variable when interpreting the effect of cash on firm performance

Before we move on to discussing the hypotheses and our results from the expanded model, we find it necessary to explain some key differences between our dependent variable (ROA) and the one used by Nason and Patel (2016) (Tobin's Q). Even though Nason and Patel also report findings using ROA as dependent variable, their discussion is based on Tobin's Q. Still, some of the underlying effects of cash will affect ROA and Tobin's Q in the same direction even though specific values are not directly comparable.

The most obvious difference between ROA and Tobin's Q is that whilst ROA is a accounting based measure of firm performance, Tobin's Q is a function of firm market value and assets. These differences create two fundamentally different performance indicators. Since Tobin's Q partially reflects the stock price of a firm, all the different factors investors consider when

[1] see https://tradingeconomics.com/united-states/gdp-growth-annual

[2] see https://tradingeconomics.com/norway/gdp-growth-annual

valuing a company are included. Tobin's Q is therefore a more forward-looking measure of firm performance, since stock prices heavily reflect investors' expectations of the future. ROA on the other hand, reflects the internal performance and is heavily influenced by the operating efficiency of a firm. Compared to Tobin's Q, ROA is based on historical factors and does not include future expectations.

A key consequence of the two performance perspectives is that effects of cash on firm performance will be reflected differently in a regression model. When using Tobin's Q, the effect of cash is determined largely by how the external market perceives the cash holdings. This is exactly what is shown by Nason and Patel (2016); the effect of hoarding cash in a recession is more sensitive to total firm cash ratio than pre-recession. In our thesis however, the inference that can be drawn from studying how cash affects ROA is different. Instead of explaining how the financial markets view firm cash holdings, using cash to as an explanatory variable to firm ROA means that we instead focus on how cash affects firms' internal strategic choices and how these choices in return determine profitability. It goes without saying a firm's strategic choices are not quantified in financial statements and that it will therefore be difficult to determine the full effect of cash on firm performance. This argument will be further discussed later in this chapter as a topic of future research. Overall, since the information transparency is significantly lower for unlisted versus listed firms, we argue that it will be more difficult to draw causality conclusions when using ROA as a dependent variable compared to Tobin's Q, due to the unobserved factors that intervenes in every firm.

5.1.1.2 Inference shows similarities between US and Norwegian firms

Despite the obvious differences between the samples analyzed, it becomes clear that our base model findings are largely consistent with those of Nason and Patel (2016). We note that when comparing specific regression results from our model to those of Nason and Patel, we do not refer to the regression output in their paper with Tobin's Q as dependent variable. Instead, we have been provided the results from their research using ROA as dependent variable, which allows for a more direct comparison of our results. See figure 7.7 in Appendix.

When examining the size of the linear and quadratic variables of cash to the findings of Nason and Patel (2016), it becomes evident that the effect of cash in their model is not only higher, but also considerably more curvilinear. Whilst the quadratic term in our base model constitute

roughly 1/3 of the linear variable, the quadratic variable is 3 times the size of the linear variable in Nason and Patel's results, making the curvilinear relationship much more pronounced for the US sample. These results indicate that the listed US manufacturing firms have higher marginal benefit of cash for low cash levels than a combination of listed and unlisted Norwegian firms. This could potentially be explained by, in line with similar arguments mentioned earlier, the fact that information is more efficiently reflected in listed firms' performance measures. At the same time, US firms who hoard too much cash subsequently suffer more than Norwegian firms in a similar situation due to the increased opportunity cost.

With regards to the similarities of the focus variables, all variable signs are equal except for the interaction term with the quadratic variable of cash ratio and recession. Despite this, their interaction terms are insignificant. This entails that although the recession term is negative and significant, they find no added effect of cash in the recession. These findings are in line with what we would expect to see when examining ROA instead of Tobin's Q. Though their quadratic interaction has a positive coefficient, we do not put emphasis on explaining the cause of this due to the highly insignificant variable. In our base model however, cash seems to have a greater impact on firm performance in recessions. The positive linear interaction and negative quadratic interaction indicates that Norwegian firms are more sensitive cash changes in recessions when studying the economic cycle as a whole.

We find that our recession terms are smaller than the results from Nason and Patel (2016): -0.009 in the base model and -0.011 in the expanded model versus -0.026 in their model. Initially, we expected the recession to negatively influence firm performance to a greater extent, but after the comparison above our results seem reasonable. As discussed section 2.3.2.1, the US economy was hit harder during the 2008/2009 recession than Norway. This supports our findings that the recession variable has less effect on firm performance for Norwegian firms compared to US firms.

5.1.2 Expanded model

5.1.2.1 Changes from base model to expanded model

As mentioned earlier, we dedicated significant time on not only creating an accurate replica of Nason and Patel (2016), but also on improving the model to increase the external validity of our results. After including three additional variables, the interpretation of the results changed quite

significantly. Table 4.2 shows a major change in the either coefficient values and/or significance of all focus variables. The key variable here is the inclusion of the lagged return on assets. Neither the market share variable nor annual sales growth have shown to be influential enough to radically change other predictors. It is also unlikely that either of these two variables create any methodological fallacies since they are not closely linked to the dependent variable or any of the other independent variables. The main argument for controlling for prior performance is, as mentioned earlier, the intuitive explanation of the concept of "Persistence of Profits". It seems reasonable to believe that firms with high performance are more likely to perform well in the next period compared to firms with low performance. Furthermore, controlling for prior performance is in line with previous academic literature (Gerhart and Milkovich, 1990; Mullins, 1996).

5.1.2.2 Cash and firm performance

As the analysis section showed, we found support for hypothesis 1 when examining the base model. However, when regressing the expanded model, the cash squared variable is only significant at a 10.1 % level. Although this is outside of the formal rejection level, it still implies that there is, to some extent, a nonlinear effect of cash on firm performance. The underlying assumptions for this hypothesis was that cash has both benefits and costs, and that the benefits would outweigh the costs until a certain point. Our results indicate that cash definitely has a positive effect on firm performance, and that the negative aspects of having too much cash does not affect ROA to the extent we expected. In the following section, we will discuss our findings and its implications, in light of theory on the costs and benefits of cash on firm performance. We will divide the effects of cash on performance into direct and indirect effects, where the direct effects stem from actually deploying a firm's cash buffer. The indirect effects comprise of hoarding cash without investing it.

The positive effect of cash on firm performance

We clearly find that cash has a positive effect on firm performance. This positive relationship is consistent throughout our study, and can be explained indirectly and directly by the flexibility and signaling benefits of cash outlined in the theory section. By viewing the scatter plot of ROA and cash ratio in figure 7.5 in Appendix, we see that firms with higher cash ratios typically have higher ROA than firms with low cash ratios. This finding further confirms that cash does not

only have a positive effect on firm performance, but that cash-rich firms typically outperform those with low cash levels.

A firm's financial buffer could indirectly affect firm performance positively through signaling and flexibility effects. When considering signaling effects, we recall that Fresard (2010) emphasizes the strategic dimension of cash. By having a large cash buffer, a firm can influence the competitive choices of its rivals. In line with this, Kim and Bettis (2014) further argues that excess cash can provide a competitive deterrence that could ultimately serve as an entry barrier. Signaling the ability to compete aggressively could for example reverse a rival's decision to cut prices in order to gain market shares, because of the expectation that the cash-rich firm will respond full-force. The result could be an unprofitable, long-lasting price war. Hence, the signaling effect has the potential to be quite powerful. Another powerful indirect effect of cash holdings is having the flexibility to wait for more information when uncertainty is high. The ability to sustain increased option values of waiting allow firms to evaluate credible threats and delay making irreversible resource commitments, until key uncertainties have been resolved (Ghemawat and Del Sol, 1998). Due to this, they can reduce investment risk and thereby increase firm performance by selecting the best investment opportunities.

It is however important to note that it is difficult to detect or measure how these indirect benefits of cash actually influence ROA. We are for example not able to detect whether firms' cash holdings have served as a strategic deterrence towards competitors, and consequently not the effect on ROA either. We only have theoretical grounds to assume that the beneficial effects of cash disclosed by researchers are linked to the positive relationship we find between cash ratios and ROA.

The direct effect of cash holdings on ROA is related to the actual use of cash. For cash to become a firm-specific strategic asset, it needs to be actively used to acquire, accumulate or develop resources or capabilities. In turn, these resources and capabilities can affect firm performance and potentially generate competitive advantages. As mentioned by Nason and Patel (2016), a benefit of holding cash is also the increased flexibility in strategic responses that enables quick decision-making and implementation of strategies. Flexibility allow firms to take advantage of and benefit from profitable investment opportunities, preferably before their less cash-rich competitors get the chance to. This way, the increased flexibility due to cash can affect firm performance directly. It also minimizes the corresponding risk of under-investing in these opportunities. Under-investment could be a typical problem for firms without sufficient cash

reserves as external capital becomes costly, or financial constraints inhibits access to financing. In addition to converting cash into investments, firms can use their cash holdings to not only signal the ability to respond aggressively to rivals and new entrants, but actually execute measures to deter entrance; such as boosting capacity or filling a market niche. Subsequently, cash directly affect performance through firms' strategic responses.

The similar measurement problem for indirect effects also arise for the direct effects of cash on firm performance. The accounting data we used in our analysis does not enable us to investigate whether high cash holdings led to firms actively using their cash to pursue firm strategies. This could however be an interesting topic for future research.

Cash-rich firms go unpunished

Too much cash could have negative signaling effects from the perspective of financial markets, stakeholders and strategic partnerships, which could be detrimental to firm performance. We expected the negative effects of having too much cash to be reflected through a pronounced curvilinear relationship, represented by a negative cash squared variable. The regression output confirms that the effect of cash is diminishing as cash levels increase, but the curvilinear relationship is weak. After replicating Nason and Patel's study through our base model, we found that firms are punished harder for high cash ratios than when regressing the expanded model. Since we focus on interpreting the results from the expanded model, we continue the discussion based on that the curvilinear relationship is weak.

The diminishing effect of cash indicates that the marginal benefit of an increased unit of cash is continuously decreasing. The negative effects of having high cash holdings could partially be explained by indirect signaling effects. An assumption external actors might draw from a firm having large cash reserves is that they suffer from managerial issues such as unwillingness to pay dividends to shareholders or other forms of entrenchment that enhance poor governance (Jensen, 1986). Secondly, excess cash could imply that the firm is over-investing in less profitable investment opportunities (Richardson, 2006), or that they lack profitable investment opportunities to deploy its cash on (Jensen, 1986). It could also signal that managers are not acknowledging how technology developments and rapidly changing competitive landscapes require firms to adapt and re-strategize in order to meet the changing expectations of customers. However, our findings indicate that the negative effects of cash is diminishing as already mentioned, but will not evolve into an inverse U-shape for any rationally high cash-ratios. Cash-rich firms are

clearly not punished as hard for hoarding cash as what we had theoretical grounds to expect. Potential explanations of these findings will be further highlighted through discussions on the decomposition of time periods and industries.

5.1.2.3 Cash and firm performance in recession

From the regression output in table 4.2 we found that the interaction term of recession and cash is statistically significant for all the regression models. The recession positively impacts the effect of cash on firm performance, indicating that there is a discrepancy between how cash affects firm performance in recessions compared to normal times. This interaction term confirms our expectations on how the effect of cash would develop over different time periods. The typical characteristics of recessions, with reductions in demand and tightening of credit constraints (Knudsen and Lien, 2014), could make cash buffers even more important for firms than in normal times. However, when investigating the impact of recessions further by comparing the effect of cash on firm performance pre-, during, and post-recession, we find somewhat contradicting results.

Recalling hypothesis 2, we expected to find that the effect of cash on firm performance is most pronounced during recessions. However, as table 4.3 indicates, the curvilinear relationship seems to be most pronounced in the pre-recession period. This is confirmed and illustrated in the margins analysis in figure 4.12. This section will continue by partly comparing our findings for pre-recession and recession to those of Nason and Patel (2016), and also discuss the linear effect of cash post-recession. We will identify potential reasons why the relationship between cash and firm performance develops differently for the three time periods.

The effect of cash pre-recession versus during recession

When testing hypothesis 2 on the expanded model, we find that the curvilinear relationship between cash and firm performance in the pre-recession period becomes inverse U-shaped, consistent with what Nason and Patel (2016) found. In this scenario the diminishing effect of additional cash is visible for both accounting based and market-based performance indicators. The diminishing effect of cash in recession however does not shift to an inverse U-shaped relationship for cash ratios between 0 and 1. This is not consistent to Nason and Patel's finding, where the penalty for holding cash starts for cash ratios of 0.4 in recessions. In comparison, our results show that the marginal effect of cash on firm performance during recession does not be-

come negative before cash ratios above 2. The fact that we detect a virtually linear relationship during recessions, indicates that the disadvantages of cash might not be as reflected in ROA, compared to Tobin's Q. This is likely due to the fundamental differences between these two dependent variables; as mentioned before, Tobin's Q is a forward-looking measure, whilst ROA is based on past performance. It is more likely that the negative signaling effects of high cash levels are more efficiently and comprehensively reflected in the stock market than in accounting information.

The negative signaling effects could also potentially affect more qualitative aspects of a firms' performance, which might be harder to capture in quantitative performance measurements. As an example, if a firm is perceived as having managerial issues, relationships with stakeholders could be harmed. Opportunities for entering into strategic partnerships or alliances could also be limited. If a firm's employees are negatively impacted by entrenched managers, it could possibly lead to the resignation of valuable employees with firm-specific knowledge whom could be expensive and time consuming to replace. Overall, the time aspect is also important to consider. Since the signaling effects only impact firm performance indirectly, through the effect on for example stakeholders, it is difficult to know when the effect on ROA would be visible. If a firm's excess cash holdings lead to entrenched managers and poor governance, suppliers could choose to not renew a contract with that particular firm. The firm's access to necessary inputs could be limited or their conditions with suppliers could be worsened. Over time, these conditions could impact ROA negatively, and the underlying cause would be the firm's excess cash. It is also difficult to establish when the effects of investments are visible in ROA. In line with Nason and Patel (2016), we assumed that return of investments would be reflected in the financial statement the same year. This is naturally a debatable assumption. If a firm over-invests in unprofitable investment opportunities, the negative results of these could be realized over a larger time span than the time periods we focus on. The same reasoning applies for investments in profitable projects. The effects from deploying cash might not yet be reflected in firms' ROA.

In sum, the relationship between cash and firm performance during the recession is virtually linear, whilst the same relationship in pre-recession is more curvilinear. From business cycle theory it makes sense that cash levels have a diminishing effect on firm performance pre-recession, because of the expansion period that often hits before a recession. Holding high cash levels when the economy is experiencing a boom could negatively affect firm performance due to the

increased opportunity cost of not investing. This is based on the assumption that a booming economy offers substantial investment opportunities. The finding that the curvilinear relationship during recessions dissipates, entails that the marginal effect of cash is no longer diminishing as cash levels increase. As a consequence, a firm's returns can benefit from higher cash levels than in pre-recession. This can be explained by the increasing costs of external financing in recessions, which could make cash more valuable. Generally, the benefits of cash that have been discussed previously may become enhanced during recessions. The increased financing constraints firms face means that holding cash becomes increasingly more important. Firms will depend on internal financing in order to uphold investments and face challenges following the recession, and will be less punished for hoarding cash. Consequently, the potential negative aspects of excess cash are downplayed, resulting in a linear marginal effect of additional cash.

The linear effect of cash post-recession

Moving on to post-recession, business cycle theory states that a recession is often followed by a new economic boom. Hence, the post-recession relationship should be more curvilinear and similar to pre-recession, since the opportunity costs of hoarding cash increases as potential profitable investments increase. Instead we find that the curve becomes even more linear than during recession. One possible reason for this development could be tied to tough lessons from the tumultuous recession period. Managers and the economy as a whole acknowledged how pivotal cash is in obtaining a stable financial state. The negative signaling effects related to high cash holdings which likely influenced the relationship between cash and performance to be curvilinear might not have been viewed as negative to the same degree as before the recession. As described in the theory section, after the recession firms saw the advantage of having large cash buffers to avoid cash squeeze. In rapidly changing business environments with increasing uncertainties, firms had a precautionary motive to hoard cash. The development of yearly average cash ratios shown in figure 4.5 indicates that firms' cash ratios slowly increased after the recession. The linear relationship could reflect the shift from typically viewing large cash holdings with great skepticism before the recession, to realizing the importance of accumulating cash buffers after the recession.

5.1.3 Knowledge intensity and cash

5.1.3.1 High cash levels for knowledge intensive firms

Our descriptive statistics for cash and knowledge intensive industries clearly showed that firms in the highest KI group hoard more cash relative to firms with lower knowledge intensity. Confirmation of hypothesis 3 supports existing theory on this topic (Lyandres and Palazzo, 2016; Bates et al., 2009). We propose that a key cause of this observation is that firms with high knowledge intensity are in need of greater financial flexibility than firms with lower knowledge intensity. Examples of this can be seen consistently in news; firms in the oil sector, offshore supply etc. often issue debt and undertake financial restructuring despite arguably meager future outlooks. The reason why this does not happen for knowledge intensive firms is that the cost of similar financing is simply too high. It should be noted that studying firm cash holdings in innovative industries could be a thesis topic alone (similar to Lyandres and Palazzo (2016)) and has consequently been outside our scope.

5.1.3.2 Questioning the rejection of hypothesis 4

In section 2.3.3 we laid the foundation for our hypothesis (H4) that cash has a bigger impact on firm performance as knowledge intensity of firms increase. The main argument was that external finance is potentially much more expensive for firms with high knowledge intensity since these firms often cannot offer as much collateral compared to firms with lower knowledge intensity. The results from our analysis showed that we could not accept H4 due to an unsuspectingly high cash ratio coefficient for KI2 and a more or less equal effect of cash for KI3. Our findings seemingly contradict the intuition provided in section 2.3.3 that firms with high knowledge intensity should value additional cash more than firms with lower knowledge intensity due to the increased cost of external financing. Building on this and recalling Nason and Patel (2016), the importance of increased flexibility was expected to partially dictate a high performance related impact of cash. The coefficients for KI3 and KI4 indicate no substantial difference between the two groups, in addition to being lower than the same coefficients for KI2. Since we quite surprisingly reject H4, the following discussion will elaborate on underlying factors related to this hypothesis. First, we will focus on investment complexity. Secondly, we move on to the question of why the effect of cash is low for high knowledge intensive industries, despite high cash holdings. Even though we rejected H4, we will present arguments as to why we still

believe cash is especially important for firms with high knowledge intensity.

With regards to the relationship between firm response and profitability, we have previously assumed that, based on Nason and Patel (2016), the effect of investments will be visible in the same accounting year. Whether or not this is true will naturally depend on the type of investments. It is likely that, in general, investments in industries with low knowledge intensity will yield income quicker than investments in high knowledge intensity industries. For example, increasing production capacity will almost certainly have an immediate impact of return on assets given. On the other hand, it might take years for an investment in an R&D process to be profitable. The examples above might partially explain why the cash coefficient is lower for KI 3 and KI4 compared to KI2.

This leads us to the next topic of discussion: what are the causes of low cash effect on firm performance for high knowledge intensity firms, despite the fact that these firms have overwhelmingly higher cash ratios? As shown in figure 4.8, KI4 has consistently higher cash ratios than the other three KI groups. An important factor that can explain the coefficient differences between KI2 and the upper two KI groups is the path complexity from a unit of cash to increased firm performance. For firms with high knowledge intensity, much of the value creation originates from intricate R&D processes where the underlying investments occurred several years earlier. Furthermore, such investments are often much riskier than investments of firms with lower knowledge intensity. For example, manufacturing firms investing in production increases will face much lower failure risk than pharmaceutical companies contemplating whether to start new research. Therefore, it will generally be much easier to trace the effects of cash on return on assets for firms with low knowledge intensity. The above arguments should be considered when studying the regression outputs; though the cash ratio coefficient is lower for KI3 and KI4 compared to KI2, it does not mean that cash is less important for firms in these categories. Cash could in fact be crucial even though the direct effect on firm performance is low.

With regards to the importance of cash for firm operations, there are several factors that we think do not come to light in our research. We believe that there is a crucial difference between the estimated effect of cash that we find in our regression models and the true importance of cash for firms. As mentioned, our results show that the coefficient for cash is more or less the same for KI4 and KI3, despite the obvious differences in average cash levels between these two industry groups. Additionally, the effect of cash is, as mentioned, arguably more easily traced to ROA for firms in low knowledge intensive industries. Consequently, we believe

that there are unexplained reasons why firms with high knowledge intensity hoard significantly more cash. One feasible solution we have mentioned before is the flexibility high cash holdings offer. Firms in high knowledge intensive industries are generally more exposed to environmental and operational uncertainty which means that financial flexibility is important. Not only can external financing be expensive due to this uncertainty, the dynamics and constant change in the competitive landscape may force firms to be able to react quicker than firms in less dynamic industries. The importance of financial flexibility will naturally vary across industries, but one key factor remains; it is difficult to quantify how cash affects firm performance through increased flexibility. Even if the increased flexibility does not lead to additional investments, which in turn will affect ROA, assuring that a firm has the ability to adapt quickly adds to the importance of cash.

According to Gamba and Triantis (2008) firms will adopt a flexibility policy that is in line with the cost of external financing. This supports our previous discussions; firms with high knowledge intensity levels tend to face increased external borrowing cost due to risky projects and low collateral values. Operational flexibility is obviously not reflected in financial statements and may therefore shadow the true importance of cash. Examples of how cash can impact firms through increased flexibility are especially conspicuous during times of distress; firms with low cash levels may be forced to sell off assets or sub-divisions of the firm below market value in order to survive. Often, the acquirers are firms with superior financial flexibility and capitalize on competitors' weak position. The discussion above intends to highlight why cash is crucial for firms with high knowledge intensity, despite the evident lower cash coefficient values in the regression analysis.

5.1.3.3 Less knowledge intensive industries benefit from high levels of cash in recession

Our next hypothesis (H5) was that cash will have a greater impact on firm performance in recessions for firms with low knowledge intensity, compared to firms with high knowledge intensity. In our theory chapter we outline that firms that are highly dependent on external financing, are hit harder during recessions. As mentioned, firms with high knowledge intensity face higher external financing costs so managers will likely foresee the importance of financial flexibility and hoard cash as a preventive measure. The consequence is that firms with high knowledge intensity are less dependent on external financing since they intend to avoid drastic investment

drop in line with Aghion et al. (2012). Supported by figure 4.8, this could also partially explain why we saw an unexpected low cash coefficient for KI4 when testing H4; since firms already have high cash holdings, an additional unit of cash has low marginal effect on firm performance. Naturally, we expected this to entail that the opposite would be the case for firms with lower knowledge intensity, hence H5.

As shown in table 4.5, we further investigate the relationship between cash and firm performance, but we now split KI2 and KI4 into the three different time periods. The time period in focus for H5 is recession (column 2 & 5), however all time periods were included to answer hypothesis 6. The main finding here is that it becomes clear that the effect of cash on firm performance in the recession has a pronounced curvilinear relationship for firms with low knowledge intensity. For the KI4 group however, the same relationship is more or less linear. This entails that for cash ratio values <0.4, the marginal benefit of an additional unit of cash is greater for KI2 than KI4. For cash ratios greater than 0.4 however, the effect of cash diminishes for KI2. This implies that H4 is confirmed up to a cash ratio of 0.4, but for levels higher than 0.4, the effect of cash is higher for KI4. This concave relationship for KI2 is caused by the fact that, in the event of a recession, firms with low cash ratios will benefit substantially from additional cash. Low cash levels in recessions could itself be a signal of financial distress and new capital would likely boost firm performance. Therefore, it also seems reasonable that the effect on firm performance is diminishing as cash ratio increases. For KI4 however, we see little change in the marginal benefit of cash in recession compared to what we found when examining hypothesis 4. More cash is seemingly always better for firms in high knowledge intensive industries. This findings support Knudsen and Lien (2014) and is in line with pecking order theory discussed in chapter 2. Firms with high knowledge intensity will value cash highly regardless of the current business cycle due to the importance of financial flexibility and the uncertainty these firms face.

5.1.3.4 Cash varies less for high knowledge intensive firms

The final hypothesis that was examined in light of the knowledge intensity groups was whether the effect of cash on firm performance varied less throughout the business cycles for firms with high knowledge intensity versus firms with low knowledge intensity (H6). In order to answer this hypothesis, we again refer to the focus variables in table 4.5. We stated in the analysis that for KI2, the interpretation of actual variation for cash would depend on whether the quadratic terms are included or not. Since the total effect is reduced by the negative quadratic terms and

this effect is nonlinear, the overall effect will be heavily dependent on the given cash ratio that is used. Given the input of a 23% cash ratio (as mentioned in the Analysis chapter), we saw that the direct effect of cash on firm performance varied less for KI4 than KI2. It is worth mentioning that not only is the variation among the linear terms more stable, the quadratic variables are also all insignificant. An explanation of this observation relates to Bernanke (1983); firms who are heavily focused on R&D activities, which we have argued is more relevant for KI4 than KI2, are less sensitive to economic fluctuations. Additionally, we have previously argued that we believe cash is important for firms with high knowledge intensity for other reasons than the direct effect on firm performance. Following these arguments, it seems unsurprising that the cash variables exhibit lower levels of variation for KI4 compared to KI2.

5.1.4 Labor versus capital intensive industries

As shown in the analysis section, the findings from both the regression output and the marginal analysis graphs indicate that cash has a greater effect on firm performance for labor intensive industries than for capital intensive industries. Therefore, we rejected hypothesis 7. Additionally, the margins analysis (figure 4.14) clearly shows that the wholesale industry has higher ROA than manufacturing for any given value of cash. The hypothesis was formulated on the theoretical basis that capital intensive industries have higher fixed costs that remain stable throughout demand fluctuations. This would entail that holding a higher cash buffer could be more important for firm performance in capital intensive industries than for labor intensive industries, due to a riskier cost structure for capital intensive industries. However, based on the analysis results, the conflicting argument of a negative relationship between capital intensity and risk seems more likely to hold.

From the descriptive statistics (figure 4.11) we clearly see that labor intensive firms, represented by the wholesale industry, have higher cash levels than capital intensive industries. A reason for this might be that the ability to minimize costs when revenues fluctuates is more limited for labor intensive firms than for capital intensive firms due to higher wage rigidity. As a consequence, wages are perhaps in the gray area between variable and fixed costs. In Norway, there are strict laws on when and how to lay off employees. The presence of unions is also strong, ensuring that workers' rights are not being violated. It is not easy to scale the workforce up and down whenever an economic downturn hits, and especially not if the workforce is more specialized or inhabits firm-specific knowledge that would take time to accumulate for new

employees. The policies in Norway might therefore give labor intensive firms incentives to keep larger cash holdings against potential sales fluctuations. It would be interesting to see if the same result would have been found for U.S. firms, where the labor market is less restricted by employment laws and short-term contracts are more common.

Even though we reject our hypothesis that cash has a greater effect on firm performance for capital intensive firms than labor intensive firms, the overall difference is marginal. Despite the fact that the coefficient difference is highly statistically significant, which is the prerequisite for the discussions above, cash does not seem to be a major factor for explaining the ROA discrepancy between the two industries. Referring to the margins plot, we see that the development of ROA as cash increases is highly cointegrated. This indicates that the marginal benefit of additional cash is similar for both industries. The profitability difference is consequently explained by other variables in our model.

Despite not being a focus variable in our research, we provide a short discussion of the market share variable. Throughout all previous regressions, market share has been positively correlated with firm performance. Theoretically, this makes sense as increased market share equals increased market power, which in turn should enable firms to capture more of the total value creation in their respective markets. Our findings directly contradicts Buzzell et al. (1975) who, as mentioned previously, argue that market share has a strong, positive effect on firm performance. Our results show that a one percent increase in market share will reduce ROA by -0.665 percentage points. We believe that the wholesale industry in Norway may be reversely affected by market share; the less firms in an industry, the higher the competition. The most obvious example is the food retail industry. Even though few firms dominate the market, price competition is fierce and profits are consequently low. The same competitive dynamics can be seen in retail industries related to sports goods and clothing. On the other side, a small wholesale firm operating in a niche market may enjoy higher returns on assets despite lower overall market share due to less fierce competition.

5.2 Robustness

Throughout our work, we have been balancing the concept of external versus internal validity. The goal of our study was to, as accurately as possible, approximate the effect of cash on firm performance. Due to the complexity of the data set and the challenge of quantifying this relationship however, there were certain choices that had to be made in order to find any meaningful results. In this section we will discuss potential weaknesses that arose based on these choices and how this might potentially influence our results and conclusions. We note that we have already discussed data concerns in section 3.6, therefore we now focus on underlying factors that have not already been covered.

5.2.1 Impact vs response of recessions

As discussed in section 2.3.2.2, when a recession hits there are only two factors, except unexplained noise, that will affect future firm performance: the impact of the recession and the firm response. This creates a problem when it comes to understanding why firm performance develops as it does; when using accounting data, we can only view the firm results and not whether these results were caused by changing market conditions or because the firm actively responded to the recessions. Recalling Sánchez and Yurdagul (2013), firms have been increasing their cash holdings steadily for the last decades. Still, it is difficult to accurately specify what the cause of this is. Even though increasing cash holdings obviously improves a firm's operational flexibility, there is no direct link if this extra cash has been employed solely to sustain losses in an economic downturn or if it has been actively managed to capitalize on improved investment opportunities. Furthermore, the ever-present error term makes if challenging to capture the true causal effects of both the recession impact and firm responses. There will always be numerous factors that purposely or inadvertently affect firm performance, but cannot be attributed to either the impact or response categories.

5.2.2 Qualitative cut-offs for key variables

During our data treatment we implemented two different methods for the removal of extreme observations. Whilst the Cook's D method has greater statistical validity, the qualitative cut-offs are to a greater extent subject for skepticism. It can be argued that our cut-offs should

be different, both based on economic knowledge and the distribution plots, but this would be the case regardless of which values we chose. As mentioned in the discussion of sample outliers (section 3.2.2), we had numerous iterations when considering the specific variable limits. Overall, we have to assume that our economic intuition, in combination with the scatter plots, gives basis to apply such qualitative cut-offs. Discarding the qualitative criteria however, opens up for a new discussion. If these cut-offs where changed, or removed altogether, there would be around 3 000 additional observations in the sample. Although an argument in favor of including these variables is that we ideally want to remove as few observations as possible, the removed observations are so extreme that we believe that this alone does not hold. Further, including these observations drastically changes the regression results. In one instance, we predicted around 97 % of variation in firm performance with our expanded model. This is simply unrealistic considering how many factors that influence firm performance and supports our decision to remove observations based on qualitative cut-offs.

5.2.3 No observation-specific examination

As discussed above, we used qualitative cut-offs for key variables in an effort to remove extreme observations that should not have been included in our sample. The fact that we did not individually examine each observation before removal might entail that some observations that should have been included instead was removed. If this is the case, we have reduced the external validity of our results and potentially missed out on important information. On the other hand, considering the size of our data set, we argue that this effect would be extremely small. In addition, closely inspecting the accounting information of thousands of firms would simply require too much time relative to the inference gains. Therefore, we have to accept that some "good" observations might have been removed and, more likely, that some "bad" observations have been included in our analysis.

5.2.4 Panel data with gaps

When removing observations from our initial data set, we do not take into account that some firms may have abnormal years where the given observation is within our removal filters. Consequently, our panel data set contains gaps. Although this theoretically creates some drawbacks in the interpretation of the regression results, the occurrence of this problem is low and we

believe the overall effects are negligible.

5.2.5 Limitations of using return on assets as dependent variable

A limitation of our research is that we only use an accounting-based measure as our dependent variable. Whilst Tobin's Q would reflect how cash affects investors' view of firm value, return on assets only captures firm performance through income. This means that we can only measure how cash affects firm performance directly and could partially explain why the cash coefficient is higher for firms with low knowledge intensity than firms with higher knowledge intensity. Although market-based indicators of firm performance can open for interesting relationships worthy of further examination, our data set contain overwhelmingly unlisted firms. Therefore, using such a measure would simply not be viable and return on assets is therefore potentially the best dependent variable we could use.

5.2.6 Exclusion of lagged independent variables

As mentioned in section 3.4.4, we do not include lagged independent variables in our regression model. This assumption is based on Nason and Patel's (2016) argument that the effects of a firm's actions will be visible the same year. Naturally, this is a simplification that has ramifications for different types of investments. We have previously argued that firms in knowledge intensive industries, where R&D investments typically account for a large share of total investments, undertake longer and more complex investments. As a consequence, these investments will have a longer time-span and it might take several years before the investment yields profits. This might be a partial explanation as to why the coefficients for KI group 3 and 4 are surprisingly low. We recognize that not including lagged independent variables eliminates the possibility of examining how cash in one period affects firm performance the next period. However, we believe that simply including lagged control variables from one year to the next would not be a good method to draw inference from. Instead, if we were to have studied how lagged independent variables affected firm performance, we would likely have used inter-period comparisons[3]. This opens a whole new set of potential research topics and methodological approaches that we decided not to pursue in this thesis.

[3] i.e. how cash holdings during the recession affects firm performance post-recession

5.3 Theoretical implications, take-aways for managers and future research

This thesis has aimed at providing empirical evidence of the impact of cash on firm performance, both in periods of neutral economic growth as well as during recessions. In this section we discuss the theoretical implications following the conclusion that cash in fact has a positive effect on firm performance. Further, we challenge fundamental aspects of the resource-based view, more specifically the assumptions of heterogeneity and immobility. Additionally, we discuss the more practical implications of our findings. Lastly, we present potential future research topics based on the findings in our thesis.

5.3.1 Theoretical implications

5.3.1.1 Cash and capital market efficiency

First of all, we contradict the perception that financial markets are perfectly competitive and efficient. Based on this assumption, assets will never be sold unless the value of the resource is fully reflected in the price, and rational actors will not pay more than the expected value it will generate. All pure profits of implementing a certain strategy will be anticipated and competed away, and so having enough cash to invest in assets will not enhance firms' profitability or ability to achieve abnormal returns. Our results however, indicate that cash indeed affects firm performance and that this effect varies across business cycles and industries. On this basis, we can argue that financial markets are imperfectly competitive and inefficient.

Another fundamental aspect of the perfect financial market assumption is that all investments with a positive NPV will be financed (Knudsen and Lien, 2014). This entails that, theoretically, financing is uninteresting from a strategic perspective. If this was true, it would not be necessary for firms to hoard cash in order to achieve financial flexibility since information transparency would ensure that investors similarly identify all profitable investment opportunities. As a consequence, we would expect firms to hold very little cash regardless of industry factors. However, our findings contradict this. We see that not only does average cash holdings vary significantly depending on the level of knowledge intensity or capital intensity, firms' cash holdings on average have been steadily increasing for the last decades. Furthermore, the impact

of cash on firm performance also differs throughout our research.

5.3.1.2 Implications of finance in RBV

Next, we will evaluate cash as a resource in light of the underlying assumptions of the resource-based view: resource heterogeneity and immobility. We have seen in our study that the cash levels firms possess clearly differ. Our results show that cash levels increase with firms' ROA, highly knowledge intensive firms hoard more cash than less knowledge intensive firms, and that labor intensive firms hoard more cash than capital intensive firms. Subsequently, firms within and across different industries possess different cash levels. To begin with, cash might not be considered a heterogeneous resource since more or less all firms have some amounts of cash, but there are grounds to argue that the level of cash holdings are heterogeneous across firms and industries. Furthermore, different levels of cash holdings allow certain firms to be more skilled in accomplishing certain business activities than other firms. Financing of R&D projects can for example be difficult to obtain externally, due to the uncertainty in outputs. Subsequently, cash-rich firms can more easily undertake investments in R&D, than firms lacking internal financing. Internal cash buffers could therefore be considered a heterogeneous resource.

In order for the heterogeneity of cash to be long lasting, the resource needs to be imperfectly mobile. The assumption of immobility can be discussed with regards to firms' ability to access financing, which may vary across business cycles and types of investments. This is closely tied to the inefficiency of capital markets, tightening of financing constraints, and costly external capital for certain investments. The costs of external financing increase during recessions, and firms without sufficient internal capital might choose to forgo profitable investments because external capital is too costly, in line with the pecking order theory (Myers and Majluf, 1984). When financially constrained firms struggle to access external funding, cash buffers can make or break businesses. From a competitive view, cash-rich firms can seize profitable investments without being prevented by financing limitations and gain an advantage over rivals. The financing of assets are also typically more difficult to obtain for certain resources that are viewed as important in creating profitability and competitive advantages (Knudsen and Lien, 2014), an argument which is closely related to the discussion of heterogeneity. If a firms' rivals are unable to access financing, we argue that cash can be viewed as an imperfectly immobile resource. Having the financial flexibility to commit to investments in times of restricted access to financing could potentially increase the competitive advantage of the acquired resources.

The discussion above puts emphasis on recessions and financing difficulties for certain resources and capabilities when evaluating the heterogeneity and immobility of cash as a strategic asset. If all firms can easily access financing then cash would not be interesting in terms of explaining differences in firm performance. In times of economic crisis, the theoretical implications indicate that cash can have an important role as a strategic asset. However, whether the assumptions of RBV hold or not is probably most dependent on the internal conditions of particular rivals within a market, and whether excess cash gives one firm an advantage and ability to perform certain activities better than its competitors.

5.3.1.3 Deploying cash to generate competitive advantage

Fundamental aspects of strategy and finance that reject the importance of cash on firm performance do not seem to hold empirically. However, when considering if cash can be valued as a firm-specific strategic asset, the deployment of cash is key. Cash needs to be deployed to acquire, accumulate or develop resources and capabilities which in turn could impact firm performance. If these resources or capabilities are out of reach from financially constrained rivals, and are used to perform activities that generate abnormal returns, financing could be acknowledged as an underlying source of competitive advantage. Whether the advantage is sustained or temporary could depend on the firm's ability to realize the benefits reaped from the resources, as well as the competitive effect of the firms' first mover advantage over its rivals. If the resources and capabilities could be easily imitated or substituted, the advantage will be lost. In recessions, the ability of cash-rich firms to exploit new opportunities might allow them to exit the crisis as a winner, while their rivals become losers.

5.3.2 Practical implications of analysis results

5.3.2.1 Mangers' cash policy dilemma

Our findings do not only have theoretical implications with regards to how fundamental contributions from the strategy field view cash as a potential source of competitive advantage. The results also have a practical application value that firms and managers can benefit from. As mentioned previously, there are several weaknesses in our analysis and we do not claim to have identified the true causal effect of cash on firm performance. Yet, we believe our results can be used as one of many tools to help managers optimize their cash holding policies.

Our first, and perhaps most important insight, is that there are both benefits and costs associated with holding cash and that the influence of each of these two factors vary across business cycles and industries. The regression output in table 4.3 and the corresponding illustration in figure 4.12, shows that the downsides of holding high levels of cash pre-recession are more severe than during the recession and post-recession. Our results indicate that firms during and after the recession are less punished for holding excess cash. This can be caused by a reduction of the negative signaling effects, since managers and other stakeholders acknowledge that cash is more important in the two latter periods than in the pre-recession period. A take-away for managers could be that the signaling effects, that for decades condemned cash holdings as something negative, no longer affect firms' performance to the same degree. This development could be beneficial for managers to take under consideration when evaluating cash policies. By applying this knowledge, managers have an incentive to increase cash holdings in order to maximize profitability.

When we studied the effect of cash on firm performance for different levels of knowledge intensity, it became clear that the associated benefits and costs varied significantly. As shown in figure 4.13, there is a clear curvilinear relationship for KI2, indicating that the costs of cash outweighs the benefits after a certain cash level. For managers in low knowledge intensive firms, this entails that even though cash has a positive marginal impact on firm performance even for quite high cash ratios, the effect of additional cash is quite rapidly diminishing. Mangers in firms with low levels of knowledge intensity, need to be aware of the increasing costs of high cash levels. However, according to our results, managers in firms with high knowledge intensity should hoard as much cash as possible.

The last research topic was related to comparing the effect of cash on firm performance for labor intensive and capital intensive industries. Our results showed that this effect was marginally greater in the wholesale industry than the manufacturing industry. We attributed the difference to the increased importance of wages in labor intensive industries. Following this, managers in labor intensive firms, where we argue that wage rigidity is high, should take precautions and hoard cash. As mentioned earlier, employee rights are strong in Norway and consequently labor is not easily scalable in the short run. Hence, wages are rigid up to a certain point in time and managers in labor intensive firms should build up cash reserves to sustain short-term business cycle fluctuations.

5.3.2.2 Conflicting interests for managers and society

Regardless of how the benefits and costs of cash on firm performance vary across business cycles and industries, cash seems to have a consistently positive effect on ROA for very high cash ratios throughout our analysis. This indicates that increasing cash levels far beyond the amount required to maintain existing assets, will create additional value for firms. Based on our results, managers have incentives to build up large cash buffers. From a socioeconomic point of view, this could have damaging implications since the society generally benefits from firms investing their money instead of hoarding it. This is due to the fact that firm spending is crucial to sustain economic growth and create jobs. If the trend of cash hoarding continues it might challenge government policies in the future, and provoke government intervention to enforce firms to use cash instead of hoarding it. Firms might prefer to hoard cash due to future economic outlook or to benefit from improved signaling effects, whilst the optimal socioeconomic solution would be to increase investments. It can be concluded that the society and firms in some cases have contradicting interests with regards to cash hoarding. The optimal value of cash holdings from managers' perspective will likely conflict with the optimal value of cash holdings from a socioeconomic perspective.

Overall, with regards to the practical implications of our study, we believe there are too many unexplained factors for our results to give precise indications of how cash policies should be handled. On the other hand, we clearly show that firm cash management should not be ignored due to the significant relationship between cash and firm performance. Still, it is important to point out that we merely scratch the surface of a research topic that is virtually untouched.

5.3.3 Future research

Since our research is groundbreaking with regards to studying Norwegian firms, we believe a wide approach is more important as a first contribution to this research field. Early in our work, we decided that we would focus on providing, to an extent, generalized information. With regards to studying the relationship between cash and firm performance, we postulate we can provide substantially more value by approaching the subject broadly and not focusing too much on specific and narrow hypotheses. However, there are many possible extensions that we have not looked into that can be studied further.

One of the most interesting research topics we considered was to examine how investments in

one time period affect performance in another period. We urge future research to investigate the link between firm cash holdings and investments to examine how investing cash affects firm performance in different time periods. For example, do investments during an economic downturn increase firm performance more than investments during economic upswings? Further, it could be interesting to study more qualitative data on the decision-making processes and reaction patterns of managers during the financial crisis, to see whether they actually spent cash to exploit new investment opportunities or chose to hold cash to buffer against threats.

Additionally, we recognize that there is potential with regards to studying specific industries more closely. As mentioned before, our industry groups were at the highest NACE code level which means that there can be significant within-industry variation. Future studies could focus more specifically on certain industries that exhibit labor or capital intensive traits more clearly than the more generalized sub-sample we used in our thesis.

Another potential research topic we have identified based on our work is to study how cash holdings affect firms' strategic choices. More specifically, whether or not cash affect how firms position themselves preemptively, and react to changes in demand and in the competitive environment. Based on the accounting information we have used it has not been possible to study the strategic choices firms have undertaken during our sample period. This type of qualitative information is not only demanding to acquire, it would also significantly limit the number of observations. Still, we believe this would be a potential approach to learn how firms use their cash holdings and how this in turn affects firm performance.

6. Conclusion

The purpose of this thesis has been to examine the relationship between cash and firm performance. We used the paper by Nason and Patel (2016) as a starting point and applied their model to our SNF data set, before we expanded the model by adding additional control variables. Though not the specific of our study, we allocated significant resources to studying this relationship in light of the 2008/2009 recession. Further, we looked at how cash affects firm performance in different knowledge intensive industries. Lastly, we investigated two major industries to see if this effect varied depending on whether the industry was labor or capital intensive.

Throughout our analysis we find that cash has a clear impact on firm performance regardless of industry, knowledge intensity characteristics and time-period segmentation. The linear term of cash is highly significant in every regression we run and hovers around 0.1 for nearly all time periods, KI groups and industries. The quadratic term is less consistent; in some cases, we identify a curvilinear relationship, whilst sometimes the quadratic term is low and insignificant indicating a linear relationship between cash and firm performance.

After replicating the model by Nason and Patel (2016), we found that our results are fairly similar as what they find in their study on US manufacturing firms. Generally, our variables have a lower impact on return on assets, however this is not surprising considering the differences between the data sets. After expanding the base model, we conclude that the curvilinear relationship is now weakly curvilinear. Furthermore, the effect of cash was halved after controlling for prior performance through the lagged variable of return on assets. We also applied our expanded model to each time period separately in order to examine how the effect of cash differs across different stages of the business cycle. We found that the curvilinear relationship is most pronounced pre-recession and more or less linear during- and post-recession.

The next part of the thesis focused on applying our expanded model to different industries to examine how the effect of cash varied. The results from dividing all firms into knowledge intensity groups showed that even though firms with high knowledge intensity clearly have higher relative cash holdings, the effect of cash on firm performance was lower. When reviewing the same effect during recessions we found that for firms with low knowledge intensity cash

has a pronounced curvilinear relationship to firm performance, whilst the same relationship is linear for firms with high knowledge intensity. Following the intention of studying industries, we choose two major industries in order to see if the impact of cash is different depending whether the industry is labor or capital intensive. Our results showed that cash in fact has a greater impact on firm performance for labor intensive industries which is the exact opposite of what we hypothesized.

Mainstream theories within the strategy and finance field discard cash and other financial assets as negligible with regards to creating competitive advantages and affecting firm performance. Based on our findings in this study we dare to challenge these assumptions. Cash is not an isolated source of advantage, however cash may enable firms to undertake strategies and activities that may lead to competitive advantages. Though the final resource may be contributed with creating the competitive advantage, cash might have been an overshadowed necessity. Furthermore, access to finance is hardly something all firms easily have and the cost will vary significantly across industries and time periods. We have previously discussed the importance of financial flexibility, especially for firms in knowledge intensive industries. Further, we argue that financial flexibility likely has positive effects on firm performance, but that these effects are not fully captured in our regression model. Overall, we conclude that cash may in fact be king and should not be discarded as dead money.

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7. Appendix

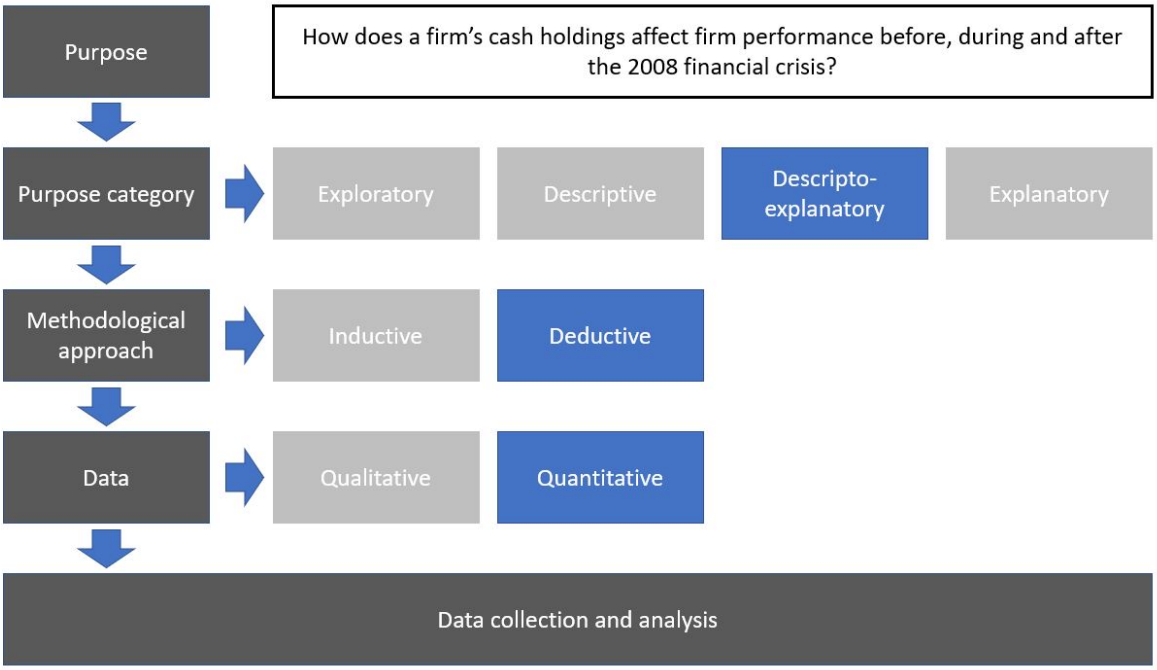

Figure 7.1: Research design

Inflation index

2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
100	97,9	95,9	93,9	93,3	92,1	89,9	88	84,8	84,2	82,3	81

Figure 7.2: Inflation values that have been used to adjust all quantitative input values. 2015 has been used as base year.

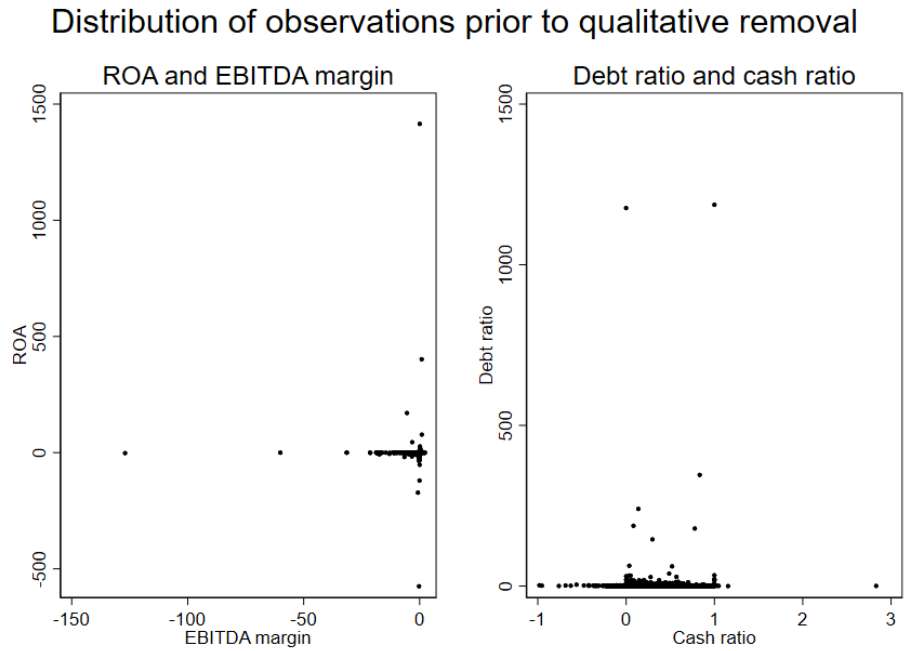

Figure 7.3: Distributions before outlier removal

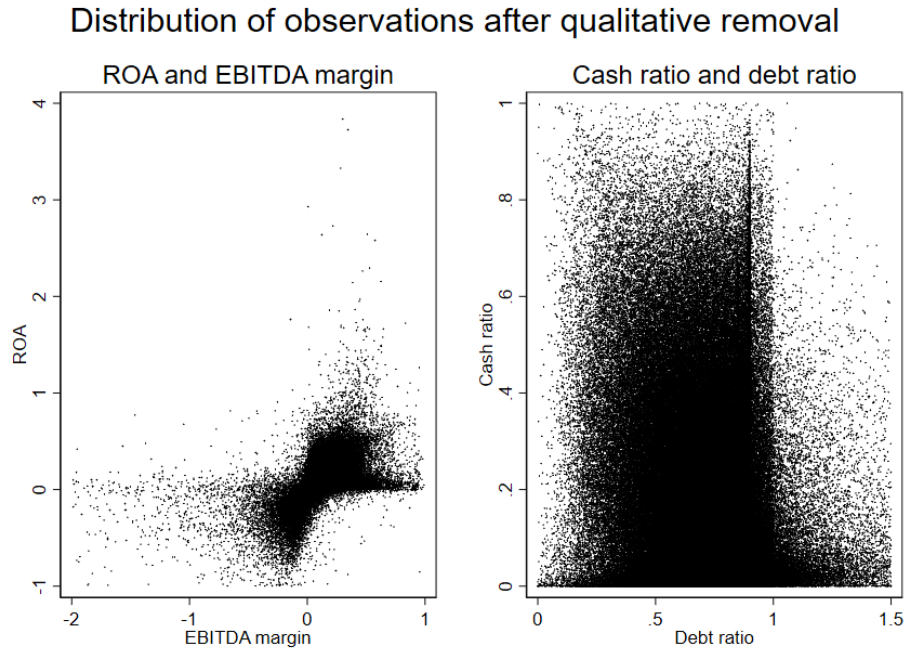

Figure 7.4: Distributions after outlier removal

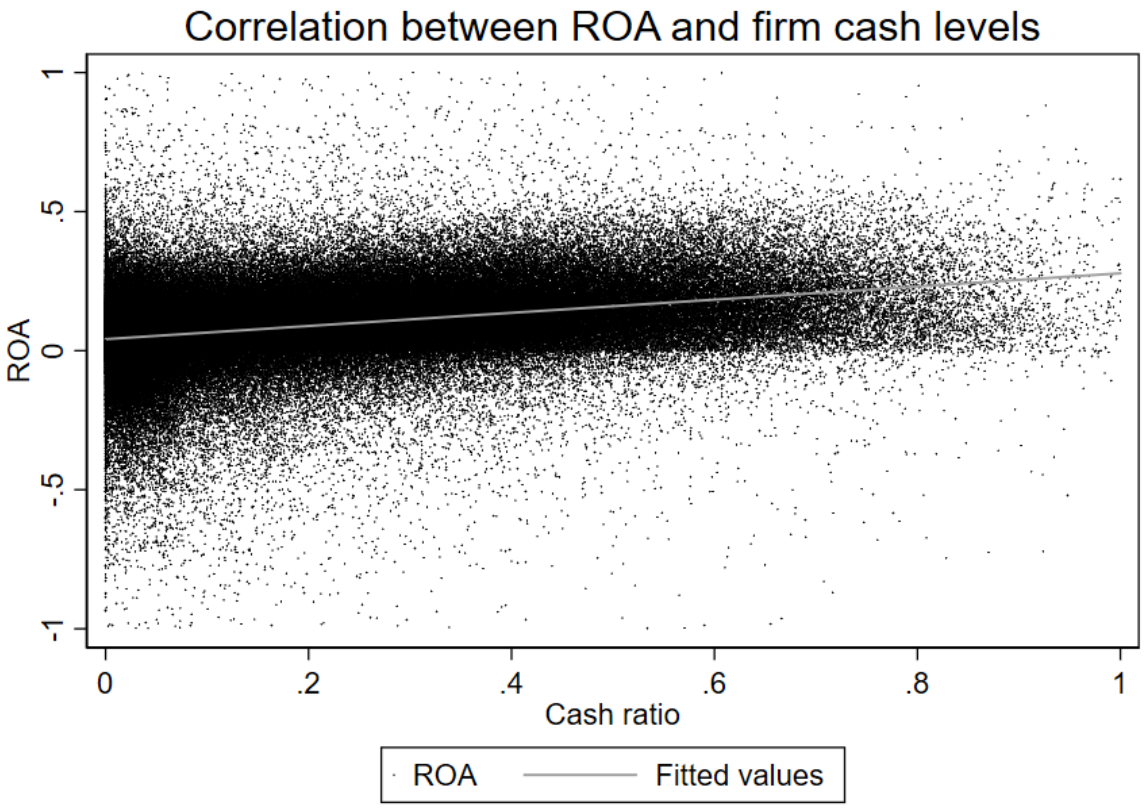

Figure 7.5: Distribution of ROA versus cash for all observations from 2005-2015

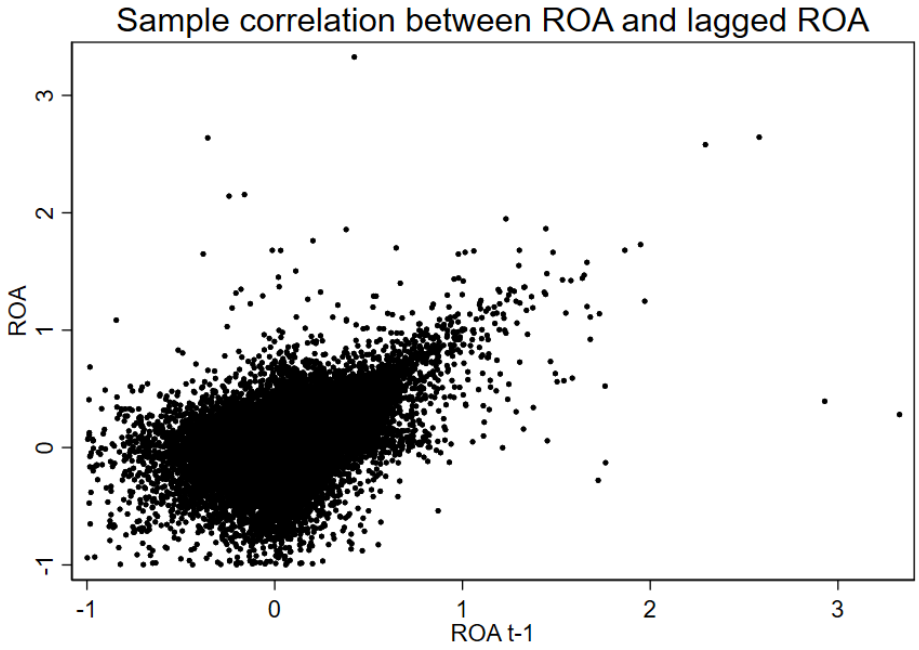

Figure 7.6: Autocorrelation for dependent variable

```
Linear regression                               Number of obs =      8,463
                                                F(290, 8171)  =          .
                                                Prob > F      =          .
                                                R-squared     =     0.4637
                                                Root MSE      =     .20677

                             Robust
roa          Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

AbsSlack    .0000203   .0001495     0.14   0.892    -.0002727    .0003133
DebtRatio  -.0250374   .0111685    -2.24   0.025    -.0469305   -.0031443
CapEx      -.0037656   .0025985    -1.45   0.147    -.0088592    .0013281
%           .0235411   .0011319    20.80   0.000     .0213222     .02576
lnemp       .0395351   .0032437    12.19   0.000     .0331767    .0458936
cashhat     .8829117    .116021     7.61   0.000      .655481    1.110342
cashhatsq  -2.679558   .2165104   -12.38   0.000    -3.103974   -2.255143
1.PostR    -.0260379   .0104005    -2.50   0.012    -.0464254   -.0056503

PostR#c.cashhat
1           .0409079   .1359536     0.30   0.764    -.2255957    .3074115

PostR#c.cashhatsq
1           .3330487    .315077     1.06   0.291    -.2845823    .9506797
```

Figure 7.7: Regression output from Nason and Patel (2016) with ROA as dependent variable

Table 7.1: Descriptive statistics of key variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ROA	0.104	0.108	0.120	0.100	0.0796	0.0791	0.0854	0.0888	0.0844	0.0908	0.0873
	(0.13)	(0.14)	(0.14)	(0.16)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
EBITDA marg.	0.0847	0.0881	0.0900	0.0803	0.0689	0.0721	0.0752	0.0753	0.0740	0.0764	0.0750
	(0.11)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)
Cash Ratio	0.188	0.196	0.210	0.214	0.215	0.213	0.213	0.216	0.215	0.219	0.224
	(0.18)	(0.19)	(0.19)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.21)
Sales growth	0.112	0.136	0.172	0.0628	-0.0181	0.0479	0.103	0.0884	0.0578	0.0697	0.0537
	(0.38)	(0.38)	(0.40)	(0.33)	(0.40)	(0.34)	(0.36)	(0.34)	(0.38)	(0.39)	(0.36)
Slack	0.471	0.472	0.469	0.484	0.500	0.499	0.497	0.499	0.504	0.503	0.504
	(0.32)	(0.30)	(0.27)	(0.29)	(0.30)	(0.30)	(0.28)	(0.30)	(0.28)	(0.28)	(0.29)
Debt Ratio	0.752	0.749	0.737	0.725	0.708	0.701	0.706	0.701	0.697	0.692	0.689
	(0.19)	(0.18)	(0.19)	(0.20)	(0.21)	(0.21)	(0.21)	(0.21)	(0.22)	(0.22)	(0.22)
C. Intensity	0.0424	0.0437	0.0464	0.0529	0.0323	0.0456	0.0363	0.0283	0.0331	0.0399	0.0469
	(0.59)	(0.69)	(0.57)	(0.56)	(0.69)	(0.78)	(0.88)	(0.83)	(0.62)	(0.67)	(0.97)
Altman's Z	3.505	3.480	3.600	3.644	3.511	3.521	3.557	3.591	3.604	3.652	3.645
	(2.55)	(2.32)	(1.96)	(3.71)	(2.18)	(2.18)	(2.39)	(2.06)	(2.11)	(2.64)	(1.99)
Size	10.62	10.63	10.64	10.62	10.60	10.61	10.61	10.61	10.61	10.61	10.60
	(1.11)	(1.12)	(1.12)	(1.11)	(1.11)	(1.12)	(1.13)	(1.13)	(1.13)	(1.14)	(1.14)
Observations	15777	17482	20178	20457	20711	20136	21553	22535	22794	23072	22708

mean coefficients; sd in parentheses

Table 7.2: Descriptive statistics of key variables - Wholesale

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ROA	0.103	0.110	0.121	0.100	0.0795	0.0820	0.0851	0.0935	0.0799	0.0763	0.0709
	(0.12)	(0.12)	(0.13)	(0.15)	(0.14)	(0.14)	(0.13)	(0.13)	(0.13)	(0.14)	(0.14)
EBITDA marg.	0.0646	0.0703	0.0739	0.0645	0.0521	0.0570	0.0595	0.0610	0.0562	0.0519	0.0496
	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Cash Ratio	0.158	0.157	0.173	0.178	0.182	0.179	0.174	0.175	0.172	0.170	0.169
	(0.16)	(0.16)	(0.17)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.17)
Sales growth	0.0935	0.113	0.161	0.0356	-0.0429	0.0223	0.0813	0.0703	0.0228	0.0605	0.0342
	(0.28)	(0.27)	(0.35)	(0.30)	(0.37)	(0.27)	(0.30)	(0.34)	(0.24)	(0.40)	(0.29)
Slack	0.304	0.298	0.298	0.316	0.330	0.335	0.327	0.329	0.329	0.324	0.321
	(0.22)	(0.21)	(0.17)	(0.24)	(0.20)	(0.25)	(0.20)	(0.22)	(0.20)	(0.19)	(0.18)
Debt Ratio	0.738	0.735	0.723	0.710	0.684	0.676	0.681	0.670	0.667	0.663	0.662
	(0.19)	(0.18)	(0.19)	(0.19)	(0.20)	(0.21)	(0.20)	(0.20)	(0.21)	(0.22)	(0.22)
C. Intensity	0.00847	0.0164	0.0139	0.0179	0.0121	0.0176	0.00630	0.0194	0.0188	0.0198	0.0260
	(0.11)	(0.10)	(0.10)	(0.14)	(0.16)	(0.73)	(0.30)	(0.33)	(0.25)	(0.53)	(0.64)
Altman's Z	3.667	3.635	3.762	3.742	3.628	3.637	3.643	3.726	3.710	3.771	3.738
	(1.66)	(1.63)	(1.65)	(1.75)	(1.75)	(1.72)	(1.66)	(1.70)	(1.68)	(3.48)	(1.73)
Size	11.02	11.03	11.07	11.05	10.98	10.98	10.99	11.01	11.00	11.02	11.01
	(1.13)	(1.12)	(1.14)	(1.15)	(1.15)	(1.17)	(1.17)	(1.18)	(1.19)	(1.19)	(1.21)
Observations	2538	2716	2993	2963	3042	2930	3075	3109	3069	3045	2965

mean coefficients; sd in parentheses

Table 7.3: Descriptive statistics of key variables - Manufacturing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ROA	0.0853	0.0914	0.106	0.0838	0.0596	0.0550	0.0632	0.0688	0.0615	0.0640	0.0630
	(0.11)	(0.12)	(0.13)	(0.14)	(0.14)	(0.13)	(0.12)	(0.13)	(0.14)	(0.13)	(0.14)
EBITDA marg.	0.0800	0.0830	0.0882	0.0776	0.0591	0.0624	0.0657	0.0663	0.0628	0.0643	0.0655
	(0.10)	(0.11)	(0.12)	(0.12)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)	(0.12)
Cash Ratio	0.139	0.144	0.156	0.153	0.162	0.162	0.156	0.158	0.161	0.158	0.163
	(0.15)	(0.15)	(0.16)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)	(0.18)	(0.17)	(0.18)
Sales growth	0.132	0.163	0.181	0.0484	-0.0632	0.0225	0.102	0.0781	0.0431	0.0726	0.0458
	(0.45)	(0.41)	(0.42)	(0.30)	(0.30)	(0.31)	(0.35)	(0.35)	(0.43)	(0.41)	(0.35)
Slack	0.455	0.453	0.446	0.461	0.484	0.486	0.484	0.481	0.490	0.488	0.484
	(0.19)	(0.21)	(0.21)	(0.20)	(0.22)	(0.20)	(0.26)	(0.30)	(0.22)	(0.23)	(0.30)
Debt Ratio	0.719	0.716	0.705	0.691	0.668	0.662	0.659	0.657	0.648	0.644	0.633
	(0.19)	(0.18)	(0.19)	(0.20)	(0.21)	(0.22)	(0.21)	(0.22)	(0.22)	(0.22)	(0.22)
C. Intensity	0.0355	0.0551	0.0586	0.0575	0.0235	0.0274	0.0245	0.0337	0.0221	0.0403	-0.00707
	(0.62)	(0.56)	(0.96)	(0.53)	(0.47)	(0.42)	(0.76)	(0.63)	(1.08)	(1.00)	(1.56)
Altman's Z	2.876	2.935	3.068	3.038	2.895	2.877	2.933	2.995	3.008	3.018	3.079
	(1.36)	(1.28)	(1.35)	(1.38)	(1.56)	(1.41)	(1.40)	(1.45)	(1.59)	(1.53)	(1.48)
Size	10.81	10.83	10.88	10.85	10.82	10.82	10.86	10.87	10.86	10.89	10.89
	(1.23)	(1.25)	(1.26)	(1.25)	(1.25)	(1.25)	(1.26)	(1.26)	(1.27)	(1.30)	(1.30)
Observations	2976	3193	3514	3484	3398	3231	3273	3384	3326	3277	3136

mean coefficients; sd in parentheses

Table 7.4: Industry classification

Industry	NACE code
KI-group 1 - Low knowledge intensity	
Preparation and spinning of textile fibres	131
Manufacture of other textiles	139
Manufacture of knitted and crocheted apparel	143
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing and dyeing of fur	151
Saw milling and planing of wood	161
Manufacture of products of wood, cork, straw and plaiting materials	162
Manufacture of steam generators, except central heating hot water boilers	253
KI-group 2 - Medium low knowledge intensity	
Aquaculture	032
Mining of non-ferrous metal ores	072
Quarrying of stone, sand and clay	081
Mining and quarrying n.e.c	089
Processing and preserving of meat and production of meat products	101
Processing and preserving of fish, crustaceans and molluscs	102
Manufacture of dairy products	105
Manufacture of grain mill products, starches and starch products	106
Manufacture of bakery and farinaceous products	107
Manufacture of other food products	108
Manufacture of prepared animal feeds	109
Manufacture of beverages	110
Weaving of textiles	132
Manufacture of wearing apparel, except fur apparel	142
Manufacture of pulp, paper and paperboard	171
Manufacture of articles of paper and paperboard	172
Printing and service activities related to printing	181
Manufacture of rubber products	221
Manufacture of plastics products	222
Manufacture of glass and glass products	231
Manufacture of other porcelain and ceramic products	234
Manufacture of cement, lime and plaster	235
Manufacture of articles of concrete, cement and plaster	236

Continued on next page

Table 7.4 – *Continued from previous page*

Industry	NACE code
Manufacture of abrasive products and non-metallic mineral products n.e.c.	239
Manufacture of basic iron and steel and of ferro-alloys	241
Manufacture of basic precious and other non-ferrous metals	244
Casting of metals	245
Manufacture of tanks, reservoirs and containers of metal	252
Manufacture of cutlery, tools and general hardware	257
Manufacture of domestic appliances	275
Manufacture of motor vehicles	291
Manufacture of bodies (coachwork) for motor vehicles; trailers and semi-trailers	292
Manufacture of furniture	310
Manufacture of sports goods	323
Manufacturing n.e.c.	329
Construction of residential and non-residential buildings	412
Construction of roads and railways	421
Construction of utility projects	422
Building completion and finishing	433
KI-group 3 - Medium high knowledge intensity	
Mining of hard coal	051
Extraction of natural gas	062
Processing and preserving of fruit and vegetables	103
Manufacture of vegetable and animal oils and fats	310
Manufacture of furniture	104
Manufacture of basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms	201
Manufacture of paints, varnishes and similar coatings, printing ink and mastics	203
Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	204
Manufacture of other chemical products	205
Manufacture of pharmaceutical preparations	212
Manufacture of tubes, pipes, hollow profiles and related fittings, of steel	242
Manufacture of structural metal products	251
Manufacture of weapons and ammunition	254
Treatment and coating of metals; machining	256
Manufacture of other fabricated metal products	259

Continued on next page

Table 7.4 – *Continued from previous page*

Industry	NACE code
Manufacture of computers and peripheral equipment	262
Manufacture of consumer electronics	264
Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus	271
Manufacture of wiring and wiring devices	273
Manufacture of electric lighting equipment	274
Manufacture of other electrical equipment	279
Manufacture of general-purpose machinery	281
Manufacture of other general-purpose machinery	282
Manufacture of agricultural and forestry machinery 283	
Manufacture of metal forming machinery and machine tools	284
Manufacture of other special-purpose machinery	289
Manufacture of parts and accessories for motor vehicles	293
Building of ships and boats	301
Manufacture of transport equipment n.e.c.	309
Manufacture of medical and dental instruments and supplies	325
Repair of fabricated metal products, machinery and equipment	331
Installation of industrial machinery and equipment	332
Electric power generation, transmission and distribution	351
Demolition and site preparation	431
Electrical, plumbing and other construction installation activities	432
Other specialised construction activities	432
Wholesale of food, beverages and tobacco	463
Wholesale of household goods	464
Wholesale of other machinery, equipment and supplies	466
Other specialized wholesale	467
Sea and coastal passenger water transport	501
Sea and coastal freight water transport	502
Freight air transport and space transport	512
Support activities for transportation	522
Satellite telecommunications activities	613
KI-group 4 - High knowledge intensity	
Extraction of crude petroleum	061
Support activities for petroleum and natural gas extraction	091

Continued on next page

Table 7.4 – *Continued from previous page*

Industry	NACE code
Manufacture of basic pharmaceutical products	211
Manufacture of electronic components and boards	261
Manufacture of communication equipment	263
Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks	265
Manufacture of irradiation, electromedical and electrotherapeutic equipment	266
Manufacture of air and spacecraft and related machinery	303
Steam and air conditioning supply	353
Wholesale of information and communication equipment	465
Passenger air transport	511
Publishing of books, periodicals and other publishing activities	581
Software publishing	582
Wired telecommunications activities	611
Wireless telecommunications activities	612
Other telecommunications activities	619
Computer programming, consultancy and related activities	620
Data processing, hosting and related activities; web portals	631
Activities of head offices	701
Architectural and engineering activities and related technical consultancy	711
Technical testing and analysis	712
Research and experimental development on natural sciences and engineering	721
Research and experimental development on social sciences and humanities	722
Other professional, scientific and technical activities n.e.c.	749

	ROA	Cash ratio	$Cash^2$	IV	Market share	Annual sales growth	Slack	Debt ratio	Altman's Z	C. Intensity	Size
ROA	1.000										
Cash ratio	0.316***	1.000									
$Cash^2$	0.276***	0.939***	1.000								
IV	0.302***	0.978***	0.925***	1.000							
Market share	-0.007***	-0.048***	-0.032***	-0.036***	1.000						
Annual sales growth	0.117***	-0.006***	-0.009***	-0.009***	0.027***	1.000					
Slack	-0.135***	0.063***	0.063***	0.066***	0.007***	-0.071***	1.000				
Debt ratio	-0.179***	-0.182***	-0.151***	-0.199***	-0.017***	0.064***	-0.000	1.000			
Altman's Z	0.303***	0.249***	0.194***	0.232***	-0.051***	0.028***	-0.295***	-0.079***	1.000		
C. Intensity	-0.004*	-0.036***	-0.029***	-0.032***	0.005**	0.035***	0.063***	-0.011***	-0.049***	1.000	
Size	-0.031***	-0.211***	-0.167***	-0.173***	0.294***	0.134***	-0.307***	0.005**	0.036***	0.007***	1.000

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7.5: Correlation matrix