Master Thesis

The determinants of cash holdings: Evidence from German listed firms

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Abstract

This thesis examines the firm specific determinants of cash holdings for a sample of 270 German listed firms over the period from 2005 to 2013. I test the predictions for the various firm-specific determinants, which are suggested by three theoretical models: the trade-off model, the pecking order theory and the free cash flow theory. I find that firm size, leverage, bank debt and liquid assets have significant negative influences on cash holdings. Moreover, the variable investment opportunity turns out to be positively related with cash holdings. Hence, it can be concluded that the trade-off model prevails in explaining most of the variation in cash holdings among German listed firms. The pecking-order theory receives reasonable support as well, while there is only weak support for the free cash flow theory. Besides, I find that the overall effect of the firm-specific determinants, and particularly the effect of leverage, decline during the period after the global financial crisis (2009-2013). This may be attributed to the creditors' increased prudence and the tightening of their credit policy, following the financial crisis.

Keywords: *Cash holdings, trade-off model, pecking-order theory, free cash flow theory, firm-specific determinants*

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1 Introduction

Cash is an essential component on each company's balance sheet. Although the metaphor: "Cash is the lifeblood of every company" is being used almost inflationary by various textbooks and academics within the business domain, it is still a good phrase to highlight the importance of the concept. So when talking about cash, the first central question that emerges is: "What are the reasons for a company to hold cash?"

This question has been arousing the interest of scholars for decades and it is still a focal point of discussion in modern financial literature. This may be due to the controversial nature of the topic because in a world of perfect capital markets, where capital would always be available to fund new projects, there would not exist any benefits related with holding cash. However, in the real world with financing frictions, information asymmetries and transaction costs the story becomes more complicated. Therefore, researchers have devoted a great deal of attention in order to investigate the determinants for companies to hold cash.

One popular explanation is that cash provides low cost financing for firms (Ozkan and Ozkan, 2004). According to this view, the presence of information asymmetry between firms and external investors raises the costs of external financing and hence the use of internal funds is preferred (Myers and Majluf, 1984). Next to this, there are transaction costs and other financial restrictions as well as agency problems of underinvestment and asset substitution (Myers, 1977; Jensen and Meckling, 1976). Clearly, all these factors speak in favour of holding cash, thus managers in imperfect capital markets would simply try to minimize these costs by always keeping a sufficient amount of cash in hand. However, there are also potential adverse effects that are related with holding cash. A central argument supporting this view is that the everlasting agency conflict between managers and shareholders in a firm becomes more severe, once firms have large amounts of free cash flow (Jensen, 1986). Shareholders may fear the risk that managers will pursue investment opportunities, using excess cash, which serve their own interest rather than the interest of the shareholders.

Given the ambiguity that is inherent in these theoretical predictions, it remains an empirical question whether cash holdings can be explained by optimal financial planning and precautionary motives rather that by managerial opportunism (Drobetz and Grüninger, 2007).

There have been several empirical papers attempting to identify the determinants for companies to hold cash. Mostly, scholars employed predictor variables stemming from

three basic theoretical models, namely the trade-off model, the pecking-order theory and the free cash flow theory (Jensen, 1986; Myers, 1977; Myers and Majluf, 1984). These theories cover the aforementioned potential factors that may drive a firm's decision to hold more or less cash.

The majority of studies conducted so far in this particular domain are based on US firms (e.g. Bates et al., 2009; D'Mello et al., 2008; Han and Qui, 2007; Harford et al., 2008; Kim et al., 1998; Opler et al., 1999). In contrast, there is only a limited number of papers available that focuses on the cash holdings of firms across countries (e.g. Ferreira and Vilela, 2004; Ozkan and Ozkan, 2004; Pinkowitz and Williamson 2001). Among those is the paper by Ferreira & Vilela (2004), which focuses on publicly listed surviving and non-surviving firms from the EMU countries over a period from 1987 to 2000. Another study that deals with non-US firms is the one by Ozkan & Ozkan (2004), which is based on non-financial listed UK firms. Furthermore, Pinkowitz & Williamson (2001) study the determinants for cash holdings in German as well as Japanese publicly traded industrial firms and Bigelli & Sanchez-Vidal (2010) investigate Italian private firms. When considering the publications of high quality financial journals, the coverage of research on cash holdings in German firms is rather sparse, especially starting from the year 2000. Since, this paper examines a sample period from 2005 to 2013, it can be regarded as a valuable contribution to the academia in a sense that it will deliver updated findings on the determinants of cash holdings in German listed firms, by testing factors that have been proposed by previous authors. Moreover, to the best of my knowledge, there are only a few papers that examine the determinants of cash holdings of German listed over the period of the financial crisis. Hence, it may be interesting to see which effect the financial crisis exerts on the firm-specific determinants of cash holdings.

However, the main goal of this paper is to examine the effects of the firm-level determinants on cash holdings, proposed by the trade-off model, the pecking order theory and the free cash flow theory. Hence, the following research question and the respective subquestions are formulated as follows:

RQ: To what extent do the firm specific determinants, proposed by the trade-off model, the pecking-order theory and the free cash flow theory, have an influence on cash holdings of German listed firms?

Subquestions

1. How are cash holdings defined?
2. Which firm specific factors have a significant influence on cash holdings of German listed firms?
3. What may be reasons for the positive or negative influences of the respective firm specific factors on cash holdings?

The sample for this study comprises 270 German listed firms over the period from 2005 to 2013. By means of different regression analyses I test the influence of the firm-specific determinants on cash holdings. The main findings are that firm size, leverage, bank debt and liquid assets exert significant negative influences on cash holdings, while investment opportunity and cash holdings are positively associated. Thereof it can be concluded that the trade-off model receives the strongest support and the pecking-order theory receives reasonable support as well. In contrast, there is only little support for the free cash flow theory. As part of a supplementary analysis I also test whether different sample compositions have an impact on the explanatory power of the firm-specific determinants and on cash holdings. Here, I find that DAX listed firms hold significantly less and TecDAX listed firms hold significantly more cash than the remaining sample firms. Moreover, I find that in the period after the global financial crisis, the impact of the various firm-specific determinants on cash holdings declines.

The remainder of this thesis is organized as follows. Section 2 briefly reviews the extant literature on the determinants of cash holdings and presents the main underlying theories. In Section 3 it is described, which research methods are applied to analyse the data. Subsequently, in Section 4, the data is briefly described and the measurement of variables is presented. Eventually, the results of the regression analyses are presented and discussed in Section 5. Based on the results, a conclusion is drawn in Section 6.

2 Literature review

In the following section the extant body of literature, revolving around the topic cash holdings, will be reviewed. In doing so, the concept of cash holdings and its advantages and disadvantages will be explained. Next to that it will be defined, which components constitute cash holdings. Afterwards, the three theoretical models: trade-off model, pecking order theory and free cash flow theory will be explained and their assumptions about the various firm specific determinants will be examined. Although the primary purpose of this thesis is to determine the effects of the firm-specific determinants on cash holdings, recent efforts in the literature have found that also less observable factors such as institutional differences and the national culture of the firms' countries of origin have an effect on cash holdings (Chang and Noorbakhsh, 2009; Chen et al., 2015; Guney et al., 2007). Next to that, scholars also find that the quality of corporate governance of each firm exerts an influence on cash holdings as well (Dittmar et al., 2003; Dittmar and Marth-Smith, 2007; Harford et al., 2008). Hence, after dealing with the firm-specific determinants I will discuss these other factors that might also affect cash holdings. Finally, the suggestions by the theories as well the findings by the respective authors will be summarized and hypotheses will be formulated, accordingly.

2.1 Cash holdings

Cash is a crucial component for the day-to-day operations of every company. It provides the firm with liquidity and it facilitates the payment of various types of obligations. Without sufficient liquid assets a company will not be able to meet those obligations and hence it will be forced to declare bankruptcy, sooner or later. According to the literature, cash holdings are commonly defined as cash and marketable securities or cash equivalents (Opler et al., 1999). Cash equivalents are current assets, which can be converted into cash in a very short term and are thus characterized by a high degree of liquidity. They include for instance U.S. treasury bills, certificates of deposits, banker's acceptances and further money market instruments. Those securities have a low-risk, low-return profile (Ferreira and Vilela, 2004; Opler et al., 1999; Ozkan and Ozkan, 2004).

If there were perfect capital markets, firms would not feel the need to hold liquid assets, but they would be easily able to raise external capital. As this is not the case in the real world, it is to assume that financial frictions are responsible for causing such ambiguous predictions with respect to holding cash (Drobetz and Grüninger, 2007). Thus,

there are a few basic theoretical models that emerge from the extant body of academic literature and compete for an explanation of the variation in the level of cash holdings across firms.

There are indeed several benefits related with holding cash, but there are also disadvantages and costs that firms have to incur when they hold cash. In fact, there might be a large variety of reasons, which justifies the holding of cash, but from the literature one can identify two dominant motives, which presuppose certain behaviours related with the use of cash (Ozkan and Ozkan, 2004). The first one is the transaction cost motive and the second one is the precautionary motive. According to the transaction cost motive there are fixed and variable costs related with raising external capital, which gives rise to the assumption of an optimal level of cash holdings and prompts firms to hold cash as a buffer (Ferreira and Vilela, 2004; Opler et al. 1999; Ozkan and Ozkan, 2004). In contrast there is the precautionary motive, which stresses the presence of asymmetric information, agency costs and the opportunity costs of forgone investments. Here, the notion is that if the costs of adverse selection of external finance are excessively high, firms tend to accumulate cash or other liquid assets as prevention mechanism in order to hedge against future shortfalls in cash and being forced to pass on positive net present value investments. So, from those two motives one can derive three main categories with distinct underlying theoretical assumptions. The first category represents the transaction cost model, the second deals with information asymmetries and the agency cost of debt and the third category comprises agency costs related to managerial discretion. Although, former papers also dealt with those theoretical models, there is no clear consensus on the way the models are related to their respective theoretical foundations. This may be due to the fact that the theories overlap to a certain extent with regard to their model explanations. For instance, Ferreira and Vilela (2004) assume a clear-cut distinction between three theoretical models: the trade-off model, the pecking order theory and the free cash flow theory. In contrast, Opler et al. (1999) categorize their theoretical section based on the factors: transaction costs, information asymmetries, agency costs and financing hierarchy, without explicitly allocating them to their respective theories. Moreover, Ozkan and Ozkan (2004) and Bates et al. (2009) apply yet another categorization. Thus, the absence of a clear taxonomy regarding the theories impedes the comparability between the findings about the determinants of cash holdings by different authors.

In order to facilitate a good overview and enable a distinction between the underlying theoretical assumptions I am going to follow the structure proposed by Ferreira and Vilela (2004). Henceforth, I will distinguish between the trade-off model, the pecking order theory and the free cash flow theory. That way one can easily summarise the predictions by the different models, and develop the hypotheses subsequently.

2.2 Firm-specific determinants

2.2.1 Trade-off model

According to the trade-off model, which assumes that the management of a firm is concerned with the maximization of shareholder value, the goal would be to reach an optimal level of cash holdings by weighing the marginal costs and benefits of holding cash (Ferreira and Vilela, 2004). First, cash holdings effectively reduce the likelihood of financial distress, because in case the firm faces unexpected losses or capital market constraints, cash can act as a safety reserve. Second, firms may benefit from cash on their balance sheets by saving transactions costs related to raising funds on the capital market and also to avoid the liquidation of assets to meet obligations (Opler et al., 1999). Put more simply, the holding of cash can serve as a buffer between the firm's internal resources and the funds that would have to be generated externally, which as a result minimizes costs. Finally, sufficient cash holdings can ensure the pursuance of an optimal investment policy, especially when the firms' access to external capital markets is limited (Ferreira and Vilela, 2004). Hence, those firms would not be forced to pass on positive NPV investment projects. This benefit particularly pertains to high growth firms, with large amounts of intangible assets, whose firm value is largely determined by their growth opportunities. However, a traditional source of the cost of cash holdings is represented by opportunity costs, which are incurred by firms when they forgo profitable investment opportunities. These opportunity costs are generally also referred to as a liquidity premium. This liquidity premium expresses itself by means of a lower return that the firm generates by holding these assets (Kim et al., 2011). In Appendix 7, this trade-off between the benefits and costs of holding cash or liquid assets is illustrated by the marginal cost of liquid asset shortage curve and the marginal cost of liquid asset (holdings). At the point where those two curves intersect, there is an optimal amount of cash holdings according to the transaction costs model.

Firm size

The Miller and Orr (1966) model of demand postulates that large firms can benefit from economies of scale with respect to cash management[1]. Therefore, large firms would hold less cash than small firms. A further premise of this model is that it is expected that there is no correlation between the fees of borrowing and the size of a loan, which indicates that such fees are a fixed amount (Ferreira and Vilela, 2004). This leads to the assumption that smaller firms are encouraged to hold more cash than larger firms, because raising funds is more expensive for them. Another argument that is supportive of this view is that larger firms have a lower probability of financial distress because they have a higher level of diversification, which in turn reduces their costs of capital (Rajan and Zingales., 1995).

Leverage

It is generally accepted that highly levered firms entail a higher risk of bankruptcy, due to the fact that the rigid nature of amortization plans by creditors pressures the treasury management of firms (Ferreira and Vilela, 2004; p.299)[2]. In order to reduce this related risk, highly levered firms are expected to hold larger amounts of cash. However, there is another notion, which challenges this assumption. Generally, the extent to which a firm is financed by debt gives an indication of a firm's ability to raise debt. Thus, firms with high leverage ratios are also expected to have a better access to debt capital and hence they would hold less cash, accordingly. So, from a static trade-off perspective the factor leverage would have a somewhat ambiguous relation with cash holdings, due to these competing assumptions.

Bank debt

With bank debt the expected relation is similar as compared to leverage. A high bank debt ratio indicates that the respective firm has a close relationship with banks. Due to

[1] The Miller and Orr model (1966) is a cash management tool that helps firms determine their optimal cash balance by allowing for daily fluctuations in cash in- and outflows between an upper and a lower limit. Only when those limits are reached a sale or purchase of cash or marketable securities is necessary.

[2] With the term "rigid nature" the necessity of interest payments shall be stressed. Unlike dividend payments, interest payments cannot be omitted, otherwise creditors can force the firm to declare bankruptcy (Rajan and Zingales, 1995).

the monitoring function of banks, it is believed that information asymmetries can be mitigated and wasteful behaviour by managers prevented (Pinkowitz and Williamson, 2001). This would ultimately lead to reduced costs for additional bank loans and thus firms with high bank debt ratios would be inclined to hold less cash than firms with low bank debt ratios (Ferreira and Vilela, 2004).

Cash flow

According to Kim et al. (1998), cash flow represents a ready source of liquidity and hence it acts as a substitute for cash holdings. Thus one would expect a negative relation between cash flow and cash holdings.

Cash flow volatility

Generally, the more volatile the cash flows of a firm are, the less certainty there is about their future occurrence. Therefore, firms with highly volatile cash flows are more likely to face financial distress in the future. Hence, those firms would be inclined to hold larger cash reserves as opposed to firms with more stable cash flows, in order to reduce the associated risk of financial distress. Consequently, it is expected that cash flow volatility and cash holdings have a positive relation (Ozkan and Ozkan, 2004).

Liquid assets substitutes

Ferreira and Viela (2009) posit that all liquid assets other than cash can be regarded as substitutes, because its quick liquidation can provide ready funding in times of need. Liquid assets other than cash may be for instance net working capital and for some types of companies even inventory can serve as liquid asset, when it is quickly convertible into cash. Hence, one can infer that firms with large amounts of liquid assets would hold less cash. Thus, the relation is expected to be negative. This is also supported by the fact that the conversion of non-cash liquid assets to cash is deemed cheaper and easier than the conversion of other assets (Ozkan and Ozkan, 2004). A popular example of such a means of raising liquidity would be the liquidation of receivables through factoring or securitization (Opler et al., 1999).

Investment opportunity set

Due to the fact that costly external financing raises the probability of a firm to pass on valuable investment opportunities, firms hold sufficient liquid assets, (e.g. in the form of cash) in order to be able to take advantage of most of the profitable investment opportunities that present themselves at a certain point in the future, at lowest costs (Kim et al., 2011; Opler et al., 1999; Ozkan and Ozkan et al., 2004). As a result, it is suggested that firms with greater investment opportunities tend to accumulate larger amounts of cash in order to prevent raising costly external capital. Hence, one would expect a firm's investment opportunities and its cash holdings to be positively related. This especially holds with firms, whose values are largely determined by their growth opportunities because these firms generally have a higher exposure to adverse shocks and financial distress (Kim et al., 2011). Investment opportunities are recorded as intangible assets on a balance sheet and therefore, as soon as the firm faces financial distress, those opportunities cease to exist. This ultimately affects the costs of external capital for high growth firms because investors and creditors have less collateral in case of a bankruptcy. So, it is expected that those firms aim to hedge against this risk by holding larger amounts of cash.

Dividend payments

Ferreira and Vilela (2004) suggest that firms that pay dividends can rise funds at low costs by reducing dividend payments. On the opposite, firms that do not pay dividends would have to go to the capital market to raise funds. Hence, it is expected that dividend payments have a negative influence on cash holdings. However, this view stands in contrast with some empirical evidence. Brav et al. (2005) investigate the dividend payout policy of firms in the 21st century. The authors interviewed financial executives of 384 firms and they found out that that those executives would rather decide to pass on positive NPV projects than making dividend cuts. This finding can be attributed to the detrimental effect, announcements about dividend cuts have on the share price of a company (Hiller et al., 2013). Moreover, Brav et al. (2005) find that the majority of the interviewed executives (68%) would rather raise external capital before cutting dividends. Hence, the inherent contradictions of dividend payments lead to an ambiguous expectation regarding the relation with cash holdings.

2.2.2 Pecking-order theory

The second main theory, this paper deals with, is the pecking-order theory. Myers and Majluf (1984) posit that information asymmetries between managers and shareholders make external financing costly. Hence, in the presence of asymmetric information managers tend to prefer the use of internally generated funds to informational sensitive external capital and that they follow a so-called hierarchy of financing policies. Here, internal funds represent the most favourable option to finance investments, followed debt capital and the issuance of equity is viewed as being the least favourable source of financing. . Myers and Majluf (1984) argue that this particularly applies to firms, whose values are determined by growth options. If a firm is evaluating several investment opportunities that may increase its value, while being short of cash, it probably has to pass on some of those valuable investments. Thus, firms with such investment opportunities would be inclined to hold more cash in order to decrease the likelihood of being forced to give up some of those value-enhancing investments.

Size

The pecking-order theory posits that large firms presumably have been more successful and therefore they should have more cash available, after controlling for investment (Ferreira and Vilela, 2004).

Cash flow

Also the cash flow of a firm is expected to be positively related with cash holdings when applying the financing hierarchy theory on this matter. Since, internally generated funds are preferred over costly external capital a firm is induced either to retain the excess cash available after accounting for capital expenditures or to pay off debt (D'Mello et al., 2005). Accordingly, firms with high cash flows would hold large amounts of cash and vice versa.

Investment opportunity set

According to Ferreira and Vilela (2004), in the presence of a large set of investment opportunities firms require large stocks of cash, because cash shortfalls would imply that the firms would have to forgo those opportunities. Hence, one would expect a positive

relation. This prediction basically aligns with the predictions of the trade-off model, however, the interpretation differs a bit. While the trade-off model argues more from a transaction cost perspective, the pecking order theory rather represents the precautionary motive of holding cash. This means that the trade-off model merely regards the high costs of external capital as the issue, whereas the pecking order theory points at the possibility that the firm may even be completely restricted from external financing.

Leverage

In line with the hierarchy of financing assumption, the pecking-order theory posits that when the level of investment exceeds the level of retained earnings, the amount of cash held decreases and the amount of debt increases, accordingly (Ferreira and Vilela, 2004). Thus from a pecking-order perspective the relation between leverage and cash holdings would also be negative.

Bank debt

As with the trade-off model the pecking order theory also predicts a negative relation with bank debt. Banks tend to be more effective in reducing problems associated with information asymmetries and agency conflicts than other lenders. It is being argued that this is mainly due to their "comparative advantage in monitoring a firms' activities and in collecting and processing information" (Ozkan and Ozkan, 2004; p.2108). Additionally, a banks willingness to provide a loan is generally received by the public as a positive sign, which ultimately leads to a decrease in the firms' external costs of capital. Thus the precautionary motive for holding cash is reduced.

2.2.3 Free cash flow theory

The free cash flow theory challenges the assumption about an optimal level of cash holdings. According to Jensen (1986), firms may not always be inclined to hold the amount of cash that will maximize the shareholders' value. The theory is based on the notion that there are some firms that hold excessive cash. Jensen (1986) argues that managers tend to appreciate cash because it enhances their discretionary power to make investments and acquisitions that would not have been approved by the capital market, and thus they have more flexibility to pursue their own interests. For shareholders this might not be a desired situation because it can have a detrimental effect on the value of the firm. So, despite the benefits for managers to hold cash, the related agency

problems, caused by this, may ultimately undercut firm value. This is due to the fact that shareholders automatically downgrade a stock when they believe that managers may be hoarding cash for non-identifiable purposes. Hence, Jensen (1986) argues that increases in leverage may enhance firm value, while cash holdings play a less significant role. This view is also supported by Myers and Majluf (1984), who suggest that firms do not target any specific holding-levels.

Investment opportunity set

From an agency or free cash flow perspective, entrenched managers of firms that only have poor investment opportunities at their disposal, tend to hold more cash in order to ensure the availability of funds to invest even in negative NPV projects (Drobetz and Grüninger, 2007; Ferreira and Vilela, 2004). Eventually, this would lead to a destruction of shareholder value. Hence, according to this perspective the relation between investment opportunities and cash holdings would be negative.

Leverage

The agency perspective emphasizes the monitoring role of debt. In a highly levered firm managers are disciplined by debt covenants and requirements that are imposed on them by their creditors. Hence, managers would have less discretionary power over the employment of funds. In contrast, managers in firms with a low amount of leverage have a greater leeway in decision-making because they are less subject to monitoring and thus their discretionary power is larger. Therefore, it is expected that less levered firms hold more cash (Ferreira and Vilela, 2004; Opler et al., 1999).

Bank debt

In line with the trade-off model and the pecking order theory, the free cash flow theory also predicts a negative relation with bank debt. According to Pinkowitz and Williamson (2001) bank debt, because of its monitoring role, should contribute to an elimination of the cash hoarding behaviour by managers, who pursue their own interests, rather than the interests of the shareholders.

Size

Ferreira and Vilela (2004) posit that larger firms generally have a higher degree of shareholder dispersion. In turn this would give rise to superior managerial discretion.

Opler et al. (1999) argue that firm size is a takeover deterrent because in order for the bidder to acquire a large target it requires more resources. Next to that, managers of large firms can more easily benefit from the use of the political arena (Opler et al., 1999). Hence, Ferreira and Vilela (2004) argue that the enhanced discretionary power enables managers to exert a higher influence on firm and investment policies, which leads to a greater amount of cash. Here, one would expect a positive relation between firm size and cash holdings.

2.2.4 Ownership and control

An additional factor influencing cash holdings, which is not examined in the regression analyses due to the lack of data, is the type of ownership and control of a firm. Guney et al. (2007) study the cash holding behaviour of 4,069 companies from France, Germany, Japan, the UK and the US. Their findings show that the ownership in the UK, in the US and in Japan is largely dispersed while in France and Germany it is highly concentrated. For Germany they measure the highest ownership concentration of 50%.

Guney et al. (2007) argue that the ownership concentration can potentially impact the agency costs between managers and shareholders. They posit that one way to control agency problems would be to effectively monitor the behaviour by managers. However, for shareholders, who own merely a small share of the firm, the costs of monitoring would outweigh the benefits that would arise from reduced agency problems. In contrast, shareholders who have a claim on large parts of the firm, would be able to monitor the managers more effectively. Consequently, firms whose ownership is largely concentrated are better able to control for these agency problems and thus they also face lower costs of external capital. This in turn would mean that those firms feel less of an incentive to hoard large amounts of cash. Guney et al. (2007) support this assumption by the results of their regression analysis.

2.3 Country-specific determinants

Beside the firm-specific determinants, there are also country-specific determinants such as creditor protection, shareholder protection and national culture that affect the cash holding incentives of firms (Guney, 2007). Hence in this section I discuss several country-specific factors, found by previous authors, which have an effect on cash holdings.

2.3.1 Legal environment

Dittmar et al. (2003) refer to agency problems between shareholders and managers, which are also central to the free cash flow theory (Jensen, 1986). As opposed to the trade-off model and the pecking order theory, the agency cost motive (or free cash flow theory) has received rather weak support by the vast majority of studies. Dittmar et al. (2003) claim that a reason for this may be that most studies about corporate cash holdings have been conducted in the US. Since in the US (a common law country) shareholders enjoy a high protection, they can force managers to return excess cash. Hence, in countries where there is already a good shareholder protection, the variation in agency costs is too low to determine a significant effect on cash holdings. Therefore, Dittmar et al. (2003) choose to draw an international sample of firms in order to shift the attention to the role of corporate governance in the determination of cash holdings. In their paper they study more than 11,000 firms from 45 countries and they find evidence that companies in countries with weak shareholder protection, hold significantly more cash than companies that are located in countries with strong shareholder protection. This finding may be explained by the fact that entrenched managers in countries with weak have a higher discretionary power, because they can escape the scrutiny of the capital market more easily. This leads them to accumulate excess cash (Guney et al., 2007).

Moreover, Guney et al. (2007) distinguish between shareholder and creditor protection. Contrary to the shareholder protection, they assume that firms in countries, which offer a good creditor protection tend to accumulate higher amounts of cash. This is due to the fact that in the presence of strong creditors, the likelihood of bankruptcy increases when firms face financial distress. Hence, they argue that those firms tend to more conservative regarding the levels of cash they hold as they want to reduce the threat, represented by those strong creditors.

2.3.2 National Culture

Another influential country-specific factor, which has just recently started to attract more attention, is the national culture. Thus, the coverage of literature on the effect of national culture on cash holdings is still sparse. Chang and Noorbakhsh (2009) and Chen et al. (2015) studied the impact of national culture on cash holdings. The central assumption of their papers is grounded on the notion that, despite similar levels of investor protection among different countries, firms might still differ in the way they perceive agency problems and in the way they value financial flexibility, which is caused by their diverse cultural inheritances (Chang and Noorbakhsh, 2009). Both papers apply the cultural dimensions by Hofstede (1980) on the cash holdings of firms from more than 40 different countries. The framework by Hofstede (1980) consisted originally of four dimensions, where each dimension captures a particular cultural characteristic. The four dimensions are: individualism, power distance, uncertainty avoidance and masculinity. I will only briefly explain the meaning of each of these dimensions. Individualism in this context basically refers to the degree to which managers are concerned with their own wealth and interests, rather than with the wealth of shareholders. Power distance refers to the degree to which employees are willing to accept large differences in managerial power within the organisation. Uncertainty avoidance refers to the degree to which firms are reluctant to accept uncertain or unknown situations. Eventually, masculinity represents the degree to which managers are performance, and results-driven rather than seeking for equality and maintaining social relationships. Chang and Noorbakhsh (2009) find that firms in countries that are characterized by a high degree of uncertainty avoidance and masculinity tend to hold larger cash reserves. Moreover, Chen et al. (2015) find a significant negative association between individualism and cash holdings and in line with Chang and Noorbakhsh (2009), they also find a significant positive relation between uncertainty avoidance and cash holdings. Their interpretation for this finding is that firms, which do not tolerate uncertainty, especially with regard to future cash flows, are more inclined to hold larger cash reserves as a buffer to ensure against financial distress. Chen et al. (2015) state that the precautionary motive for holding cash is basically a function of uncertainty. Next to that, the negative relation between individualism can likely be explained by the fact that highly individualistic managers tend to be overly confident with the firms situation and thus tend to underestimate the need of cash. Finally, Chang and Noorbakhsh (2009) argue that the positive relation between masculinity and cash hold-

ings can be attributed to the fact that highly masculine managers strive for personal success and this sometimes involves taking risky, value-reducing investment opportunities. However, this would not be possible with external funds as they need approval by the capital market and hence masculine managers are inclined to accumulate large amounts of cash, in order to avoid that situation.

So, in conclusion it is to remark that when comparing the cash holdings of firms from different countries with each other, it is important to take into account differences regarding the legal environment as well as the national culture of a firm's country of origin. As I am observing a single country in this thesis, though, these country specific factors will not be relevant in the following regression analyses. Nevertheless, it is important to mention those factors as well in order to provide a more holistic view on the concept of cash holdings.

2.4 Hypotheses Development

In this section the predictions of the three models: trade-off model, pecking-order theory and free-cash flow theory as well as the findings of the respective authors regarding the influence of the firm-specific factors: firm size, leverage, bank debt, cash flow, cash flow volatility, liquid assets, investment opportunity and dividend payment on cash holdings are summarized in Table 1 and Table 2, respectively.

Table 1: Summary of model predictions

Firm-specific factors	Trade-off model	Pecking-order theory	Free Cash flow theory
Firm size	-	+	+
Leverage	-/+	-	-
Bank Debt	-/+	-	-
Cash Flow	-	+	n.a.
Cash Flow Volatility	+	n.a.	n.a.
Liquid Assets	-	n.a.	n.a.
Investment Opportunity	+	+	-
Dividend payment	-	n.a.	n.a.

In Table 1 the relationships of the firm-specific factors with cash holdings are displayed. Here, a "+" indicates that the explanatory (firm-specific) variable is significantly positively related with the dependent variable. A "-" indicates a negative relationship and in cases in which the models do not make any assumptions on the relation to cash holdings, the respective variables are denoted with "n.a." *Source:* Ferreira and Vilela (2004)

Table 2: Summary of findings on cash holdings

Firm-specific factors	Ozkan and Ozkan (2004)	D'Mello et al. (2008)	Opler et al. (1999)	Ferreira and Vilela (2004)	Drobetz and Grüninger (2007)	Harford et al. (2008)	Kim et al. (2011)
Firm size	n.s.	-	-	-	-	n.s.	-
Leverage	-	-	-	-	-	-	n.a.
Bank Debt	-	n.a.	n.a.	-	n.a.	n.a.	n.a.
Cash Flow	+	n.a.	+	+	+	+	n.s.
Cash Flow Volatility	n.s.	n.a.	+	-	+	+	n.a.
Liquid Assets	-	-	-	-	-	-	-
Investment Opportunity	+	+	+	+	n.s.	n.s.	+
Dividend payment	n.s.	n.a.	-	n.s.	+	-	-

In Table 2 the relationships of the firm-specific factors with cash holdings are displayed. Here, a "+" indicates that the explanatory (firm-specific) variable is significantly positively related with the dependent variable. A "-" indicates a negative relationship and "n.s." indicates that the authors do not find a significant relationship between the respective firm-specific variable and the dependent variable. Cases in which authors did not test the respective variables are denoted with "n.a."

Table 1 depicts a summary of the respective model predictions by the trade-off model, the pecking order theory and the free cash flow theory about the relation between the firm specific determinants and cash holdings. Moreover, Table 2 summarizes the empirical findings of various authors who empirically tested the effect of the firm specific determinants on cash holdings.

Starting with the variable leverage, one can see that all three models impute a negative relation with cash holdings, while the trade-off model is still ambiguous about its prediction. The ambiguity of the trade-off model is due to the fact that on the one hand highly levered firms should hold more cash because of the increased risk of bankruptcy while on the other hand high leverage ratios indicate good relationships with creditors, representing lower costs of additional financing. The pecking-order theory emphasizes the financing hierarchy and argues that it is a logical consequence when cash holdings decline, leverage, as the second best source of financing, must increase in order to satisfy the investment requirements. Further, the free cash flow theory argues that high leverage ratios would discipline managers and thus less cash would be held. So, taking together the predictions of all three models, I shall apparently assume a negative relation between leverage and cash holdings:

Hypothesis 1: Cash holdings are negatively related to leverage.

Coming to the variable bank debt, the expected relation is obvious. All three models assume a negative relation between bank debt and cash holdings. The argumentation of the trade-off model is based on the premise that once firms establish banks as a major source of financing, those banks will obtain profound knowledge not only about the financials, but also about the strategic planning. This reduces the costs of additional financing. The pecking-order theory also stresses the monitoring function of banks and posits that high bank debt ratio help reducing information asymmetries and consequently lowering the costs of external capital. Finally, the free cash flow theory states that bank debt helps reducing agency problems and preventing managers from hoarding excess cash. Hence, there is an overall agreement on a negative relation.

Hypothesis 2: Cash holdings are negatively related to bank debt.

For the factor firm size, the trade-off model supposes a negative relation to cash holdings while both the pecking order theory and the free cash flow theory posit a positive relation. The trade-off model argues that larger firms benefit from economies of scale regarding cash management and thus large firms would hold less cash than small firms. On the opposite, the pecking order theory posits that larger firms tend to be more successful in general and consequently they can obtain more cash from retained earnings. Next to that, the free cash flow theory argues that larger firms have a higher shareholder dispersion, which enhances the discretionary of managers, which leads them to hold more cash. Although it appears that there is overall agreement on a negative relation between firm size and cash holdings, when looking at Table 2, from a theoretical point of view it is reasonable to predict a positive relation as the pecking-order theory and the free cash flow theory outweigh the trade-off model. Thus one can state:

Hypothesis 3: Cash holdings are positively related to firm size

Regarding the factor cash flow in Table 1, one notices that the assumptions of the trade-off model and the pecking order theory are conflicting. The trade-off model suggests a negative relation between cash flow and cash holdings, since it is argued that it

serves as a substitute to cash holdings, which would reduce the need for cash. On the opposite, the pecking-order theory assumes that when cash flow is high, cash holdings will also be high because cash flow represents internally generated funds. However, this discrepancy, put forth by the models, does not manifest itself in the empirical findings by the authors in Table 2. Obviously, all the authors, who tested the influence of cash flow on cash holdings observed a positive relation. Hence, there is reason to suggest that the pecking order theory tends to be superior in explaining the relation between cash flow and cash holdings. Thus it can be stated:

Hypothesis 4: Cash holdings are positively related to cash flow.

Coming to cash flow volatility, it is to remark that merely the trade-off model gives a suggestion about the relation to cash holdings. Due to the fact that a high cash flow volatility leads to an increased uncertainty about future earnings, the probability of financial distress rises, accordingly. In order to prevent this, firms would accumulate more cash in order to reduce likelihood of financial distress. Hence, the trade of model suggests a positive relation between cash flow volatility and cash holdings. It appears that the empirical findings in Table 2 generally approve the suggested relation, except for Ferreira and Vilela (2004), who find a negative relation. However, as the majority of papers finds a positive relation, as predicted by the trade-off model, it is reasonable to hypothesize the following:

Hypothesis 5: Cash holdings are positively related to cash flow volatility.

Also regarding liquid assets the trade-off model is the only model that makes an assumption about its influence on cash holdings. As with cash flow, liquid assets also serve as substitutes to cash and hence, from a trade-off perspective, a firm with large amounts of liquid assets would hold less cash because those assets can be easily transformed into cash. Therefore, the relation between liquid assets and cash holdings would be negative. When looking at Table 2 one can see that the empirical evidence clearly confirms this assumptions. Hence, one can reasonably presume the following:

Hypothesis 6: Cash holdings are negatively related to liquid assets.

According to the trade-off model and the pecking order theory the factor investment opportunity would have a positive relation with cash holdings. As already mentioned the trade-off model stresses the increased transaction costs that would be required to fund new projects, while the pecking order theory emphasises the possibility that the firm may be completely restricted from external capital. However, the free cash flow theory suggests a negative relation. While the trade-off model and the pecking order theory resemble each other in terms of their argumentation for a positive relation, the free cash flow theory argues that entrenched managers especially hoard cash when they have less investment opportunities because they want to exert their discretionary power, even if it means that they would have to invest in negative NPV projects. Given that the available evidence by the authors in Table 2 consistently agrees on a positive relation and that the reasoning of the former two models appears more sensible, one can assume that:

Hypothesis 7: Cash holdings are positively related to investment opportunity.

Dividend payments are suggested by the trade-off model to have a negative impact on cash holdings. The pecking order theory and the free cash flow theory do not make assumptions about this factor. The trade-off model posits a negative relation between cash holdings and dividend payments because firms would just cut or omit dividends in case they were short of cash. However, this proposition is objected by empirical evidence, which suggests that the vast majority of firms is reluctant to omit or cut dividends due to the detrimental effect this would have on firm value and that executives would rather raise external funds than cutting dividends (Brav et al., 2005; Drobetz and Grüninger, 2007). Nevertheless, three of four papers in Table 2 find a significant negative relation between dividend payments and cash holdings, while only one paper finds a positive relation. From a trade-off perspective one can derive the following hypothesis:

Hypothesis 8: Cash holdings are negatively related to dividend payments.

The formulated hypotheses in this section shall be tested using different kinds of regression analyses. These will be explained in the coming section.

3 Research methods

In the following section it will be described, which research methods are used in this study to test the influences of the respective firm specific variables on cash holdings. Through careful argumentation it will be outlined and justified why the respective methods are applied to this particular dataset. In the first paragraph the type of data and its advantages and disadvantages are explained. In the second paragraph the regression analyses are explained.

3.1 Panel data

As the data for this paper is collected from different firms (units) over multiple periods, it is referred to as panel data (or longitudinal data). This is due to the fact that it comprises a cross-sectional, as well as a time-series dimension. The cross sectional dimension is represented by the observations that are being made at a single point in time across multiple units (firms). The time-series dimension manifests itself as the successive measurement of the same unit over a time interval. One of the advantages of panel data over either cross sectional or time series data is that due to the fact that you study a cross section over multiple periods you automatically increase the number of observations, which increases your degrees of freedom and hence allows you to employ more explanatory variables in your model (Verbeek, 2008). This makes the data more informative and it also decreases the chance of colliniearity among explanatory variables. Another advantage of panel datasets is that they enable to control for individual heterogeneity. It can lead to biased estimates of the regression coefficients if these individual specific effects are not controlled for (Baltagi, 2008; Mátyás and Sevestre, 2008). Hence, panel data analysis can better detect effects that are not observable in pure cross sections or pure time-series data. Moreover, panel datasets are more suitable to study complex, dynamic behavioural models. This is because cross sections only provide data of e.g. individuals or firms of one point in time, whereas panel data can show how these individuals or firms change over time (Wooldridge, 2002).

One of the limitations of panel data is simply that problems like multicollinearitity and autocorrelation, which exist among cross sections and time series, respectively, also need to be addressed in panel datasets. Moreover, panel datasets are often characterized by missing observations because e.g. firms merge or go bankrupt.

3.2 Regression analyses

The sample of this study consists of 2430 firm-year observations over the period from 2005 to 2013. The fact that this dataset contains a cross-sectional as well as a time series dimension makes it panel data. Since one has to account for both of these dimensions, it requires a more sophisticated set of regression analyses in order to estimate the influences of the respective independent variables on the dependent variable. The most common methods, suggested by the bulk of literature, dealing with panel data, represent:

- The Pooled OLS-Model
- The Fixed-Effects-Model (FEM)
- The Random-Effects-Model (REM)

Moreover, the regression by Fama and MacBeth (1973) is also applied by a number of authors (e.g. Ferreira and Vilela, 2004; Opler et al., 1999; Pinkowitz and Williamson, 2001; Subramaniam et al. 2011). This type of regression is referred to hereafter as Fama MacBeth regression. This regression consists of two stages and it has originally been developed and extensively used for the analysis of the cross-section of stock returns. More specifically, it is used to estimate factor risk premiums in the analysis of linear factor models (Skoulakis, 2008). Although it is a frequently used regression that is being applied on panel data, it has not yet been analysed by the econometric literature, nor has it even been mentioned in standard panel data econometric texts (Skoulakis, 2008). Another method that is quite similar to the Fama MacBeth regression, and applied by Ferreira and Vilela (2004), is the cross-sectional regression using means of the variables over time. In line with the aforementioned authors, the following regressions will be applied in the analysis: the pooled OLS regression, the Fixed-Effects-Model, the Random-Effects-Model, the Fama MacBeth regression and the cross-sectional regression using means. Here, it is to remark that either a Fixed-Effects- or a Random-Effects-Regression is performed. Through running a test by Hausman (1978), it can be identified which of these two tests is more suitable to the properties of the dataset in this paper. The purpose of performing several different types of regressions is to enhance the reliability of the relations between the independent variables and the dependent variable. In the following, each regression analysis will be explained and its individual advantages and drawbacks will be outlined.

3.2.1 Pooled OLS regression

As the name already suggests, a pooled regression simply pools the observations across multiple cross sections from two or more points in time into one large cross section, while disregarding the heterogeneity between the units as well as the time variant effects of the data. (Wooldridge, 2013). A major advantage of this approach is that one can easily increase the sample size by pooling observations from different time periods. This can especially be helpful in cases when one wants to include many explanatory variables in the regression equation, while only having a small amount of cross sectional data of one period available. Thereby, one can increase the degrees of freedom, which facilitates a more accurate and consistent estimation of the regression coefficients. This type of regression is applied by several authors (Bates et al., 2009; Ferreira and Vilela 2004; Pinkowitz and Williamson, 2001).

However, when heterogeneity is present in the dataset, the estimators of the OLS-regression will become inconsistent and biased (Wooldridge, 2013). In order to account for the time variant effects of the data dummy variables for the different years will be included in the regression term. So, for the years 2006 to 2013 dummy variables will be established, where a “1” indicates if the observation was made in that year and a “0” if the observation was not in that year. The year 2005 represents the base year. That way one allows for different intercepts for the respective years and thereby one can avoid the problem of serial correlation. Furthermore, it will also distinguished between the different natures of the sample firms in terms of their industry affiliation, because it is assumed that the type of industry also has an effect on the cash holdings of that firm. This is again done by establishing dummy variables for the respective industries, where a “1” indicates membership in the respective industry and “0” if otherwise. The categorization will be based on the 2-digit SIC-codes that are assigned to the respective firms in the sample, where the industry with SIC-code 01 (Agricultural production) serves as the base industry. In total these comprise 43 different sub-groups of industries. Here, one might argue that it would suffice to aggregate them into 4 broad categories, namely manufacturing, transportation, trade and services, as these are the main groups. However, this would miss the point of controlling for industry specific effects. By aggregating one would e.g. simply neglect the distinction between high-tech manufacturing firms and firms that manufacture furniture, for instance. As these two types of industries are com-

pletely different from each other, in terms of the nature of their businesses, it is reasonable to apply a more detailed distinction. Such a pooled regression model would look as follows:

$$CASH_{it} = \beta_0 + \beta_j x'_{it} + \alpha' + \delta' + \mu_{it}$$

$i = 1,2, \dots, N$; and $t = 1,2, \dots, T$; for every variable j = 1,…,k
x'= vector of explanatory variables
α'= vector of industry dummy variables
δ'= vector of year dummy variables

While taking the industry influences into account as observable factors, there are still factors that cannot be observed, or at least cannot be measured (Wooldridge, 2013). These may comprise the corporate culture of a firm, special management practices and capabilities, relationships with stakeholders and several more. These might also exert influences cash holdings. In fact, this alone would not even pose a problem because these unobserved effects are reflected in the error term of the regression. However, if these unobserved factors are correlated with both, the dependent and one or more independent variables then the Gauß-Markov theorem would be violated (Wooldridge, 2013). One of the assumptions of the Gauß-Markov theorem is that the expected value of the error term equals zero for any of the given independent variables. If that assumptions does not hold, the estimators will become biased and inconsistent. This issue is also referred to as “omitted variable bias”. Although it is quite likely that there are indeed unobservable factors like for instance bank relationships that influence both cash holdings and leverage and thus lead to inconsistent, biased estimators, this type of regression is still frequently applied by researchers who study the effects on cash holdings (Ferreira and Vilela, 2004; Opler et al., 1999).In order to be able to compare the regression results with previous researchers, a pooled regression analysis will also be conducted in this paper.

3.2.2 Cross-sectional regression using means

The cross-sectional regression using means over time is essentially similar to the pooled OLS model, except that the pooled effects model uses year dummies instead of averaging in order to account for the time series effects. In line with Opler et al. (1999) and Ferreira and Vilela (2004) the regression model is also applied in this paper. Due to the fact that the dependent as well as the independent variables are averaged over the 9 year period, one basically reduces the sample to a single cross-section, while eliminating the time-series dimension. Hence, the regression equation simply looks like this:

$CASH_i = \beta_0 + \beta_j x'_i + \alpha' + \mu_i$

Where, $i = 1,2,\dots,N$; for every variable j = 1,…,k

x'= vector of explanatory variables

α'= vector of industry dummy variables

3.2.3 Fixed-and Random-Effects Model

In the pooled OLS model, the assumption is that in each period the error term is uncorrelated to the explanatory variables. However, for some datasets this assumption is too strong (Wooldridge, 2002). Wooldridge (2002) points at the fact that the primary motivation of panel data models is to solve the “omitted variable problem”. The two most important linear panel data models that take into account these unobserved individual or firm specific factors (i.e. unobserved heterogeneity) are the Fixed-Effects-Model and the Random-Effects-Model. Regarding the literature on cash holdings, the Fixed Effects model is among the most applied type of regression. A large number of previous authors apply the Fixed Effects model in their analyses (Bates et al., 2009; Drobetz and Grüninger, 2007; Harford et al., 2008; Kim et al., 1998; Opler et al., 1999; Ozkan and Ozkan, 2004; Pinkowitz and Williamson, 2001). The two models are distinguished based on the assumptions they pose regarding the relation between the firm specific unobserved factors and the explanatory variables. A typical equation of such a linear panel data model looks like this:

$$CASH_{it} = \beta_j x'_{it} + \alpha_i + \mu_{it}$$

Where $i = 1, \dots, N$ firms and $t = 1, \dots, T$ periods of time, for every variable j = 1,…,k

Here, $CASH_{it}$ represents the dependent variable for firm i at time t. Furthermore, x' represents a vector of all the independent/explanatory variables for firm i at time t. The β represents the regression coefficient that is estimated for x'. Next to that, the equation contains α_i and μ_{it}. So, α_i represents the unobservable firm specific effect, which is time invariant. Thus, this variable only has a cross-sectional dimension denoted by i. Such unobserved firm specific factors are typically factors such as the corporate culture or certain management styles of a firm, which are difficult to measure and which do not vary over time. The μ_{it} represents idiosyncratic factors or idiosyncratic disturbances, which vary across sections and over time. The Random-Effects-Model makes the assumption that the unobserved firm specific factor α_i is not correlated with any of the explanatory variables x'_{it}:

$$E(\alpha_i | x_{it}) = 0$$

Furthermore, the strict exogeineity assumption has to hold for the random effects model.

$$E(\mu_{it} | x_{it}, \alpha_i) = 0$$

That means that the unobserved idiosyncratic factors should be uncorrelated with any of the explanatory variables at any time. On the contrary, the fixed effects model allows for correlation between the unobserved firm specific effects and the explanatory variables, meaning:

$$E(\alpha_i | x_{it}) \neq 0$$

However, the assumption of strict exogeneity is also necessary for the fixed effects model. According to Wooldridge (2013), the fixed effects model is "widely thought to be a more convincing tool for estimating ceteris paribus effects" (p.477), since it allows arbitrary correlation between α_i and x'_{it}. Nevertheless, the random effects model is applied in certain situations. In the fixed effects model the unobserved firm specific effects α_i are eliminated through the process of time demeaning. This process involves subtracting time averages from the corresponding variables. Thereby, it is taken account of the firm specific unobserved fixed effects. However, not only α_i is cancelled out of the equation, but also all explanatory variables that are constant over time. Hence, if the key explanatory variable is time invariant, the fixed effects estimator is inappropriate. It is still common practice among researchers to apply both types of regressions and then

formally test whether there are statistically significant differences between the coefficients of the time-varying explanatory variables (Wooldridge, 2013). Such a test has been initially proposed by Hausman (1978) and some econometrics packages routinely perform this test under the assumptions of the random effects model. Here, the idea is that the random effects model is used unless the tests rejects the assumption: $E(\alpha_i|x_{it}) = 0$. So the null hypothesis would be that the firm specific unobserved factors are uncorrelated with the explanatory variables and the alternative hypothesis would state that there is a correlation. Hence, in the analysis section such a test is applied on the sample data, using the statistics package STATA, and based on the outcome of the test it will either be chosen for the fixed-effects or the random effects model.

3.2.4 Fama MacBeth regression

The regression by Fama and MacBeth (1973) involves two stages. In the first stage a time series regression is computed for every firm. In doing so, the time series of the dependent variable cash ratio for every firm is regressed against the time series of the independent firm-specific variables in order to determine the betas.

$$CASH_t = \beta_0 + \beta_j x'_t + \mu_t$$

For a total of N-firms, while t=1, 2, 3… T; for every variable j = 1,…,k

Here the betas denote the exposure of cash holdings to the respective firm specific factors for each individual firm. In the second stage, the cross-sections of cash ratios are then regressed against the betas, which have been determined in the first stage, for every year. This is done because the goal is to determine the influence of these betas on the entire sample of cash holdings of all firms over time. The coefficients "γ" represent those influences:

$$CASH_i = \beta_0 + \gamma_j \beta_j x'_i + \mu_i$$

For a total of T-periods, while i=1, 2, 3…, N; for every variable j = 1,…,k

Finally, the coefficients "γ" for every firm-specific factor are then averaged across T periods (9 years) and the standard deviation and t-statistics can be easily computed. For instance the t-statistics for the factor firm size are computed as:

$$\frac{\gamma_{SIZE}}{\sigma_{\gamma SIZE}/\sqrt{9}} \quad \text{; Where T=9}$$

The results basically indicate by how much cash holdings would change over time if one were to increase the exposure of the respective firm specific factors by one unit, while assuming ceteris paribus.

4 Data description

4.1 Sampling

The data for this study is obtained from the financial database ORBIS. The database contains detailed and comprehensive financial information on numerous publicly listed firms worldwide as well as on some private firms. For the analysis, only publicly listed German firms are included, due to the fact that publicly listed firms have a higher availability and consistency of financial data, which is needed to study the impact of the mentioned firm-specific determinants on cash holdings. Firms are required to have available accounts over the period from 2005 to 2013, in order to remain in the sample. Moreover, financial firms, denoted by industry SIC codes from 6000 to 6999, are excluded from the sample because they are subject to certain capital requirements. Besides, utility firms with industry SIC codes from 4900 to 4999 are excluded as well because they are generally subject to state regulations. These sample requirements are in line with the ones by Ferreira and Vilela (2004) and Opler et al. (1999). Furthermore, I require each of the sample firms to have available accounts on cash and cash equivalents as well as on total assets over the entire sampling period, otherwise they are dropped from the sample. For the remaining explanatory variables I require firms to have at least five years of continuous time-series observations on cash holdings, otherwise they are dropped from the sample, as well (Opler et al., 1999; Ozkan and Ozkan, 2004). Next to that, it is to remark that in the regression analyses I will only include firm-year observations, which report a value for each of the variables that are included in the regression equation. Given the above mentioned criteria the paper is provided with a fixed sample of 270 firms, which represent a total of 2430 firm-year observations for the variable cash ratio. In Table 3 there is an annual overview of the firm-year observations for each variable.

Table 3: Annual firm-year observations

YEAR	CASH	SIZE	LEV	BANK	CF	LIQ	INVO	ZSCORE
2005	270	270	270	164	270	270	268	252
2006	270	270	270	164	269	270	268	253
2007	270	270	270	169	270	270	269	260
2008	270	270	270	161	268	270	268	252
2009	270	270	270	163	270	270	268	257
2010	270	270	270	165	269	270	267	258
2011	270	270	270	165	269	270	269	258
2012	270	270	270	157	269	270	269	255
2013	270	270	270	156	269	270	269	259
Total	2430	2430	2430	1464	2423	2430	2415	2304

Moreover, Table 4 below depicts the industry classifications and the respective amount of firms that affiliate to the particular type of industry. The grouping of the industries is based on the two-digit SIC codes. One can see that by far the most firms are manufacturing firms. The second largest industry is represented by service firms and the transportation industry constitutes the third largest industry among the sample firms. The agricultural, mining and construction industry is only weakly represented by 1, 3 and 2 firms, respectively.

Table 4: Industry classifications

Industry	SIC codes	N
Agriculture Forestry and Fishing	01-09	1
Mining	10-14	3
Construction	15-17	2
Manufacturing	20-39	148
Transportation	40-48	33
Wholesale Trade	50-51	13
Retail Trade	52-59	8
Services	70-89	62

4.2 Measurement

4.2.1 Dependent Variable

The variable cash holdings will be the dependent variable because the purpose of this paper is to identify the determinants of cash holdings and its effects. Hence, it is assumed that cash holdings are dependent on the several firm specific factors that are proposed by the three theoretical models. The firm specific factors therefore represent the independent variables in this study.

In order to measure cash holdings, the cash ratio is used as a proxy. The extant literature has suggested several definitions of the cash ratio of which two are being most widely employed:

1. The first one defines the cash ratio as cash and cash equivalents to total assets (Bates et al., 1999; Kim et al., 1998; Ozkan & Ozkan, 2004). This simply measures the portion of a company's assets, which is held in cash. It is a traditional measure and it is employed in the majority of papers that deal with cash ratios.

2. The second one is slightly different. It uses the ratio of cash and cash equivalents to net assets, where net assets represent total assets minus cash and marketable securities (Ferreira & Vilela, 2004; Opler et al., 1999; Pinkowitz and Williamson, 2001). Here, the liquid asset holdings are deflated by the book value of total assets, net of liquid assets, based on the view that "a firm's ability to generate future profits is a function of its assets in place" (Opler et al., 1999; p.15).

In this thesis I use both variables, however the ratio of cash to total assets will be the primary variable, based on which I draw my conclusions. Regression models using the ratio of cash to net assets can be found in Appendix 4. Although it is not expected that the two ratios yield significantly different results, it may enhance the robustness of the findings. Only with regard to the univariate analysis one would be able to distinguish both ratios as the ratio of cash and equivalents to net assets will certainly be higher than the other, which is also confirmed by Ozkan and Ozkan (2004).

4.2.2 Independent Variables

The firm-specific factors, which have been extensively examined in Section 2, are going to be the independent variables in the regression analyses. Hence, in the following the operationalisation for each of the variables firm size, leverage, bank debt, cash flow, cash flow volatility, liquid assets, investment opportunity and dividend payment will be stated.

Firm size

In line with several previous authors the natural logarithm of total assets is computed as a proxy for real firm size (Ferreira and Vilela, 2004; Kim et al., 1998; Opler et al., 1999; Pinkowitz and Williamson, 2001).

Leverage

As a proxy for leverage, the ratio of total debt (short-term debt + long-term debt) to total assets will be used. This is in line with the majority of previous authors (e.g. Ferreira and Vilela, 2004; Kim et al., 1998; Ozkan and Ozkan, 2004; Pinkowitz and Williamson, 2001).

Bank debt

The variable bank debt will be measured by the ratio of bank debt to total debt (short-term debt + long-term debt). This approach is in accordance with Ferreira and Vilela (2004) and Ozkan and Ozkan (2004).

Cash flow

The variable cash flow is measured as the earnings after taxes plus depreciation divided by total assets. This measurement is also in line with Ferreira and Vilela (2004) and Ozkan and Ozkan (2004).

Cash flow volatility

As a proxy for the volatility of cash flows the standard deviation of cash flows over the sample period (9 years) is divided by total assets. This approach is in line with Ozkan and Ozkan (2004). However, here it has to be remarked that this variable is generally

only suited to cross-sectional regressions, as it would yield the same value for each year if one were to apply it to panel data. Therefore, I will only include it in the cross-sectional regression, which uses averages over time.

Liquid assets

The variable liquid assets is measured as the ratio of net working capital to total assets, because net working capital can be regarded a substitute for cash. In this case net working capital is calculated as current assets – current liabilities – total cash and cash equivalents, as suggested by a number of previous authors (Bates et al., 1999; Opler et al., 1999; Ozkan and Ozkan, 2004).

Investment opportunity

As proxy for investment opportunity the market-to-book ratio will be employed. The market-to-book ratio is measured as the book value of assets – the book value of equity + the market value of equity divided by the book value of assets. Since growth options as intangible assets are not reflected on the balance sheet, the market value of equity is used as an indicator for growth options (Bates et al., 1999; Opler et al., 1999; Ozkan and Ozkan, 2004).

Dividend payment

Finally, a dummy variable will be established, indicating whether or not the respective firm paid a dividend in a certain. Here, the dummy variable will be assigned a “1” if the respective firm made a dividend payment in the given year and a “0” if otherwise.

4.2.3 Control Variables

Moreover, following Kim et al. (1998) and Drobetz and Grüninger (2007) I also introduce 2 control variables, which are intended to control for the probability as well as the costs of financial distress.

Z-Score

The Z-score has been developed by Altman (1968) and is intended to serve as a proxy to express a firm’s likelihood of facing financial distress. It is calculated by the sum of several financial ratio’s, of which each is assigned with a different weight. The exact calculation is presented in Table 5 below. Generally, the higher a firms’ Z-score the lower

the firms' probability of facing financial distress. Therefore, I follow Kim et al. (1998) and Drobetz and Grüninger (2007), who employ the inverse of the Z-score in their regression analyses. The sole purpose behind this is to avoid confusion when it comes to inference of the results. Since the Z-score serves merely as a control variable, its influence is not central to goal of this paper. Nevertheless, one would expect a negative relation between the probability of financial distress and cash holdings, since firms in financial distress are simply unlikely to hold excess cash (Drobetz and Grüninger, 2007).

Research and Development Expenses

Another control variable that will be included is the regression analyses is a dummy variable for research and development. Following Titman (1984) it is expected that firms with highly specialized products face higher costs in the event of liquidation. Since, highly specialized products generally require investments in research and development, I will introduce a dummy variable as a proxy for this effect. Here, a "1" is assigned if the firm invested in research and development and a "0", if otherwise.

Table 5: Overview of Measurements

Variable Name	Abbr.	Measurement
Dependent Variables		
Cash ratio	$CASH$	$\frac{Cash\ and\ Cash\ Equivalents}{Total\ Assets}$
Net cash ratio	$CASHN$	$\frac{Cash\ and\ Cash\ Equivalents}{Total\ Assets - Cash\ and\ Cash\ equivalents}$
Independent Variables		
Firm size	$SIZE$	$\ln(Total\ assets)$
Leverage	LEV	$\frac{Total\ Debt}{Total\ Assets}$
Bank debt	$BANK$	$\frac{Bank\ Debt}{Total\ Debt}$
Cash Flow	CF	$\frac{Earnigs\ after\ Taxes + Depreciation}{Total\ Assets}$
Cash Flow Volatility	$CFVOL$	$\frac{Standard\ Deviation\ of\ Cash\ Flows}{Total\ Assets}$
Liquid assets	LIQ	$\frac{Current\ Assets - Current\ Liabilities - Cash\ and\ Cash\ Equivalets}{Total\ Assets}$
Investment opportunity	$INVO$	$\frac{Book\ Value\ of\ Assets - Book\ Value\ of\ Equity + Maket\ Value\ of\ Equity}{Total\ Assets}$
Dividend payment	DIV	"1" if firm paid out dividend; "0" if firm did not pay out dividend
Inverse Z-score	1/ZSC	$1 / (3.3 * \frac{EBIT}{Total\ Assets} + 1.0 * \frac{Sales}{Total\ Assets} + 1.4 * \frac{Retained\ Earnings}{Total\ Assets} + 0.6 * \frac{MV\ of\ Equity}{BV\ of\ Total\ Debt})$
Research and Development	$RDDUM$	"1" if firm invested in R&D; "0" if firm did not invest in R&D

The first column of the Table depicts the names of the dependent and the independent variables, the second column depicts the abbreviations of the respective variables (as they appear in the regression equations and tables) and in the third column one can see how each variable is measured.

5 Results

In this section the descriptive statistics as well as the results of the regression analyses are presented. First, the univariate characteristics of the dependent as well as the independent variables will be outlined and discussed, briefly. Afterwards, the results of each of the regression analyses will be presented separately and in the end the different regression results are compared with each other. Next to that, in a supplementary analysis, I apply different sample groupings and I will elaborate on the effects of the financial crisis on the regression coefficients, by creating pre-crisis and post-crisis subsamples and compare the results.

5.1 Descriptive statistics

In Table 6 the descriptive statistics for each of the variables are displayed. Given a small number of extreme outliers that are not driving any of the results, I winsorize the variables cash ratio, net cash ratio, size, leverage, bank debt, cash flow, liquidity, investment opportunity and z-score at 0.5% at each tail. This is in line with the approach by Harford et al. (2008). Next to my main dependent variable, I also include the descriptive statistics of the net cash ratio, denoted by CASHN. Starting with the dependent variable CASH one state that the German listed firms of this sample hold on average about 15% of their assets in cash. When comparing this to Ozkan and Ozkan (2004), who determined a mean of 9.9% for their sample of UK firms, this is quite a large difference. Opler et al. (1999) find a mean value of 17% for their sample of US firms. However, he we have to apply the ratio CASHN is order to facilitate a comparison, because Opler et al. (1999) apply the net cash ratio in their paper. I find a net cash ratio of 23.3 %. This is a difference of 5.3 %, which is also quite large.

Moreover, Ferreira and Vilela (2004) also study, among other EMU countries, cash holdings in German listed firms. They find that German firms hold on average 14.8% in cash. However, they also employ net assets in their computation. Thus, there is again quite a large difference between the means. These differences may partly be explained by the different sample periods, in which the data has been gathered. While the sample period of this paper ranges from 2005 to 2013, Ferreira and Vilela (2004) for instance analyse data over the period from 1987 to 2000. This argument is supported by Bates et al. (2009), who monitor the development of cash ratios of US firms from 1980 to 2006. They find that the mean cash to total assets ratio of the firms more than doubles from

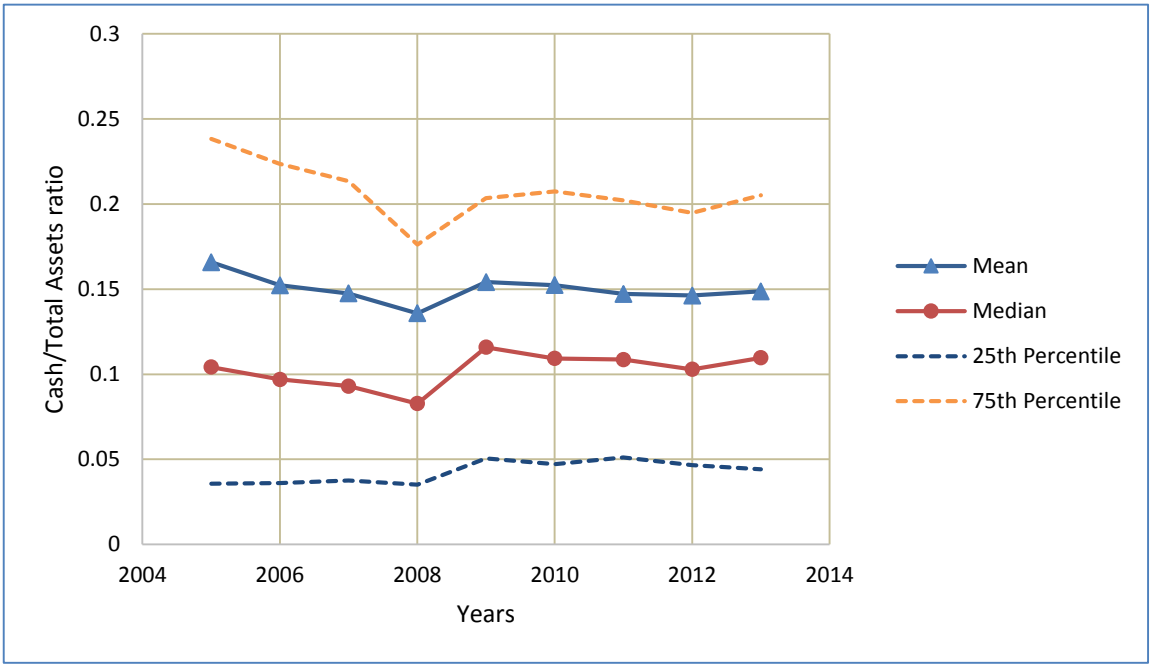
10.5% in 1980 to 23.3% in 2006. Bates et al. (2009) conclude that a significant part of this shift can be explained by the fact that the firms themselves changed, because they held less inventory and receivables and they incurred higher research and development expenses. Additionally, their cash flows became riskier, which also lead them to hoard more cash. Hence, it is reasonable to assume that such a shift might has taken place in Germany as well. That could justify the differences in cash ratios found by previous authors, as compared to this thesis. The variable firm size has a mean value of 12.44. Regarding previous authors the closest to this value is reported by Drobetz and Grüninger (2007), who report a mean of 12.76 for their sample of Swiss firms. Moreover, Ozkan and Ozkan (2004) report a value of 10.87, which is also relatively close to my value. In turn, Ferreira and Vilela (2004) determine a value of 18.16 for their German sample and 17.93 as an average for EMU countries. On the opposite, Opler et al. (1999) merely find a mean value of 4.59 for firm size. Also, Pinkowitz and Williamson (2001) find for their German sample only a mean firm size of 6.12. These differences can certainly be attributed to the different sampling periods, as one can assume that the average size of listed firms has generally increased from the 1990s to the 2000s. Regarding the variable leverage, the mean of 0.55 is closest to the mean by Kim et al. (1998) of 0.52. In contrast, the majority of other authors report significantly lower debt ratios, mostly around 0.20 to 0.25 (Bates et al., 2009; Ferreira and Vilela, 2004; Harford et al., 2008; Opler et al., 1999). The reason for such a difference may be due to the fact that the composition of long- and short-term debt balance sheet items differs from my paper. Consequently, the mean ratio of bank debt in this thesis of 18% is significantly less, compared to the other authors, who also study the influence of bank debt and find ratios between 0.56 and 0.88. (Ferreira and Vilela, 2004; Ozkan and Ozkan, 2004; Pinkowitz and Williamson, 2001). Coming to cash flow, one can note that the mean value of 0.075 is close to the values found by Drobetz and Grüninger (2007) and Ozkan and Ozkan (2004) of 0.081 and 0.088, respectively. The variable liquid assets yields a mean value of 0.063, which is relatively close to the value by Harford et al. (2008), who report a value of 0.066. The remaining authors report values ranging from 0.021 to 0.196 (Han and Qui, 2007; Ozkan and Ozkan, 2004; Pinkowitz and Williamson, 2001). Finally for the variable investment opportunity I find a mean value of 1.64, which is quite close to the range from 1.42 to 1.95, reported by the majority of previous authors (Ferreira and Vilela, 2004; Han and Qui, 2007; Harford et al., 2008, Opler et al., 1999; Ozkan and Ozkan, 2004; Pinkowitz and Williamson, 2001).

Table 6: Descriptive statistics

Variable	Mean	SD	Min	25%	Median	75%	Max	N
CASH	0.150	0.146	0.005	0.042	0.103	0.204	0.690	2430
CASHN	0.233	0.351	0.005	0.043	0.115	0.256	1.584	2430
SIZE	12.44	2.259	7.824	10.854	12.120	13.884	18.631	2430
RSIZE (mln €)	4825	2090	10.5	517	1835	10711	324000	2340
LEV	0.551	0.198	0.101	0.412	0.569	0.692	0.932	2430
BANK	0.179	0.165	0.000	0.038	0.133	0.282	0.646	1464
CF	0.075	0.107	-0.464	0.051	0.084	0.119	0.329	2423
CFVOL	0.065	0.088	0.004	0.021	0.039	0.067	0.778	2430
LIQ	0.063	0.174	-0.463	-0.043	0.063	0.184	0.487	2430
INVO	1.642	0.784	0.607	1.173	1.431	1.831	5.161	2415
DIV	0.573	0.495	0	0	1	1	1	2430
ZSCORE	0.537	0.420	0.055	0.306	0.438	0.630	2.907	2304
RDDUM	0.494	0.500	0	0	0	1	1	2430

In Figure 1 the development of the mean and median cash ratio of the underlying sample over the period from 2005 to 2013 is depicted. One can also see the development of the 25th and 75th percentiles of cash ratios. What becomes immediately obvious is the initial drop of the median cash ratio to ca. 8.3% by the end of 2008 and the subsequent rise to 11.6 % by the end of 2009. Part of this extreme development of the cash ratio during that period could certainly be attributed to the aftermath of the financial crisis, starting in 2007. As stated by Campello et al. (2010), banks started to restrict their lending after 2007, which lead firms to increasingly use cash holdings to fund their operations and projects. This would explain the minimum cash ratio by the end of 2008. Moreover, Song and Lee (2012) study the long-term effects of the Asian financial crisis on cash holdings by Asian firms and they find that after the crisis, firms became more conservative and held more cash. Again, this reflects the trend of cash holdings in Figure 1, since there is a higher average level of cash holdings after 2009. This is particularly obvious with the median cash ratio. After 2009 the development of the cash ratio seems to be more stable, although the median cash ratio steadily declines from ca. 11.6% in 2010 to ca. 10.3% in 2012, until it rises again to ca. 11% in 2013. The preceding drop might to some extent be related with the debt crisis in the Eurozone, however certainly to a lesser extent as compared to the global financial crisis.

Figure 1: Cash ratio development



This figure depicts the development of the cash ratio over the entire sampling period from 2005 to 2013. One can see the mean and the median as well as the 25th and the 75th percentile of the cash ratio.

5.2 Regression analyses

In this section the results of the regression analyses will be presented. Here it is to remark that for each regression it is tested whether the data is normally distributed and whether heteroskedasticity is present. The data is tested for heteroskedasticity using the White (1980) test. This is important because heteroskedasticity means that the variances of the residuals of the explanatory variables are unequally distributed and this can potentially lead to biased estimators. The null hypothesis of the test states that the data is homoskedastik. In case the p-value of the test yields a value of less than 0.05, one can reject the null hypothesis, which means that the data is heteroskedastik. If that occurs, I will compute a robust estimation of the regression coefficients, using the statistics package STATA. This is easily done as the software can automatically adjust for such circumstances. Regarding the issue of multicollinearity I computed a correlation matrix as well as the variance inflation factors (short: VIF), which can be found in Appendix 1 and Appendix 2, respectively. The correlation matrix does not elicit any serious concerns about strong correlation among the explanatory variables, as the correlation coefficients do not exceed the range of -50% and 50% (Wooldridge, 2002). The variance inflation

factors are all below 2, which also indicates that there is little to worry about collinearity, since the rule of thumb states that only VIF's bigger than 5 enter a critical area (O'Brien, 2008).

Moreover, it is to mention that for each type of regression I will run different models, in order to see what effect the exclusion or inclusion of time- and industry dummy variables has on the regression coefficients. This is especially crucial with respect to the variable bank debt, since only 60% of the firms reported the amount of bank debt on their balance sheets. Hence, a large number of firms will be excluded from the regression models that include bank debt. The reason why I particularly distinguish between models including and excluding bank debt is that, unlike with other variables, I assume that the missing firm year observations for the variable bank debt occur systematically with smaller firms. In order to proof that I created a dummy variable for bank debt (I did not report it), which yields a 31% correlation with firm size at the 1% level. This means that there is a clear tendency that larger firms are more inclined to report their bank debt positions than smaller. Here, I compromise the randomness assumption of the Gauß-Markov theorem and therefore I find it necessary to specifically distinguish between regression models that include bank debt and models that exclude bank debt. For the other variables I shall assume that missing firm year observation occur randomly.

5.2.1 Pooled OLS regression

In this section the results of the several different OLS-regression analyses are presented. In Table 7 one can see the output of 6 different regression models. The regressions are computed twice, with and without the variable BANK. Since the White (1980) test for heteroskedasticity yielded a significant p-value, one has enough evidence to assume that heteroskedasticity is present. Hence, the regression models below are computed using robust estimations of the standard errors in order to control for the heterogeneity of variances. This is done via a simple command in STATA. The regression coefficients are not affected by such a robust estimation. Merely the standard errors and t-statistics are adjusted for the possibility that the dataset may violate assumptions of the OLS-regression, such as normality or heterogeneity (McKean, 2004).

Firstly, Model 1 presents a regression excluding bank debt. Starting with firm size, the model computes a significant negative relation with cash holdings. This is not in line with my hypothesis, but with the majority of findings by the respective authors studied in this paper (see Ferreira and Vilela, 2004; Opler et al., 1999; Ozkan and Ozkan, 2004). It supports the notion, put forth by the trade-off model, which assumes that larger firms

benefit from economies of scale regarding cash management and thus hold less cash. Also for leverage I find a significant negative relationship, which is in accordance with the findings of the other authors as well as with the predictions by the pecking-order and free cash-flow theory. Thirdly, I find a significant positive relation with cash flow. This is an interesting result since I expected, based on the literature review, a positive relation between cash flow and cash holdings. Although the trade-off model and the pecking-order theory have contradicting assumptions concerning this factor, the empirical evidence clearly suggested a positive relation. Moreover, the model computes a significant negative relation for the factor liquid assets. This is again in accordance with my previous assumption and supports view of the trade-off model, which sees positive net working capital as substitute to cash. Coming to investment opportunities one can note a significant positive relation with cash holdings. This finding is in line with the formulated hypothesis as well as with the findings by the bulk of scholars, who investigated the effect of investment opportunities on cash holdings. Eventually, the coefficient for the variable RDDUM yields a significant positive relation with cash holdings. This is also conform to what is suggested by the trade-off model regarding this factor, because generally firms that invest in research and development tend offer unique, highly specialized products or services and thus face higher costs in the event of liquidation. Hence, those firms would hold more cash. The variables dividend payment and financial distress did not yield any significant results. Finally, the adjusted R^2 of Model 1 is ca. 38 %. That means that the aggregate effect of this particular composition of explanatory variables would be able to explain roughly 37% of the variation of cash holdings between the different firms in the sample.

In Model 2 the variable bank debt is included. This implies a reduced number of observations from our sample, since only firms, which explicitly stated the amounts of bank debt, can be included in the regression. Firstly, one can note a significant negative relation with bank debt. This is in line with both the predictions by the 3 models and the findings by the authors. Secondly, it appears that the inclusion of the variable bank debt resulted in several significant changes regarding the regression coefficients of the other explanatory variables. On the one hand the coefficients of the variables firm size cash flow and research and development become insignificant, while on the other hand the model computes significant negative relations for the variables dividend payment and financial distress (1/ZSC). Regarding dividend payments, Model 2 would support Hypothesis 8, building on the trade-off model, which regards dividend cuts as substitutes

for cash holdings. That is also what other authors find for dividend payments (Harford et al., 2008; Kim et al., 2011; Opler et al., 1999).The negative relation with financial distress in line with the assumptions by Drobetz and Grüninger (2007) and Kim et al. (1998), who state that firms with high probabilities of financial distress are unlikely to hold excess cash. A reason for this change in significance levels of the coefficients may be attributed to the reduced sample size comprising only 1404 firm-year observations. However, especially with firm size, which is deemed as one of the core factors influencing cash holdings, this outcome is striking. Hence, in Appendix 5 Table H I compute a model, where leverage is excluded from the regression. This is done because of the 30% significant positive relation between leverage and bank debt. Immediately one can see that firm size becomes highly significant again. Thus one can argue that, since leverage, bank debt and firm size are correlated and may explain the same variations in cash holdings to some extent, the explanatory power of their partial effects may be diluted.

In Model 3 I introduce dummy variables for the respective years to the regression, in order to take account of the time-specific effects. For reasons of convenience I do not display all dummy variables in the regression table, but I rather indicate by a “Yes” whether the regression model contains dummy variables. When comparing Model 3 to Model 1 one can hardly notice any differences in the results. Merely the t-statistics vary in the range of 2 decimal points behind the comma. Based on that one would assume that time-specific effects do not exert such a big influence on the regression coefficients of the explanatory variables. The same holds for Model 4 including bank debt, which is almost similar to Model 2 except the variable financial distress, which is only significant at the 10% level and the R^2 increases by 1% as compared to Model 2.

In Model 5 I introduce beside the year dummies also industry dummies. These industry dummies are formed based on the 2-digit SIC codes of the respective firms. The purpose here is to control for unobserved effects that are related with the firm’s industry affiliations. One can see that all coefficients and t-statistics, that show a significant relation in Model 1, decrease slightly while the factor cash flow even becomes insignificant. This may be attributed to the fact that cash flows of firms vary to some degree, according to the nature of the industry. So, once this effect is accounted for, the relations with cash holdings tend to become weaker and regarding the factor cash flow, even insignificant. Nevertheless, at the same time the adjusted R^2 increases to 49%. This is no surprise as I have included dummy variables for every industry, in total 43 and according to

Wooldridge (2013) the R^2 automatically increases as soon as one introduces more explanatory variables to the regression model. Hence, a significant part of the variations in cash holdings can solely be explained by the firms' industry affiliation.

Finally, Model 6 includes bank debt again. The results are essentially equal to the ones by Model 4 except some minor variations in the coefficients and the t-statistics. Moreover, the R^2 has increased from 22% in Model 4 to 33% in Model 6.

Summing up the computations by the models, one notes that the variables leverage, liquidity and investment opportunity showed significant relations at the 1%-level across all model variations. The variable firm size has only shown to be significant in the absence of the variable bank debt. As already mentioned, the explanation for this can certainly be attributed to the fact that leverage, bank debt and firm size are all correlated with each other, which might impede the determination of their partial effects on cash holdings. Moreover, the variable cash flow is only shows a significant negative relation in the absence of bank debt and industry dummies. In contrast, the variables dividend payment and research and development only yielded significant relations with cash holdings in the presence of bank debt.

Table 7: OLS-Regression results

Dep. Var. CASH	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
SIZE	-0.009	-0.001	-0.009	-0.001	-0.010	-0.001
	(6.52)***	(0.80)	(6.51)***	(0.82)	(6.58)***	(1.06)
LEV	-0.389	-0.207	-0.388	-0.206	-0.379	-0.209
	(20.36)***	(9.89)***	(20.25)***	(9.67)***	(19.13)***	(9.12)***
CF	-0.114	-0.060	-0.115	-0.057	-0.056	-0.058
	(2.95)***	(1.41)	(2.96)***	(1.30)	(1.42)	(1.25)
LIQ	-0.259	-0.151	-0.259	-0.150	-0.242	-0.163
	(14.46)***	(7.51)***	(14.42)***	(7.43)***	(12.32)***	(7.29)***
INVO	0.027	0.015	0.027	0.015	0.023	0.008
	(6.54)***	(3.64)***	(6.57)***	(3.58)***	(5.67)***	(1.82)*
DIV	-0.011	-0.016	-0.010	-0.016	-0.003	-0.010
	(1.72)*	(2.81)***	(1.66)*	(2.80)***	(0.46)	(1.60)
ZSCORE	-0.012	-0.012	-0.012	-0.012	-0.002	-0.019
	(1.55)	(1.94)*	(1.56)	(1.89)*	(0.26)	(2.78)***
RDDUM	0.018	0.004	0.018	0.003	0.010	0.005
	(3.29)***	(0.71)	(3.35)***	(0.69)	(1.66)*	(0.79)
BANK		-0.104		-0.104		-0.086
		(6.55)***		(6.55)***		(4.84)***
_cons	0.461	0.268	0.472	0.269	0.450	0.291
	(21.90)***	(11.38)***	(21.07)***	(10.88)***	(18.11)***	(11.00)***
Year Dum.			Yes	Yes	Yes	Yes
Ind. Dum.					Yes	Yes
Adj. R^2	0.38	0.21	0.38	0.22	0.49	0.33
N	2296	1404	2296	1404	2296	1404

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the results of several OLS-regressions. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using robust standard errors. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally, a “Yes” indicates whether Year Dummies and/or Industry Dummies are included in the regression.

5.2.2 Cross-sectional regression using means

In this section the results of the cross-sectional regression using means are presented. As with the other regressions, the standard errors are based on a robust estimation. In total, 4 models are computed, where the first 2 models exclude industry dummies and the other 2 models include them.

Model 1 in Table 10 depicts the regression excluding bank debt and industry dummies. In line with the previous types of regressions, this model finds significant negative relations with cash holdings for the variables firm size, leverage and liquidity. Likewise, the variable investment opportunity shows a significant positive relation. Furthermore, one can note a significant negative relation with the variable cash flow at the 5 %-level. This resembles the output of Model 1 of the OLS-regressions, which also finds a significant relation with cash flow. However, this model notes a much stronger influence of cash flow of 16.6%, whereas the OLS-model only notes a coefficient of 8.2%. The adjusted R^2 of this 41%, which is relatively high since the industry dummies are not even included, yet.

Model 2 includes the variable bank debt. Here, one can notice the same effect as observed in the other regression analyses. The coefficient of firm size becomes insignificant, while the coefficients of the variables leverage and liquidity stay significantly negative. Additionally, the variable investment opportunity is insignificant in this model. With the variable cash flow, the relation becomes even stronger and significant at the 1%-level. The adjusted R^2 of this model is with 31% still relatively high.

With the introduction of industry dummies and exclusion of bank debt in Model 3, the variable firm size becomes significant again and the coefficient and well as the t-statistic even increased slightly. In contrast, the coefficients and t-statistics of the variables leverage, liquidity and investment opportunity decreased slightly, compared with Model 1. Moreover, the variable cash flow becomes insignificant, which resembles the results of the OLS-models, where the introduction of industry dummies also lead to an equalisation this effect. Again, the reason for that may be that a large part of cash flow variation across companies can be explained by the firms' industry affiliations. Finally, the adjusted R^2 increases by 5%, compared to Model 1, to 46%.

In Model 4, the industry dummies as well as the variable bank debt is included. The output is not that surprising, as it is essentially similar to Model 2, except that the coefficients as well as the t-statistics are somewhat reduced. This can also be attributed to the introduction of industry dummies that take on part of the explanation of variations in cash holdings. Finally the R^2 increases by 2%, compared to Model 2.

Table 10: Cross-sectional regression using means

Dep.Var. CASH	**Model 1**	**Model 2**	**Model 3**	**Model 4**
SIZE	-0.009 (2.24)**	-0.005 (1.57)	-0.010 (2.35)**	-0.005 (1.30)
LEV	-0.381 (9.69)***	-0.301 (7.50)***	-0.361 (8.86)***	-0.293 (6.67)***
CF	-0.166 (2.01)**	-0.233 (2.79)***	-0.098 (1.06)	-0.200 (2.18)**
CFVOL	-0.065 (0.79)	-0.044 (0.65)	-0.084 (0.94)	-0.020 (0.26)
LIQ	-0.240 (5.30)***	-0.205 (5.17)***	-0.192 (3.38)***	-0.192 (3.65)***
INVO	0.022 (2.72)***	0.011 (1.62)	0.018 (2.10)**	0.005 (0.66)
DIV	-0.021 (0.96)	-0.009 (0.49)	-0.004 (0.16)	-0.004 (0.19)
ZSCORE	-0.006 (0.36)	-0.004 (0.26)	0.009 (0.49)	0.001 (0.03)
RDDUM	0.021 (1.38)	0.010 (0.77)	0.014 (0.80)	0.006 (0.40)
BANK		-0.137 (3.43)***		-0.109 (2.44)**
Ind. Dum			Yes	Yes
_cons	0.470 (10.37)***	0.407 (9.11)***	0.434 (4.04)***	0.389 (4.42)***
Adj. R^2	0.41	0.31	0.46	0.33
N	267	156	267	156

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of the cross-sectional regression using means over time. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally a “Yes” indicates whether industry dummies are included in the regression.

5.2.3 Fixed- and Random Effects Model

In this section the results of the Fixed-Effects and Random-Effects regression models are presented. As can be inferred from Table C in the Appendix 3, the Hausman (1978) test yielded a significant p-value, which indicates that there is a high probability of correlation between the error term and the explanatory variables. This means that the Fixed-Effects model is more appropriate for computing the regression coefficients than the Random-effects model. Hence, the main focus is on the results of the Fixed-Effects model, however, the results of the Random-Effects model are displayed as well, but only for comparison purposes. As it is the case with the OLS-model, I also compute robust standard errors in order to control for the effect of heteroskedasticity.

In the Model FEM 1 the results of the Fixed-Effects Model excluding the variable bank debt are displayed. One can note that this model computes 3 significant negative relations with cash holdings for the variables firm size, leverage and liquidity and a positive relation for investment opportunity. These results are quite similar to the ones computed by the pooled OLS-model. While the signs of the coefficients of the respective variables are the same in both models, they are differing somewhat according to the strengths of their relations with the dependent variable.

Coming to Model FEM 2 one can notice that the inclusion of the variable bank debt leads to a weakening of the relation between firm size and cash holdings, which results in an insignificant regression coefficient. Again, this outcome resembles the OLS-models, which also provided insignificant results for firm size. However, the inclusion of bank debt also leads to a decline in the significance level from 1% to 10% for the variable investment opportunity. This is most likely due to the restricted amount of sample firms that are included in this type of regression rather than due to the fact that one additional variable is included. The results of Random-Effects models REM 1 and REM 2 are essentially equal regarding the estimations of the coefficients, compared to the Fixed-Effects-Models. The t-statistics are somewhat higher for the Random-Effects-Models.

Table 8: Fixed- and Random Effects Model Regressions

Dep. Var. CASH	**FEM 1**	**FEM 2**	**REM 1**	**REM 2**
SIZE	-0.030	-0.001	-0.016	-0.002
	(2.98)***	(0.10)	(4.52)***	(0.84)
LEV	-0.313	-0.252	-0.333	-0.245
	(6.96)***	(6.02)***	(8.71)***	(7.14)***
CF	0.018	0.051	-0.003	0.008
	(0.40)	(0.82)	(0.07)	(0.15)
LIQ	-0.342	-0.234	-0.323	-0.204
	(8.58)***	(6.50)***	(9.13)***	(7.08)***
INVO	0.020	0.013	0.022	0.014
	(2.66)***	(1.78)*	(3.22)***	(2.16)**
DIV	0.005	0.001	0.003	-0.002
	(0.86)	(0.14)	(0.45)	(0.32)
ZSCORE	-0.004	0.004	-0.004	0.000
	(0.48)	(0.46)	(0.42)	(0.04)
RDDUM	0.005	0.003	0.011	0.004
	(0.42)	(0.26)	(1.09)	(0.51)
BANK		0.002		-0.026
		(0.06)		(1.03)
_cons	0.677	0.255	0.511	0.278
	(5.37)***	(1.79)*	(9.87)***	(6.73)***
Adj. R^2	0.30	0.15	0.36	0.17
N	2296	1404	2296	1404

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of 2 Fixed Effects Models (FEM) and 2 Random-Effects models (REM). For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using robust standard errors. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively.

5.2.4 Fama MacBeth Regression

In this section the results of the Fama MacBeth model are presented. Firstly, it is to remark that the regression coefficients in Table 9 are computed using Newey-West (1978) standard error estimates. This is a method that controls for heteroskedasticity as well autocorrelation among the residuals.

Starting with Model 1, one can directly notice the similarities regarding the signs of the coefficient compared with the previous three regression methods. Again, the factors firm size, leverage and liquidity show significantly negative relations with cash holdings, even at the 1%-level. Also regarding the factor investment opportunity one can note a significant positive relation, which shows that there is consistency among the predictions by the various regression types that have been conducted so far. While the Fixed-Effects model did not yield any significant relations for the ZSCORE or the research and development dummy variable, the Fama MacBeth model computes significant coefficients at the 5% level for both variables. The inverse ZSCORE turns out to be negatively related with the cash ratio, whereas the research and development dummy variable shows a positive relation. These predictions basically align the ones by the OLS-models, although the OLS-models only find significant relations with the ZSCORE, when the variable bank debt is included and significant relations with RDDUM, when bank debt is excluded. Moreover, the R^2 of 38% is relatively high and can be compared with Model 1 of the OLS-regressions.

The inclusion of the variable bank debt generates a familiar picture. As with the other regression methods, the inclusion of bank debt causes a weakened relation between firm size and cash holdings, while the variables leverage, liquidity and investment opportunity remain consistently significant. Furthermore, the model shows significant negative relations with the variables dividend payment and bank debt. This output resembles the outputs of all the OLS-models that were run, including bank debt, and is in line with the hypotheses that were formulated in Section 2. Next to that, one can note that the ZSCORE coefficient remains significantly negative, whereas the research and development dummy becomes insignificant. Eventually, the R^2 declines by 14%, which again, may likely be attributed to the reduced sample size of this model.

Table 9: Fama MacBeth Regression

Dep. Var. CASH	**Model 1**	**Model 2**
SIZE	-0.009 (11.99)***	-0.001 (1.85)
LEV	-0.381 (9.12)***	-0.188 (6.19)***
CF	-0.111 (2.80)**	-0.026 (0.34)
LIQ	-0.252 (15.01)***	-0.142 (25.18)***
INVO	0.027 (8.79)***	0.012 (2.57)**
DIV	-0.009 (2.86)**	-0.016 (3.31)**
ZSCORE	-0.014 (2.55)**	-0.016 (1.64)
RDDUM	0.016 (3.00)**	0.005 (0.64)
BANK		-0.108 (5.50)***
_cons	0.451 (24.16)***	0.258 (14.54)***
Adj. R^2	0.38	0.24
N	2296	1404

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the regression results of the Fama MacBeth Model. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using the Newey-West (1978) standard error estimations in order to control for heteroskedasticity and autocorrelation. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively.

5.3 Comparison of Regression analyses

After having elaborated on each type of regression separately, this section compares the results of the respective regressions analyses with each other and similarities and differences will be discussed. In order to enhance the ease of comparison, Table 11 presents one model for each type of regression. As the results of the separate regressions indicated that the findings, excluding bank debt, appear to be more reliable, I present only four regression models as the main findings in this section. For the OLS model I will display the regression that includes year and industry dummies, as it is reasonable to assume that the parameter estimates of models, which take into account time and industry effects, are more efficient and less biased (Wooldridge, 2013). The same holds for the cross-sectional regression using means, while the time effect is already taken account of through the process of averaging. Finally, I include the results of one fixed-effects model and the Fama MacBeth model.

Starting with the variable firm size, one notes a similar picture for all four types of regressions. Firm size yields a significant negative relation with each type of regression. Here, FEM measures the largest influence of firm size of -0.03. This means that with every additional unit of firm size the cash ratio would decline by 3%. This finding contradicts Hypothesis 3 and it appears that the trade-off model is prevalent in explaining the relation between firm size and cash holdings as the other two models predict positive relations.

Continuing with the variable leverage, all 4 models compute strong negative relations with cash holdings, significant at the 1% level. Here, FMB measures the strongest influence of -38%, while the other models' coefficients are all in the range between -31% and -38%. This finding is basically in line with the predictions of all three theoretical models as well as with the majority of findings by previous authors. Thus, the results of the analysis support Hypothesis 1.

Table 11: Summary of regression types

Dep. Var. CASH	**OLS**	**FEM**	**FMB**	**CSM**
SIZE	-0.010	-0.030	-0.009	-0.010
	(6.58)***	(2.98)***	(11.99)***	(2.35)**
LEV	-0.379	-0.313	-0.381	-0.361
	(19.13)***	(6.96)***	(9.12)***	(8.86)***
CF	-0.056	0.018	-0.111	-0.098
	(1.42)	(0.40)	(2.80)**	(1.06)
LIQ	-0.242	-0.342	-0.252	-0.192
	(12.32)***	(8.58)***	(15.01)***	(3.38)***
INVO	0.023	0.020	0.027	0.018
	(5.67)***	(2.66)***	(8.79)***	(2.10)**
DIV	-0.003	0.005	-0.009	-0.004
	(0.46)	(0.86)	(2.86)**	(0.16)
ZSCORE	-0.002	-0.004	-0.014	0.009
	(0.26)	(0.48)	(2.55)**	(0.49)
RDDUM	0.010	0.005	0.016	0.014
	(1.66)*	(0.42)	(3.00)**	(0.80)
_cons	0.450	0.677	0.451	0.434
	(18.11)***	(5.37)***	(24.16)***	(4.04)***
Year Dum.	Yes			
Ind. Dum.	Yes			Yes
Adj. R^2	0.49	0.30	0.38	0.46
N	2296	2296	2296	267

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the overall results of all four types of regressions namely the OLS-Regression (OLS), the Fixed-Effects-Model (FEM), the Fama MacBeth-Regression (FMB) and the Cross-sectional Regression using means (CSM). For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using robust standard errors. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally, a “Yes” indicates whether Year Dummies and/or Industry Dummies are included in the regression.

The same effect as with leverage has also been computed for the variable bank debt. The findings including bank debt can be observed in previous regression tables.

Regarding the variables cash flow and cash flow volatility I do not find significant relations with cash holdings. Although, the evidence by previous authors suggested positive relations with both variables I do not have enough evidence to either confirm or reject those assumptions.

Coming to the variable liquid assets, the results are relatively unambiguous. Here, each of the models consistently computes a significant negative relation with cash holdings. The FEM measures the strongest influence of –34.2%. These results are in accordance with the findings by all of the previous authors studied in this paper as well as with Hypothesis 6. This gives rise to the assumption that liquid asset substitutes (net working capital) are highly relevant factors in determining the level of cash holdings. Here, the trade-off model is the only model that makes an assumption about liquid asset substitutes and it argues that when a firm has large amounts of net working capital, there is less of a need to hold cash and cash equivalents because positive net working capital could be easily converted into cash by means of factoring, for instance.

For the variable investment opportunity, the results suggest almost consistently positive relations with cash holdings. Merely, FEM provides an insignificant coefficient. The largest influence of investment opportunity is computed by FMB with 2.7%. Also regarding this factor one can note overall consistency among the findings of the previous authors. Moreover, I have enough evidence to support Hypothesis 7. Here, both the trade-off model as well as the pecking-order theory may be suitable to explain the effect. The theories are quite similar in their argumentation with respect to this factor. Both state that firms with large investment opportunities should hold more cash in order not to be forced to forgo positive NPV investments in case of capital market restrictions or to be reliant on costly external financing.

For the variable dividend payment the overall results do not suggest that this variable is a significant determinant of cash holdings. Merely with FMB one can note significant negative relations at the 5%-level. Hence, I do not have enough evidence to support Hypothesis 8. This resembles the findings by Ferreira and Vilela (2004) and Ozkan and Ozkan (2004), who do not find a significant relation with the variable dividend payment either.

Finally, Table 12 below sums up the main findings of the regression analyses, by opposing the predicted relations of the respective variables with the empirically determined relations. Clearly, for the variables leverage, bank debt, liquid assets and investment opportunity there is an alignment between the predicted and the tested relations, while the finding for firm size contradicts its predicted relation. Moreover, I did not find significant influences for the variables cash flow, cash flow volatility and dividend payment.

Table 12: Predicted and empirically determined relations with cash holdings

Variable	Predicted relation	Determined relation
Firm size	+	-
Leverage	-	-
Bank debt	-	-
Cash flow	+	n.s.
Cash flow volatility	+	n.s.
Liquid assets	-	-
Investment opportunity	+	+
Dividend payment	-	n.s.

5.4 Supplementary Analysis

In order to enhance the robustness of my findings, I vary the composition of my sample based on different indications. The purpose is to see how sensitive the regression models are to changes regarding the grouping of the underlying sample. This also involves examining pre- and post-crisis samples in order to see how the financial crisis affects the influence of the firm specific determinants.

5.4.1 Manufacturing and services sector

The first point of indication is based on the type of industry. Although I have already introduced industry dummies in the previous regression, I will apply a broader subgrouping in this section. As can be derived from Table 4, the manufacturing sector represents more than half of all sample firms in this study, while the services sector represents the second largest industry. Therefore, I run separate regression models that either include firms from the manufacturing or from the services sector. Table 13 depicts the different

regression models. Here for each type of regression I report two models, one with manufacturing firms and the other one with service firms. At the first glance, one can directly confirm that there is consistency regarding the signs of the coefficients compared to the previous regression models. With respect to firm size, it appears that firm size generally has a larger influence in service firms as compared to manufacturing firms. The cross sectional means regression does not report significant coefficients for manufacturing and only 10%-significance for service firms. However, this may certainly be attributed to the reduced number of observations.

Moreover, I find consistent negative relations with leverage across all models. Likewise, it appears that leverage has larger influence in service firms. This finding repeats itself for the variables liquidity and investment opportunity. Hence, it creates the impression that the explanatory variables generally larger in service firms. This assumption is also supported by the adjusted R^2 –values, which are generally higher for service firms. A possible interpretation for this finding may be that manufacturing firms, by nature, always have to keep an additional amount of safety stock in cash in order to facilitate smooth operations (Miller and Orr, 1968). Manufacturing firms are more exposed to factors like price shocks for input materials (e.g. crude oil) or machine failures. Therefore, the influence of those other firm-specific determinants may be weaker as compared to service firms.

Table 13: Model variations: manufacturing and services sector

Dep. Var	**OLS**	**OLS**	**FEM**	**FEM**	**FMB**	**FMB**	**CSM**	**CSM**
CASH	**Manuf.**	**Services**	**Manuf.**	**Services**	**Manuf.**	**Services**	**Manuf.**	**Services**
SIZE	-0.005	-0.027	-0.006	-0.067	-0.004	-0.027	-0.002	-0.023
	(3.40)***	(6.36)***	(0.46)	(2.71)***	(3.15)**	(10.04)***	(0.54)	(1.92)*
LEV	-0.334	-0.459	-0.276	-0.384	-0.325	-0.443	-0.342	-0.517
	(15.24)***	(11.20)***	(4.78)***	(3.71)***	(21.23)***	(6.77)***	(8.41)***	(4.58)***
CF	-0.142	-0.109	0.077	-0.010	-0.102	-0.141	-0.285	-0.219
	(2.60)***	(1.49)	(1.27)	(0.19)	(1.73)	(1.76)	(3.43)***	(1.11)
LIQ	-0.172	-0.296	-0.324	-0.378	-0.157	-0.274	-0.111	-0.310
	(8.14)***	(7.03)***	(6.01)***	(4.82)***	(17.03)***	(7.55)***	(2.18)**	(2.48)**
INVO	0.018	0.054	0.009	0.023	0.017	0.060	0.021	0.029
	(3.82)***	(6.39)***	(0.89)	(1.77)*	(2.64)**	(7.71)***	(2.51)**	(1.85)*
DIV	-0.011	-0.006	0.014	0.002	-0.012	-0.005	-0.033	0.015
	(1.65)*	(0.46)	(1.90)*	(0.14)	(3.83)***	(1.41)	(1.60)	(0.27)
ZSCORE	-0.013	-0.014	-0.002	-0.012	-0.020	-0.026	-0.006	-0.017
	(1.35)	(1.00)	(0.23)	(0.78)	(2.10)*	(2.95)**	(0.26)	(0.52)
RDDUM	0.031	0.045	0.019	0.007	0.028	0.040	0.031	0.056
	(5.17)***	(3.49)***	(1.09)	(0.38)	(2.59)**	(3.95)***	(1.99)**	(1.39)
_cons	0.363	0.699	0.339	1.122	0.341	0.649	0.338	0.683
	(12.90)***	(13.24)***	(1.94)*	(4.41)***	(15.49)***	(28.65)***	(6.94)***	(5.64)***
R^2	0.36	0.47	0.21	0.28	0.39	0.51	0.53	0.49
N	1,288	518	1,288	518	1,288	518	147	62

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

5.4.2 DAX and TecDAX firms

As a second point of distinction I decided to use the DAX and TecDAX listings. The DAX is most important German stock market index and it is comprised of the 30 largest blue chip companies in Germany, in terms of market capitalisation and order book volume. Moreover, the TecDAX is also a German stock market index, which contains the 30 largest high-tech firms in Germany in terms of market capitalisation and order book volume. The sample of this study contains 21 DAX listed firms as well as 21 TecDax listed firms. The reason why I apply this particular grouping is based on the findings of previous authors, who also investigated cash holdings. First, Brisker et al. (2013) examine the effects of the inclusion of US firms in the S&P 500 index over the period from 1971 to 2006. The S&P 500 index is also a stock market index, comprised of the largest 500 US firms and hence it is relatively similar to the DAX, although the number of firms is much higher. Brisker et al. (2013) find evidence that firms, after the inclusion, held on average 32% less cash than before the inclusion. They argue that this finding can be attributed to the fact that the inclusion in the S&P 500 index increased the visibility, the transparency and uncertainty of the respective firms, which ultimately lowered the external capital market constraints. This resulted in a decreasing influence of the precautionary motive for holding cash. Next to that, they also state that after the inclusion in the index, firms would face diminishing investment opportunities and decreasing capital expenditures, which would also lower the need for cash from a transaction cost perspective. Next to that, Bates et al. (2009) examine the development of cash holdings of US firms over the period from 1980 to 2006. In their study they, among other things, aim to determine whether high-tech firms have a higher cash ratio than manufacturing firms. Although they do not have enough evidence to fully support this assumption, they do find that there is a tendency, indicating that high-tech firms have higher cash ratios than manufacturing firms.

Hence, first of all I compute two t-tests for differences between means, where I compare the mean cash ratios of the DAX and the TecDAX listed firms with the mean cash ratios of the other firms, respectively. In Appendix 6 one can see the output of the t-tests. I find that the mean cash ratio of roughly 10% of the DAX listed firms is significantly lower than the mean cash ratio of 15% of the other firms. On the opposite, TecDAX listed firms have with 20.4% a significantly higher cash ratio than the other firms. Regarding the DAX listed firms, the lower cash ratio can be attributed to the larger size of those firms. However, the firms listed in the TecDAX are on average larger than the other firms, but their

cash ratio is clearly higher. Here one could argue using the precautionary motive of holding cash. As high-tech firms are generally characterized by high costs in R&D and high market-to-book ratios, they tend to hold larger amounts of cash (Bates et al., 2009). In this case, the latter effect seems to offset the economies of scale effect that accompanies a larger firm size.

Moreover, I present separate regressions in Table 14, including either DAX or TecDAX listed firms across all regression types in order to observe the influence on the other explanatory variables. Starting with firm size, we can only note a significant negative relation for the OLS models with DAX listed firms. The remaining models also compute negative relations, which are not significant, though. This is probably due to the small number of observations for both groups. Coming to the variable leverage, we find a higher consistency regarding the significance of the coefficients. Besides, it appears that leverage generally has a larger, as well as more a significant influence on cash holdings with TecDAX listed as compared to DAX listed firms. Next, we can note that with liquid assets there is a similar relation. Across all models the relation between liquid assets and cash holdings appears to be stronger with TecDAX listed firms. Finally, the variable investment opportunity seems to have a stronger influence with DAX listed firms in this case. However, it has to be remarked that there are only 3 model computations that report strong significance. So, there is not enough evidence to give a clear statement on that relation.

To sum up, it can be stated that generally DAX and TecDAX listed firms are affected by the same firm specific factors as compared to the remaining sample firms, however, due to the small number of observations, particularly for the CSM model, it is hard to achieve a high significance among the regression coefficients.

Table 14: Model variations: DAX and TecDAX listed firms

Dep. Var	**OLS**	**OLS**	**FEM**	**FEM**	**FMB**	**FMB**	**CSM**	**CSM**
CASH	**DAX**	**TecDAX**	**DAX**	**TecDAX**	**DAX**	**TecDAX**	**DAX**	**TecDAX**
SIZE	-0.015	-0.004	-0.035	-0.019	-0.017	0.001	-0.002	-0.009
	(2.08)**	(0.47)	(1.60)	(0.72)	(1.76)	(0.10)	(0.09)	(0.37)
LEV	-0.140	-0.626	-0.310	-0.366	-0.053	-0.442	-0.232	-0.617
	(2.36)**	(9.67)***	(2.07)**	(3.17)***	(0.69)	(19.04)***	(0.90)	(3.34)***
CF	-0.177	-0.312	-0.089	0.021	-0.458	-0.006	-0.637	-0.313
	(1.15)	(1.63)	(0.95)	(0.15)	(2.17)*	(0.02)	(0.79)	(0.63)
LIQ	-0.236	-0.321	-0.304	-0.312	-0.191	-0.270	-0.143	-0.279
	(3.91)***	(5.21)***	(2.96)***	(2.04)*	(2.60)**	(4.42)***	(0.57)	(1.92)*
INVO	0.054	0.019	0.036	0.038	0.072	0.001	0.065	-0.002
	(5.53)***	(2.03)**	(1.48)	(1.92)*	(4.62)***	(0.07)	(2.11)*	(0.08)
DIV	-0.023	-0.004	0.001	0.001	-0.028	-0.096	-0.165	0.000
	(1.10)	(0.17)	(0.08)	(0.03)	(0.61)	(1.33)	(1.54)	(0.00)
ZSCORE	0.019	0.044	0.049	0.020	0.025	-0.125	0.004	0.018
	(0.83)	(1.89)*	(1.54)	(0.71)	(1.24)	(0.93)	(0.06)	(0.42)
RDDUM	-0.060	0.026		0.025	-0.080	0.042	-0.070	0.018
	(3.86)***	(1.42)		(0.67)	(4.36)***	(2.19)*	(0.79)	(0.32)
_cons	0.448	0.526	0.810	0.516	0.427	0.503	0.377	0.631
	(4.21)***	(4.42)***	(2.23)**	(1.67)	(2.48)**	(5.36)***	(1.29)	(1.93)*
R^2	0.48	0.57	0.23	0.27	0.63	0.74	0.62	0.74
N	187	176	187	176	187	176	21	21

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

5.4.3 Impact of the financial crisis

In Section 5.1 the Figure 1 serves as an appropriate illustration of how the financial crises had impacted the development of cash holdings of the sample firms. This gives rise to the assumption that the relations of cash holdings with the explanatory variables has changed as well. In order to investigate this assumption I divide my sample into two subsamples. The first subsample is represented by the period before the crisis and including the crisis from 2005 to 2008. The second sample shall represent the period after the financial crisis from 2009 to 2013. The reason why I apply this particular subdivision is because in Figure 1 one can clearly distinguish two these two different periods. In the period from 2005 to 2008 there is basically a steady decrease in cash holdings, where the minimum point is reached in 2008. This year appears to be the turning point with respect to cash policy because of the sharp increase from roughly 8% by the end of 2008 to 11.3% by the end of 2009. Therefore, I run two regressions for each subsample in order to see whether there is a change in the regression coefficients. In order to enhance the robustness of the results I will compute these regression for all 4 types of regression analyses.

In Table 15 the results of the various regression models are depicted. First of all, we see that the same four explanatory variables as in the other previous regressions: firm size, leverage, liquidity and investment opportunity seem to be the prevailing determinant, which influence cash holdings. Starting with firm size, we can note that there is no change in the sign coefficients across all four models. The relation seems to be consistently negative with firm size in both periods. Regarding the strength of the influence of firm size on cash holdings, there is no real consensus between the models. While the OLS and the FMB models both show a slight increase in the regression coefficient in the post-crisis period, the FE model denotes a decrease in the influence and the CS model does not report a change in the coefficient. So, taking together the outcomes of all four models, we cannot clearly state whether the influence of firm increases or decreases in the post-crisis period, although the evidence speaks slightly in favour of an increase, as the FEM post-crisis estimation is only significant at the 10% level.

Table 15: Pre- and Post-crisis regression models

Dep. Var	**OLS**	**OLS**	**FEM**	**FEM**	**FMB**	**FMB**	**CSM**	**CSM**
CASH	**Pre-crisis**	**Post-crisis**	**Pre-crisis**	**Post-crisis**	**Pre-crisis**	**Post-crisis**	**Pre-crisis**	**Post-crisis**
SIZE	-0.008	-0.010	-0.047	-0.038	-0.008	-0.009	-0.008	-0.008
	(3.58)***	(5.24)***	(3.25)***	(1.73)*	(7.70)***	(15.37)***	(2.03)**	(2.25)**
LEV	-0.450	-0.315	-0.434	-0.107	-0.466	-0.313	-0.499	-0.319
	(14.83)***	(12.12)***	(8.32)***	(1.67)*	(67.71)***	(20.58)***	(11.76)***	(7.59)***
CF	-0.091	-0.018	-0.095	0.149	-0.150	-0.080	-0.218	-0.090
	(1.71)*	(0.33)	(1.61)	(2.66)***	(4.85)**	(1.25)	(2.74)***	(1.18)
LIQ	-0.265	-0.218	-0.336	-0.323	-0.282	-0.227	-0.294	-0.201
	(9.09)***	(8.13)***	(6.66)***	(6.00)***	(14.11)***	(16.34)***	(6.42)***	(4.45)***
INVO	0.026	0.020	0.023	0.007	0.028	0.027	0.016	0.026
	(4.49)***	(3.41)***	(3.15)***	(0.62)	(9.59)***	(4.23)**	(2.57)**	(2.78)***
DIV	0.002	-0.004	-0.003	0.014	-0.013	-0.005	-0.014	-0.011
	(0.18)	(0.53)	(0.37)	(1.93)*	(2.28)	(3.66)**	(0.74)	(0.52)
ZSCORE	0.009	-0.014	0.022	-0.007	-0.004	-0.022	-0.011	-0.008
	(0.75)	(1.28)	(1.80)*	(0.52)	(1.31)	(3.99)**	(0.93)	(0.44)
RDDUM	0.001	0.015	-0.017	0.006	0.008	0.023	0.011	0.027
	(0.06)	(1.82)*	(0.82)	(0.50)	(1.06)	(6.48)***	(0.72)	(1.76)*
_cons	0.456	0.424	0.960	0.675	0.494	0.417	0.549	0.403
	(13.50)***	(12.47)***	(5.21)***	(2.39)**	(37.91)***	(37.75)***	(12.43)***	(8.76)***
R^2	0.58	0.43	0.31	0.18	0.47	0.33	0.50	0.35
N	1,012	1,284	1,012	1,284	1,012	1,284	262	267

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

An interpretation for an increase of the influence of firm size after the financial crises could be provided by the trade-off model. The trade-off model suggests that small firms face higher capital market constraints as well as costs, compared to big firms, and therefore they would be inclined to hold more cash. So, the financial crisis could have amplified this influence in the sense that investors and banks became more uncertain and sceptical towards investing their money in firms, and especially small firms because they are generally more likely to face financial distress (Rajan and Zingales, 1955).

For the variable leverage Table 15 denotes a weakening of the relation to cash holdings across all models. In this case we could again argue from the perspective of the trade-off model. A high leverage ratio generally indicates that the respective firm maintains a good relation with its bank or creditors (Ferreira and Vilela, 2004). Hence, those firms tend to incur lower transaction costs, which lowers their need to hold large amounts of cash. However, in the period following the financial crisis, banks started to become extremely cautious and cut their lending. Through these credit constraints, many firms had to liquidate some of their assets in order to fund operations and were forced to pass on profitable investment opportunities (Campello et al., 2010). Therefore, one could assume that in the post-crisis period, the leverage ratio is not such a strong indicator of access to external capital markets as compared to the pre-crisis period, simply because of the extreme credit restrictions of the capital market.

Coming to the variable liquid assets, we also note a weakening of the relation across all models. This finding can also be interpreted by the trade-off model. Normally, liquid assets other than cash, like net working capital, can be seen as substitutes for cash. However, due to the financial crisis and the resulting credit constraints, the importance of holding cash as a precautionary motive has increased. While facing even tighter credit constraints as before the crisis firms might have intended to adjust for this additional amount of risk by extending their cash buffer, despite the presence of net working capital as cash substitute (Campello et al., 2010).

The overall results for the variable investment opportunity create an ambiguous picture. In the OLS and FMB model the influence becomes smaller in the post-crisis period, while the CS model computes a significantly higher influence. The FE model cannot be taken into consideration this time because it does not yield a significant regression coefficient.

6 Conclusion

This thesis examines the firm-specific determinants of cash holdings from a sample of 270 German listed firms over the period from 2005 to 2013. The main results of the regression analyses are that we find significant negative relations with cash holdings for the variables firm size, leverage, bank debt and liquid assets, consistently across all 4 types of regressions. Moreover, I find that the variable investment opportunity is consistently positively related with cash holdings. Consequently, this means that the results of the regression analyses provide enough evidence to accept 4 and reject one of 8 initially stated hypotheses.

Although both the pecking-order theory and the free cash flow theory predict positive relations with firm size, the empirical findings of this paper as well as of the bulk of other papers, seem to refute this hypothesis (Opler et al., 1999; D'Mello et al., 2008; Drobetz and Grüninger, 2007; Ferreira and Vilela, 2007). The negative relation determined for firm size can only be interpreted using the trade-off model, as it suggests that large firms benefit through economies of scale in terms of cash management and thus require less cash. On the opposite, the pecking-order theory suggests a positive relation because it assumes that larger firms are more successful and thus generate more cash. The free cash flow theory stresses that in larger firms, entrenched managers have a higher discretionary power, due to a higher shareholder dispersion, and therefore accumulate more cash. Hence, the relation between firm size and cash holdings can be best explained by transaction costs rather than by financing hierarchies or agency problems.

Regarding the variable leverage, all three models may be suitable for explaining the negative relation. From a trade-off perspective, a high leverage ratio indicates that firms maintain a good relationship to their creditors. This good relationship is associated with relatively low costs when issuing additional debt, in the event of shortages in cash. Hence, firms with high leverage ratios would be inclined to hold less cash. The explanation of the pecking-order theory is quite straightforward. Given that all firms follow the hierarchy of financing, firms would issue debt, when the level of investment exceeds the level of cash holdings and therefore leverage would increase and cash holdings would decrease correspondingly. Finally, the free cash flow theory argues that less levered firms would be less subject to monitoring, which would increase managerial discretion leading to higher cash ratios.

Concerning bank debt, the explanations by the models are quite similar compared to the variable leverage. From a transaction costs perspective a high bank debt ratio also

indicates that the firm maintains a good relation banks and thus is able to issue additional bank debt more cheaply. From the pecking-order perspective a high bank debt ratio would lessen the need for precautionary cash holdings, as banks are in a very good position to evaluate the financial performance and credit quality of firms, and thus those firms tend to be less likely to be restricted from additional funding by banks, once they built a close relationship with them (Ferreira and Vilela, 2004). The free cash flow theory picks up on the strong monitoring capabilities of banks and argues that low bank debt ratios would allow for more managerial discretion and consequently higher cash ratios.

Coming to the variable liquid assets, the trade-off model is the only model that makes a prediction regarding the relation with cash holdings. It basically interprets liquid assets other than cash and cash equivalents, namely net working capital, as substitutes for cash which can be quickly converted into cash at low costs. Therefore, a higher amount of net working capital would require less cash holdings.

Finally, the positive relation of variable investment opportunity, can be explained by both, the trade-off model and the pecking order theory. The trade-off model suggests that the costs of incurring cash shortages is higher for firms, which have large investment opportunities because in case they would have to forgo those opportunities they would expect higher losses as compared to firms with low investment opportunities (Ferreira and Vilela, 2004; Opler et al., 1999). The explanation by the pecking order theory is quite similar, as it predicts that firms with high investment opportunities keep a higher amount of precautionary cash in order not be forced to give up positive NPV projects.

The overall findings indicate that the trade-off model and the pecking order theory play important roles in explaining the determinants of corporate cash holdings, although the trade-off model seems to be superior in explaining most of the variation. In contrast, the free cash flow theory receives rather weak support, which indicates that agency problems do not have such a big influence on the cash holdings of German listed firms.

As part of a supplementary analysis, I also find that my findings are robust with different sample compositions. The results indicate that manufacturing firms and service firms are affected by the same determinants as the entire sample, whereas the firm-specific determinants appear to have stronger influences with service firms compared to manufacturing firms. The same can be stated for DAX and TecDAX listed firms. Here, I find that DAX listed firms hold on average significantly less cash than the remaining sample and TecDAX firms hold significantly more cash.

Finally, I also observed the behaviour of the regression coefficients during the financial crisis, by computing regressions for a pre- and a post crisis sample. I find that the overall influence of the firm specific determinants has weakened in the post crisis period. This particularly holds with leverage. A possible interpretation for this finding might be that creditors have become extremely cautious and tightened their credit policy after the crisis and thus firms faced higher constraints in terms of their access to external capital markets (Campello et al., 2010). As a consequence the influence of leverage declined.

6.1 Future Research

One of the limitations of this study is that it does not test the effects of corporate governance on cash holdings, which is due to the fact that the ORBIS database does not provide such detailed information on the sample firms.

Moreover, in consideration of the recent negotiations between Greece and the European Central Bank, it would be interesting to launch a study including European firms in order to measure the effect of the debt crisis and maybe even a potential exit of Greece from the Eurozone on cash holdings by European firms. However, this study has to be designed over a longer-term in order to obtain valid results, as there is not yet full clarity about the future of Greece and Europe has not overcome the debt crisis.

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Appendices

Appendix 1: Correlation Matrix

Table A: Correlation Matrix

	CASH	SIZE	LEV	BANK	CF	CFVOL	LIQ	INVO	DIV	ZSCORE	RDDUM
CASH	1										
SIZE	0.054***	1									
LEV	-0.34***	0.18***	1								
BANK	-0.15***	0.31***	0.30**	1							
CF	0.03**	0.14***	0.21***	0.12***	1						
CFVOL	0.08***	0.32***	0.07***	0.06***	0.37***	1					
LIQ	-0.09***	0.13***	0.41***	0.01	0.09***	0.07***	1				
INVO	0.14***	0.01***	0.27***	0.03	0.14***	0.08***	0.15***	1			
DIV	-0.06***	0.41***	0.14***	0.13***	0.28***	0.32***	0.16***	0.13***	1		
ZSCORE	-0.01***	-0.01	0.02***	0.07***	0.09***	0.01***	0.001***	0.01***	0.03***	1	
RDDUM	0.04	0.41***	0.13***	0.27***	0.12**	0.15***	0.22***	0.09***	0.26***	-0.03**	1

This table depicts the correlation matrix. Here the correlation coefficients between each of the dependent as well as independent variables are depicted. Based on the output of this table one would not assume any serious problems related with multicollinearity, as the correlation coefficients between the explanatory variables are all in the range between -50% and 50% (Wooldridge, 2002). *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively.

Appendix 2: Variance Inflation Factors

Table B: Variance Inflation Factors

Variable	VIF	1/VIF
SIZE	1.74	0.575204
DIV	1.41	0.708397
LEV	1.4	0.713931
RDDUM	1.39	0.721095
CFVOL	1.35	0.740415
LIQ	1.32	0.75497
CF	1.28	0.78202
BANK	1.15	0.867477
INVO	1.12	0.889948
ZSCORE	1.01	0.987132
Mean VIF	1.32	

This table depicts the variance inflation factors. This is a method for detecting multi-colllinearity among the explanatory variables in a regression. Since all VIF's are below the value of 5, it is deemed reasonable to assume there is no issue regarding collinearity (O'Brien, 2007).

Appendix 3: Hausman Test

Table C: Hausman test

	------Coefficients-------			
	(b)	*(B)*	*(b-B)*	*sqrt(diag(V_b-V_B))*
	Fixed	Random	Difference	S.E.
SIZE	-0.0304131	-0.0162138	-0.0141993	0.0047371
LEV	-0.3362548	-0.3501425	0.0138877	0.0092778
CF	0.0320622	0.0167458	0.0153164	0.0064244
LIQ	-0.3449766	-0.3280272	-0.0169494	0.0073183
INVO	0.0075352	0.0088353	-0.0013001	0.0008639
DIV	0.0057277	0.0038054	0.0019222	0.0011737
ZSCORE	-0.0050208	-0.0038558	-0.001165	0.0008278
RDDUM	0.0059595	0.0117855	-0.005826	0.003231

b= consistent under H0 and HA; obtained from xtreg

B= inconsistent under HA, efficient under H0; obtained from xtreg

Test: H0: Difference in coefficients is not systematic

$Chi^2(8) = 29.18$

$Prob>Chi^2 = 0.0003$

This table displays the output of the Hausman (1978) test. The null hypothesis states that there is no correlation between the explanatory variables and the error term and the alternative hypothesis states that there is a correlation. Since the p-value is less than 0.05, the null hypothesis can be rejected which means that the Fixed-Effects model is the appropriate model to choose for the regression.

Appendix 4: Regression models using net cash

Table D: OLS-Regression results using net cash

Dep. Var. CASHN	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
SIZE	-0.023	-0.004	-0.023	-0.004	-0.025	-0.004
	(6.93)***	(1.63)	(6.91)***	(1.62)	(7.08)***	(1.65)*
LEV	-0.829	-0.320	-0.830	-0.320	-0.824	-0.333
	(15.33)***	(8.92)***	(15.32)***	(8.78)***	(14.56)***	(8.31)***
CF	-0.344	-0.104	-0.353	-0.102	-0.168	-0.108
	(2.99)***	(1.33)	(3.06)***	(1.28)	(1.48)	(1.29)
LIQ	-0.587	-0.267	-0.589	-0.266	-0.555	-0.289
	(12.51)***	(6.80)***	(12.49)***	(6.77)***	(10.74)***	(6.87)***
INVO	0.065	0.025	0.066	0.025	0.059	0.013
	(6.05)***	(3.26)***	(6.10)***	(3.21)***	(5.41)***	(1.71)*
DIV	-0.016	-0.027	-0.015	-0.026	-0.006	-0.019
	(1.06)	(2.69)***	(0.93)	(2.68)***	(0.40)	(1.82)*
ZSCORE	-0.022	-0.021	-0.022	-0.021	0.003	-0.033
	(1.17)	(2.12)**	(1.19)	(2.10)**	(0.17)	(2.89)***
RDDUM	0.028	0.002	0.031	0.002	0.024	0.006
	(2.03)**	(0.24)	(2.21)**	(0.27)	(1.50)	(0.62)
BANK		-0.157		-0.156		-0.128
		(5.59)***		(5.58)***		(4.04)***
_cons	0.942	0.414	0.977	0.423	0.904	0.443
	(15.99)***	(9.75)***	(15.26)***	(9.42)***	(13.45)***	(9.27)***
Year Dum.	0.33	0.20	0.34	0.20	0.42	0.30
Ind. Dum.	2,296	1,404	2,296	1,404	2,296	1,404
Adj. R^2	-0.023	-0.004	-0.023	-0.004	-0.025	-0.004
N	(6.93)***	(1.63)	(6.91)***	(1.62)	(7.08)***	(1.65)*

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the results of several OLS-regressions. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using robust standard errors. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally, a “Yes” indicates whether Year Dummies and/or Industry Dummies are included in the regressions.

Table E: Fixed- and Random Effects Model Regressions using net cash

Dep. Var. CASHN	**FEM 1**	**FEM 2**	**REM 1**	**REM 2**
SIZE	-0.077	-0.012	-0.036	-0.006
	(3.22)***	(0.60)	(4.49)***	(1.46)
LEV	-0.693	-0.402	-0.739	-0.387
	(5.90)***	(5.61)***	(7.21)***	(6.63)***
CF	0.029	0.126	-0.042	0.048
	(0.25)	(1.11)	(0.42)	(0.50)
LIQ	-0.796	-0.383	-0.738	-0.336
	(6.20)***	(6.05)***	(6.61)***	(6.28)***
INVO	0.033	0.024	0.040	0.024
	(1.46)	(1.78)*	(2.18)**	(2.10)**
DIV	-0.005	-0.005	-0.008	-0.008
	(0.30)	(0.48)	(0.53)	(0.86)
ZSCORE	-0.015	0.008	-0.013	0.001
	(0.71)	(0.61)	(0.67)	(0.11)
RDDUM	-0.002	0.003	0.015	0.004
	(0.07)	(0.20)	(0.73)	(0.31)
BANK		0.003		-0.042
		(0.07)		(0.93)
_cons	1.586	0.501	1.080	0.444
	(4.90)***	(1.85)*	(7.11)***	(6.12)***
Adj. R^2	0.26	0.16	0.31	0.17
N	2,296	1,404	2,296	1,404

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of 2 Fixed Effects Models (FEM) and 2 Random-Effects models (REM). For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using robust standard errors. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively.

Table F: Fama MacBeth Regression using net cash

Dep. Var. CASHN	**Model 1**	**Model 2**
SIZE	-0.023 (18.79)***	-0.003 (2.62)**
LEV	-0.811 (7.95)***	-0.291 (6.37)***
CF	-0.350 (2.92)**	-0.048 (0.36)
LIQ	-0.575 (7.96)***	-0.251 (16.83)***
INVO	0.069 (5.76)***	0.021 (2.13)**
DIV	-0.010 (1.81)	-0.025 (2.76)**
ZSCORE	-0.025 (4.47)***	-0.024 (1.92)*
RDDUM	0.028 (4.96)***	0.005 (0.36)
BANK		-0.161 (4.59)***
_cons	0.923 (11.65)***	0.395 (13.91)***
Adj. R^2	0.34	0.23
N	2,296	1,404

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the regression results of the Fama MacBeth Model. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. The t-statistics are computed using the Newey-West (1978) standard error estimations in order to control for heteroskedasticity and autocorrelation. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively.

Table G: Cross-sectional regression using means

Dep.Var. CASHN	**Model 1**	**Model 2**	**Model 3**	**Model 4**
SIZE	-0.009	-0.005	-0.010	-0.005
	(2.24)**	(1.57)	(2.35)**	(1.30)
LEV	-0.381	-0.301	-0.361	-0.293
	(9.69)***	(7.50)***	(8.86)***	(6.67)***
CF	-0.166	-0.233	-0.098	-0.200
	(2.01)**	(2.79)***	(1.06)	(2.18)**
CFVOL	-0.065	-0.044	-0.084	-0.020
	(0.79)	(0.65)	(0.94)	(0.26)
LIQ	-0.240	-0.205	-0.192	-0.192
	(5.30)***	(5.17)***	(3.38)***	(3.65)***
INVO	0.022	0.011	0.018	0.005
	(2.72)***	(1.62)	(2.10)**	(0.66)
DIV	-0.021	-0.009	-0.004	-0.004
	(0.96)	(0.49)	(0.16)	(0.19)
ZSCORE	-0.006	-0.004	0.009	0.001
	(0.36)	(0.26)	(0.49)	(0.03)
RDDUM	0.021	0.010	0.014	0.006
	(1.38)	(0.77)	(0.80)	(0.40)
BANK		-0.137		-0.109
		(3.43)***		(2.44)**
Ind. Dum			Yes	Yes
_cons	0.470	0.407	0.434	0.389
	(10.37)***	(9.11)***	(4.04)***	(4.42)***
Adj. R^2	0.41	0.31	0.46	0.33
N	267	156	267	156

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of the cross-sectional regression using means over time. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally a “Yes” indicates whether industry dummies are included in the regression.

Appendix 5: Model variations

Table H: Dropped leverage

Dep.Var. CASH	OLS	FEM	FMB	CSM
SIZE	-0.005	0.002	-0.004	-0.012
	(3.18)***	(0.14)	(7.93)***	(3.45)***
BANK	-0.106	-0.041	-0.124	-0.170
	(5.66)***	(1.65)	(5.10)***	(3.82)***
CF	-0.023	0.094	0.027	-0.091
	(0.43)	(1.59)	(0.36)	(1.01)
LIQ	-0.100	-0.153	-0.087	-0.122
	(4.40)***	(4.60)***	(7.89)***	(2.86)***
INVO	0.016	0.017	0.023	0.020
	(3.54)***	(2.08)**	(3.03)**	(2.68)***
DIV	-0.005	0.005	-0.015	0.000
	(0.87)	(0.81)	(2.20)*	(0.01)
ZSCORE	-0.032	-0.012	-0.025	-0.020
	(4.10)***	(1.50)	(2.08)*	(1.12)
RDDUM	0.007	0.006	0.007	0.018
	(1.03)	(0.57)	(0.93)	(1.21)
Ind. Dum	Yes		Yes	Yes
_cons	0.203	0.066	0.168	0.293
	(8.02)***	(0.45)	(25.57)***	(6.49)***
Adj. R^2	0.26	0.08	0.17	0.16
N	1404	1404	1404	156

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of the 4 types of regressions, excluding the variable leverage. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally a “Yes” indicates whether industry dummies are included in the regression.

Table I: Dropped liquid assets

Dep.Var. CASH	**OLS**	**FEM**	**FMB**	**CSM**
SIZE	-0.007	-0.024	-0.006	-0.004
	(4.75)***	(2.44)**	(5.16)***	(1.12)
LEV	-0.313	-0.185	-0.314	-0.330
	(16.63)***	(4.76)***	(7.04)***	(8.24)***
CF	-0.041	0.027	-0.077	-0.111
	(0.95)	(0.59)	(1.48)	(1.31)
INVO	0.027	0.025	0.035	0.022
	(6.24)***	(3.17)***	(10.57)***	(2.66)***
DIV	-0.009	0.002	-0.021	-0.043
	(1.37)	(0.31)	(4.12)***	(1.94)*
ZSCORE	0.012	0.017	0.005	-0.003
	(1.44)	(1.85)*	(0.67)	(0.17)
RDDUM	0.009	0.004	-0.000	0.003
	(1.35)	(0.27)	(0.02)	(0.19)
Ind. Dum	Yes		Yes	Yes
_cons	0.325	0.493	0.356	0.385
	(13.71)***	(4.00)***	(22.21)***	(8.96)***
Adj. R^2	0.44	0.08	0.32	0.37
N	2,296	2,296	2,296	267

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of the 4 types of regressions, excluding the variable liquid assets. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally a “Yes” indicates whether industry dummies are included in the regression.

Table J: Dropped firm size

Dep.Var. CASH	**OLS**	**FEM**	**FMB**	**CSM**
LEV	-0.406	-0.319	-0.413	-0.410
	(20.22)***	(6.94)***	(10.23)***	(11.07)***
CF	-0.068	0.016	-0.113	-0.157
	(1.68)*	(0.35)	(2.80)**	(1.93)*
LIQ	-0.227	-0.336	-0.241	-0.221
	(11.63)***	(8.16)***	(14.67)***	(4.94)***
INVO	0.023	0.020	0.028	0.022
	(5.58)***	(2.55)**	(8.67)***	(2.75)***
DIV	-0.015	0.001	-0.024	-0.042
	(2.62)***	(0.10)	(12.28)***	(2.25)**
ZSCORE	-0.003	-0.006	-0.014	-0.012
	(0.32)	(0.57)	(2.30)*	(0.65)
RDDUM	-0.003	0.000	0.003	0.007
	(0.48)	(0.02)	(0.49)	(0.52)
Ind. Dum	Yes		Yes	Yes
_cons	0.354	0.313	0.375	0.385
	(18.00)***	(9.61)***	(15.94)***	(8.96)***
Adj. R^2	0.48	0.20	0.38	0.37
N	2,296	2,296	2,296	267

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

This table represents the robust regression results of the 4 types of regressions, excluding the variable firm size. For each explanatory variable the first row reports the regression coefficient and the t-statistics are displayed in parentheses in the subsequent row. *, ** and *** indicate significance at the 10%, 5% and 1%-levels, respectively. Finally a “Yes” indicates whether industry dummies are included in the regression.

Appendix 6: T-tests for equality between means

DAX listed firms

Group	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	2052	0.150	0.003	0.149	0.143	0.156
1	189	0.100	0.006	0.084	0.088	0.112
combined	2241	0.145	0.003	0.145	0.139	0.151
diff		0.050	0.011		0.028	0.071

diff= mean(0)-mean(1) t = 4.5526
H0: diff=0 degrees of freedom = 2239

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T<t) = 1	Pr(|T|>|t|) = 0	Pr(T>t) = 0

TecDAX listed firms

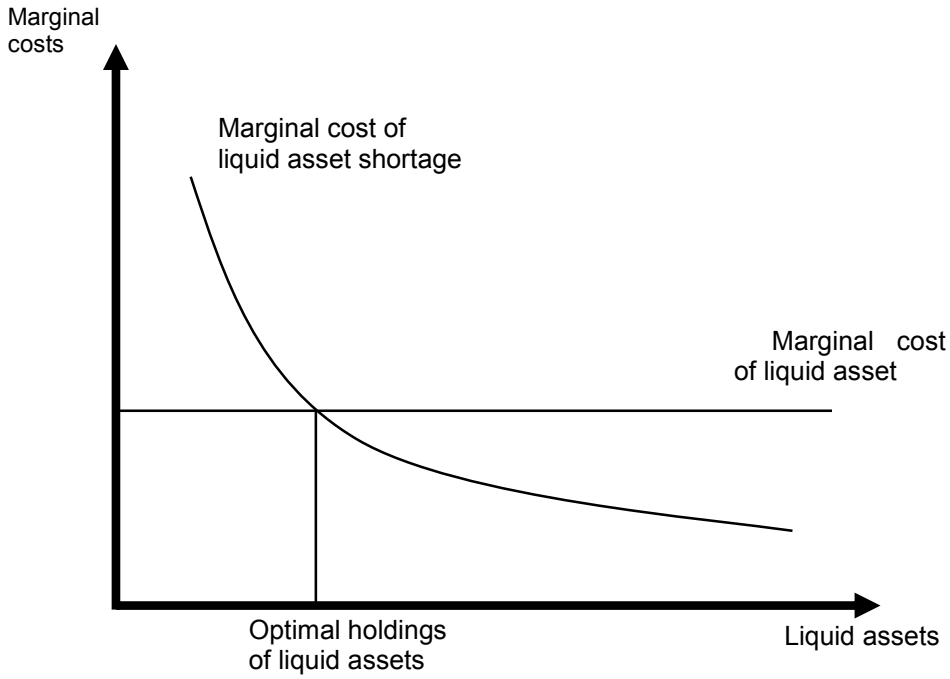
Group	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	2052	0.150	0.003	0.149	0.143	0.156
1	189	0.204	0.011	0.152	0.182	0.226
combined	2241	0.154	0.003	0.150	0.148	0.160
diff		-0.055	0.011		-0.077	-0.032

diff= mean(0)-mean(1) t = -4.8265
H0: diff=0 degrees of freedom = 2239

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T<t) = 0	Pr(|T|>|t|) = 0	Pr(T>t) = 1

Appendix 7: Transaction costs model

Figure A: Optimal holdings of liquid assets



In this figure the optimal cash or liquid asset holding amount is determined by the intersection of the two curves. One can see that the marginal cost of liquid assets is constant and non-decreasing while the marginal cost of liquid asset shortage curve is decreasing. The former constant curve basically represents the opportunity costs that firms incur when they hold cash or liquid assets. The curve is constant because the cost of holding one more dollar in cash or liquid assets stays the same. That dollar could have been invested in a more profitable investment, which yields a higher return and yet the same holds for following units of cash. On the opposite, the marginal cost of liquid asset shortage changes with the quantity of liquid asset holdings. These costs basically comprise the costs related with the risk of bankruptcy and financial distress as well as the transaction costs that are involved in liquidating assets and raising external capital. If a firm experiences shortages in cash, these can generally be addressed by either decreasing investment or selling some securities or issuing short-term bank notes (Opler et al., 1999). In this case the transaction costs involved tend to be reasonably low and acceptable for firms. However, greater shortages in cash are related with greater costs, because when firms face serious shortages they are forced to decrease investment heavily or sell more assets, which makes it relatively more costly. Starting from a certain amount of cash holdings, the marginal cost curve starts to flatten because the more cash or liquid assets are held by a firm the less impact an additional unit of cash holdings has on the marginal costs being short.