Master Thesis

Identifying the value of liquidity:

Cash flow volatility, real asset liquidity and the implied cost of equity capital

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Abstract

In the past three decades, a postmodern view of financial policy has emerged. This paradigm accepts the key insights of Modigliani and Miller, that value is created when companies make good investments and goes further by treating financial policy as critical in enabling companies to make valuable investments. Acknowledging the importance of understanding the accessibility to financing and the mechanisms underlying the components of capital structure, this study examines the relationships between cash flow volatility, real asset liquidity and the cost of equity capital. The aim of this study is to examine the extent to which the liquidity of a firm's assets reduces the impact of cash flow volatility on the cost of equity capital. On the basis of quintile mean comparisons and ordinary least squares regressions with heteroscedasticity consistent standard errors, the data of 5519 firms have been analyzed. While controlling for several potential confounding variables, the analyses showed that cash flow volatility is positively related to the cost of equity capital, that real asset liquidity is negatively related to the cost of equity capital, and, most important, that real asset liquidity reduces the impact of cash flow volatility on the cost of equity capital. The beneficial effect of real asset liquidity is stronger for firms that have greater incentives to restructure. Based on the results, the conclusion is that real asset liquidity on its own and in the interaction with cash flow volatility is an important and economically relevant determinant of the cost of equity capital. Further research is needed to examine the relationship of the findings with time-varying effects such as the economic state. This study mainly contributes to the literature by adding a piece of knowledge to the unsolved identification of the value of liquidity.

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1 Introduction

Identifying value of liquidity is one of the top ten unsolved problems in the world of finance (Brealey, Myers, & Allen, 2014). Under the circumstances of a perfect capital market, liquidity does not affect shareholder value as shareholders can easily hold cash at the same cost as firms can (Servaes & Tufano, 2006). This logic can be recognized as a variant of the Modigliani and Miller theorem (Modigliani & Miller, 1958), often referred to as the capital structure irrelevance principle that became the foundation of "modern finance". The essence of this theory is that under certain idealized assumptions (no taxes, efficient and frictionless markets, and only cash flow matters) the total value of a firm is preserved regardless of the nature of the claims against it. Modigliani and Miller (1958) proved their central claim by assuming the contrary result that the firm could change its value by adjusting its leverage and then showing that this result could not persist in a market with rational investors[1].

Over the past decades, a "postmodern" view of capital structure has emerged. The "postmodern" paradigm accepts the law of conservation of value and replaces the idea that under certain assumptions capital structure does not affect firm value with the idea that capital structure affects the value of the firm to the extent that it operates through Modigliani and Miller's assumptions, which is a contrapositive of the Modigliani and Miller theorem. According to Myers (1976), the "postmodern" paradigm goes further than the previous views on capital structure by treating financial policy as critical in enabling companies to make valuable investments, recognizing that firms face real trade-offs in how investments are financed.

Within the "postmodern" paradigm departed from the Modigliani and Miller theorem, several streams of finance research can be distilled. The trade-off theory states that firms' debt-equity ratios are determined by trading off the benefits of debt with the costs (Scott, 1976). The pecking-order theory features information asymmetries as an explanation of variation in financing policies (Myers, 1976). Assuming that external financing is only used when internal funds are insufficient. The theory states that if internal funds are not enough to finance investment opportunities, firms may or may not acquire external financing, and if they do, they will choose the different external finance sources in such a way as to minimize additional costs of asymmetric information. Asymmetric information favors the issue of debt over equity as a debt issue signals the board's confidence that the firm can repay the debt and that the current stock price is undervalued, because the issue of equity would be preferred when stocks are overpriced. An issue of equity would signal a lack of confidence in the board in that they feel the share price is over-valued, which will therefore lead to a drop in share price. Furthermore, agency costs can arise and influence financing decisions whenever interests between bondholders and equityholders (Myers, 1976) or managers and equityholders (Jensen, 1986) conflict.

The trade-off and agency theories limit the amount of money a firm can borrow. The information asymmetry implications limit the appeal for equity funding. The bottom line is that financial markets are not perfect, making external financing in any form more expensive than internally generated funds. This makes internally generated funds a competitive weapon that creates value (Froot, Scharfstein, & Stein, 1994). The extent to which companies have access to internal funds is largely determined by the availability of free cash flows.

[1] A rational investor is defined as an investor that follows a decision-making process that is based on making choices that result in the optimal level of value maximization.

Acknowledging the importance of internally generated funds, a lot of research has been done to define the consequences of uncertain cash flows; examined as the impacts of cash flow volatility. Several studies focused on the relationship between cash flow volatility and investments, identifying a negative relationship based on the premise that external funds are more costly than internal funds and firms forgo investments in periods of internal cash flow shortfalls (Minton & Schrand, 1999; Deshmukh & Vogt, 2005; Sasaki, 2016). Huang (2009), Campbell (2015) and Palkar (2017) examined the relationship between cash flow volatility and future returns. Their studies illustrate that cash flow volatility significantly reduces future returns. In addition, Palkar (2017) reports evidence that shows an important role of financial constraints in the relation between cash flow volatility and return, mentioning that volatile cash flows are more costly in the presence of capital market frictions as they impair the ability of firms to undertake all positive net present value projects, thereby leading to lower future returns. Lastly, Minton and Schrand (1999), Douglas, Huang and Vetzal (2016) and Hung and Wakayama (2005) found evidence of a positive impact of cash flow volatility on the cost of capital, measured either as the cost of debt or a factor model measure of the cost of equity capital. Whereas Minton and Schrand (1999) follow the financial constraints reasoning, Hung and Wakayama (2005) argue that creditors interpret cash flow volatility directly as a risk for which they want to be compensated.

The above-mentioned studies unequivocally conclude that cash flow volatility has a detrimental effect on investments, future returns and the cost of capital. The reasoning underlying the conclusions are two-fold. On the one hand, cash flow volatility causes periods of shortages in internally generated funds which are costly in the presence of capital market frictions, reducing the firm's ability to take advantage of positive net present value investments ultimately suppressing firm performance. On the other hand, from the perspective of investors with regards to the impact on the cost of capital, cash flow volatility is a direct indicator of risk for which investors want to be compensated. The first line of reasoning suggests that the degree to which cash flow volatility impacts the firm depends on the firm's ability to cover up shortages in internally generated funds. Moreover, it suggests that, besides the use of less appealing or limited available external financing, the degree to which cash holdings, cash equivalents or non-operating cash can be utilized is a determining factor for the impact of cash flow volatility.

To continue on the notion that the availability of cash is related to the impacts of cash flow volatility, Arnold, Hackbarth and Puhan (2018) and Edmans and Mann (2012) argue that asset sales are a pertinent source of cash alongside debt and equity issuances. Edmans and Mann (2012) relate their findings to the pecking-order theory, emphasizing the advantage of asset sales by arguing that, depending on the nature of the assets, partial asset sales can diminish less value than equity issuances. These findings are in line with prior studies that mention the use of asset sales for the purpose of corporate restructuring (John & Ofek, 1995; Maksimovic & Phillips, 2001; Yang, 2008). Schlingemann, Stulz and Walkling (2002) argue that asset liquidity plays an important role if a firm has fundamental reasons to restructure, as asset liquidity, which refers to the ease with which an asset can be converted into cash quickly and at a low cost, can explain why some firms choose to divest a business segment while other similar firms choose not to. In the light of this finding, asset liquidity is an important determinant of a firm's operating flexibility, referring to the ability of the firm to redeploy its real assets to alternative uses in response to a changing business environment. Agreeing on this notion, a recent stream of research has focused on the impacts of asset liquidity as a proxy for operating flexibility. Benmelech and Bergman (2009) found that asset liquidity is negatively related to the cost of debt. Ortiz-Molina and Phillips (2014) found evidence of a positive (negative) relation between asset illiquidity (liquidity) and the cost of equity capital. Lastly, Usman (2015) delved into the relationship between asset liquidity and cash holdings and reports evidence demonstrating that the liquidity of a firm's assets plays a role in determining the cash management policy of the firm, illustrating that firm's with a higher asset liquidity hold less cash. This finding emphasizes the importance of asset liquidity as determinant of operating flexibility.

Summarizing the previous two subsections, the impact of cash flow volatility on a firm's investment activity, future returns and cost of capital is related to the extent to which the firm can cover up the shortfalls in internally generated funds. Besides external financing and operating income, asset sales is a pertinent source of cash. The value of asset sales as a source of cash is determined by the firm's asset liquidity. Therefore, relating both streams of research, a logic line of reasoning suggests that the impact of cash flow volatility is partly determined by the liquidity of a firm's assets. This line of reasoning reveals a potential value of liquidity wherein asset liquidity functions as a natural hedge against cash flow volatility. Prior research has examined the relationship between cash flow volatility and the cost of capital and between asset liquidity and the cost of capital. Nevertheless, so far, prior studies have not identified the potential moderating effect of asset liquidity on the impact of cash flow volatility on the cost of equity capital.

This study examines the effect of asset liquidity on the impact of cash flow volatility on the cost of equity capital. Whereas prior studies examined the impacts of cash flow volatility on a wide range of performance indicators (e.g.: investment activity, future returns, cost of capital), this study focuses on the cost of equity capital to comprehensively capture the market's assessment of risk and the cost of equity financing. The primary objective of this study is to evaluate the potential benefits of asset liquidity as a natural hedge to reduce the impact of cash flow volatility on the cost of equity capital. To guide this study, the following research question is formulated:

RQ: *To what extent does real asset liquidity moderate the effect of cash flow volatility on the cost of equity capital?*

From all worldwide listed companies available on Orbis, a sample of 5519 firms is drawn. Based on the results of quintile mean comparisons and ordinary least squares regressions with heteroscedasticity consistent standard errors, this study adds to the literature in several ways. Firstly, previous work has only focused on either the relationship between cash flow volatility and the cost of equity capital or the relationship between asset liquidity and the cost of equity capital. This study unravels the interaction effect of both variables on the cost of equity capital and provides practical insights in the importance of asset liquidity as a potential natural hedge against the impact of cash flow volatility on the cost of equity capital.

Secondly, this is the first study that examines the relationship between cash flow volatility and the cost of equity capital using a contemporary implied cost of equity measure. The key advantage of using the implied cost of equity capital approach over the factor model approaches is that the cost of capital estimates with the former approach are less noisy and more accurate (Ferreira Savoia, Securato, Bergmann, & Lopes da Silva, 2019; C. Lee, Ng, & Swaminathan, 2009; K. K. Li & Mohanram, 2014; Pastor, Sinha, & Swaminathan, 2008).

Thirdly, this study contributes to the knowledge of what Brealey, Myers, and Allen (2014) called 'one of the top ten unsolved problems in the world of finance'; identifying the value of liquidity.

Besides the contributions to the literature, the findings of this study are of practical relevance for corporate managers and investment professionals. Corporate managers benefit from this study as the findings help to clarify the impact, and guide the application, of investment decisions in relation to the cost of equity capital. Practically speaking for the average firm, the impact of cash flow volatility on the cost of equity capital will be limited to a third when the firm shifts from the lowest to the highest asset liquidity quintile, which emphasizes the benefits of an investment strategy that takes asset liquidity into account. For professional investors, the added value relates to a better understanding of how cash flow volatility and asset liquidity impact the firm's expected returns and share price, as for the average firm the cost of equity capital increases with 1.11% from the smallest to the largest cash flow volatility quintile, while the increase is 1.65% for firms in the lowest asset liquidity quintile and 0.6% for firms in the highest asset liquidity quintile.

The remainder of this report is structured as follows. Chapter 2 elaborates the most prominent theories and the most relevant empirical evidence regarding capital structure, the cost of equity capital, cash flow volatility and real asset liquidity. Chapter 3 describes the research paradigm, research design and the measurements utilized in this study. Chapter 4 clarifies the results of the relevant tests regarding the analyses' assumptions and reports the results of the univariate, bivariate and multivariate analyses. Lastly, in chapter 5, the results are discussed in relation to the hypotheses and the theoretical framework, the study's limitations are elaborated, recommendations are provided and a final conclusion with implications is given.

2 Theory

Continuing on the previous chapter, this chapter describes the theoretical concepts that are related to this research. The goals of this chapter are to elaborate the theoretical aspects that are related to this study, to justify the research question and to structure the approach used to answer the research question. To understand the theoretical aspects involved within this study, this chapter reviews the most relevant literature in sequence of capital structure, the cost of equity capital, cash flow volatility and real asset liquidity. To justify the research question and structure the research approach, this chapter concludes with a theoretical framework that clarifies the (hypothesized) interrelationships of the theoretical concepts.

2.1 Theories on capital structure

Companies can choose from a wide variety of financing instruments, ranging from traditional common equity and straight debt to more hybrid or convertible forms of financing. But the fundamental question in designing a company's capital structure remains the choice between debt and equity, or 'the optimal leverage ratio'. Although academic researchers have investigated the issue for decades, there is still no clear model for deciding a company's optimal leverage ratio, the leverage that would create most value for shareholders (Koller, Goedhart, & Wessels, 2010). As there is no model for deciding the optimal leverage ratio, this subsection aims to describe the most relevant theories unpuzzling the capital structure choices. Within the finance literature, the Modigliani and Miller theorem is the fundamental theory on which the most recent theoretical contributions are build. Therefore, the theories will be described alongside the academic timeline starting with the Modigliani and Miller theorem, followed by the most relevant additions.

2.1.1 Modigliani and Miller theorem

According to Luigi and Sorin (2009) many consider the Modigliani and Miller (hereafter denoted as M&M) theory as the initial general accepted theory of capital structure, as there were no generally 'accepted theories' before. The best way to describe the importance of the M&M theorem is the fact that the theory of modern business finance starts with the capital structure irrelevance proposition (Ahmeti & Prenaj, 2015). From the publications of M&M (1958, 1961 and 1963), three important propositions can be drawn:

- Proposition 1: A firm's total market value is independent of its capital structure.
- Proposition 2: The cost of equity increases with the firm's debt-equity ratio.
- Proposition 3: A firm's total market value is independent of its dividend policy.

M&M emphasize that the propositions hold under the assumption of a perfect capital market, where there are no bankruptcy costs, no transaction costs, no information asymmetries, no distortionary taxations, and where investors can borrow at the same rate as corporations, and managers act on the exclusive behalf of shareholders. Under these assumptions, the first proposition states that the capital structure of a firm does not influence its market value and internal and external financing are regarded as perfect substitutes.

In their second proposition, M&M claim that the weighted average cost of capital (WACC) of a firm remains constant as it reflects a certain risk factor caused on the asset side of the company. Therefore, to retain a constant WACC, the cost of equity increases as a function of the increase in the debt to equity ratio. In 1963, Modigliani and Miller also include the effect of taxes in their work. They state that the firm can decrease the WACC by increasing the debt percentage in the capital structure, since such companies pay less tax, due to the tax shield it provides.

The third proposition includes the irrelevance of the dividend policy. M&M (1961) argue that the market value of a firm is determined by its earning power and the risk of its underlying assets. Therefore, in a perfect market, the value of a firm remains unaffected by its dividend policy.

The Modigliani and Miller theorem is based on the law of conservation of value that states that the value of the firm is preserved regardless of the nature of the claims against it (Brealey et al., 2014). Accepting this starting point as the foundation of "modern finance", a "post-modern" paradigm has emerged, treating the financial policy as critical in enabling companies to make valuable investments (Froot et al., 1994). The following sections elaborate the "post-modern" insights of the capital structure theory.

2.1.2 Trade-off theory

In the traditional trade-off models, the chief benefit of debt is the tax advantage of interest deductibility (Modigliani & Miller, 1963). Myers (1976) notices an important gap in the modern finance theory on the issue of corporate debt policy. He states that the theory should explain why the tax advantages of debt financing do not lead firms to borrow as much as possible, it should explain why differences in corporate borrowing exists. One plausible explanation is the trade-off theory, which states that firms seem to get an optimal, value maximizing debt-equity ratio by trading off the advantages of debt against the disadvantages (Myers, 1984). The disadvantages of debt come in the form of financial distress costs that arise from the costs of signaling (Ross, 1977), bankruptcy risks (Kraus & Litzenberger, 1973) and agency costs (Hart & Moore, 1994; Jensen & Meckling, 1976; Stulz, 1990). Whereas the advantage of debt relates to the tax-deductibility of interest that forms a tax shield. Once set, the firm will gradually move towards the debt-equity ratio in the so-called static trade-off theory. However, Myers (1984) state that firms face adjustment costs which complicates the possibility of reaching the target debt-equity ratio and explains the differences in observed variation in actual debt ratios.

2.1.3 Pecking order theory

Alternative to the trade-off theory is the second post-modern insight of capital structure as proposed by Myers (1984), the pecking order theory. The pecking order theory assumes that managers know more about the company than outside investors do, indicating that there exists an information asymmetry between both parties. Due to the information asymmetry, investors interpret the managerial actions as an attempt to improve their estimation of firm performance (Brealey et al., 2014).

The information asymmetry affects the choice between internal and external financing and between new issues of debt and equity securities. This leads to a pecking order in which investment is financed first with internal funds, reinvested earnings primarily, then by new issues of debt, and finally with new issues of equity. The pecking order is caused by costs of asymmetric information that arises from board's signals to the public with respect to financing actions. The theory assumes that external financing is only used when internal funds are insufficient. The issue of debt is theorized as board's signal of confidence that an investment is profitable and that the current stock price is undervalued, where an issue of equity would be favored in case of an overpriced stock. Therefore, the issue of equity signals a lack of confidence in the board, ultimately leading to a drop in share price.

According to Shyam-Sunder and Myers (1994), firms mainly use debt policies to offset their financing deficit, which is in line with the pecking order theory. Al-Tally (2014) confirms that firms prefer to finance new investments with internally generated funds, followed by debt capital and equity issues as a last resort. However, several studies find contradictions regarding the pecking-order theory.

Fama and French (2002) point out that the pecking order theory doesn't hold for small low-leverage growth firms as they issue more often relatively large amount of equity. Frank and Goyal (2002) conclude on their study by arguing that net equity issues track the financing deficit more closely than do net debt issues, which is contrary to the pecking order theory. Gaud, Hoesli and Bender (2005) mention that their results among the capital structure choices of over 5000 European firms cannot be fully explained by the trade-off theory nor the pecking order theory.

Finally, Rajan and Zingales (1994) show that the main determinants of capital structure are in line with both the trade-off theory and the pecking order theory, subsequent papers confirm these findings (Antoniou, Guney, & Paudyal, 2008; Deesomsak, Paudyal, & Pescetto, 2004; Frank & Goyal, 2009).

2.2 Cost of equity capital and its determinants

For a long time the cost of equity capital has been a topic of great interest in research and practice (Echterling, Eierle, & Ketterer, 2015). Various definitions of the cost of equity capital have been proposed in popular corporate finance textbooks and in the academic literature. The broad agreement among is that the cost of equity capital represents investors' required expected rate of return on investments, which represents the best available expected return on a comparable investment offered in the market. An accurate estimate of the cost of equity capital is a mutual need among managers, investors and academics for a variety of reasons, e.g.: firm valuation, capital budgeting or the examination of the effects of variables of interest on the cost of capital.

Prior to the 1950s the traditional methods for capital market investment decisions and investment portfolio management were estimates of the intrinsic value of securities (fundamental analysis) and trends or patterns in security prices (technical analysis). The traditional investment theory evaluated investments in securities under the assumption of perfect certainty without any clear or defined approach in assessing the effects of risk (Laubscher, 2001). Since the 1950s, theorists and researchers started questioning and testing the traditional assumptions concerning the pricing of securities on capital markets, incorporating risk as an explanatory factor of return. The following subsections describe the underlying theory, subsequent developments and most relevant empirical tests.

2.2.1 Capital market theory and the CAPM

Following from the criteria of rational decision-making, corporate finance theorist imply that financial decision making is based on the principle of value maximization (as is clarified by Modigliani and Miller (1958) and implied among many others). A coherent feature of the rational decision-making criteria is that investors trade off risk and return in their evaluation of investment opportunities embracing the most risk averse options providing the desired return. This risk return tradeoff is first observed by Markowitz (1952), who identifies a mean-variance relationship within stock returns which is recognized as the foundation for the development of asset pricing models. This theory suggest that the risk of a security is the standard deviation of its returns, a measure of return volatility. Markowitz (1952) observed that standard deviations of multiple securities are not additive as the returns of securities are not perfectly correlated, indicating that the standard deviation of a portfolio of risky assets is less than the sum of the standard deviations. This indication reveals the core of the modern portfolio theory which implicates that investors can reduce the level of risk through diversification and, therefore, earn the same expected return but at a lower level of risk. Hence, under the assumption of an efficient capital market, well-diversified portfolios consisting of risky and risk-free assets can be formed among a theoretical capital market line representing the most efficient risk return trade off.

As the computation of risk reduction as proposed by Markowitz (1952) is tedious, Sharpe (1964) developed a single index model, relating the return on an individual security to the return on a common index. The single index model, known as the capital asset pricing model (CAPM), incorporates the systematic risk which is associated with overall movements in the market that accounts for the component of the total risk that cannot be eliminated through portfolio diversification. The CAPM developed by Sharpe (1964) and Lintner (1965) relates the empirically expected return of an individual security to a measure of its systematic risk denoted as beta, whereas the cost of equity estimate is a function of the risk premium and beta added to the risk-free rate. The CAPM is based on several simplifying assumptions, namely: all investors view the risk and return characteristics of individual shares in the same manner, transaction costs can be ignored, investors have homogeneous beliefs, no single investor is able to affect prices through individual buying or selling decisions, investors have access to the same information and analyze it in the same way, investors can borrow and lend at the risk-free rate of interest, shares are divisible and liquid, taxes have no real effect on investment in shares, and investors are only concerned about risk and return (Laubscher, 2001).

Many studies seem to indicate that the basic CAPM is inaccurate and have identified a factor or factors that appear to be omitted form the CAPM. These factor models, particularly the arbitrage pricing theory, were developed in an attempt to capture all aspects influencing the behavior of share returns. The next subsection describes the multifactor asset pricing models.

2.2.2 Multifactor asset pricing models

A growing number of studies found that the market beta alone cannot explain the cross-sectional variation in average security returns. Fundamental variables such as size (Banz, 1981), ratio of book-to-market (Chan, Hamao, & Lakonishok, 1991; Rosenberg, Reid, & Lanstein, 1985), the price earnings ratio (Basu, 1983) and macroeconomic variables account for sizeable portion of the cross-sectional variation in expected returns. Moreover, the CAPM is beset by a number of problems including the fact that the market is described as the only source of risk, raising doubts whether returns are only dependent on this single source (Rossi, 2016). From these and other criticisms, Ross (1976) developed a multifactor theory known as the arbitrage pricing theory (APT) in an attempt to provide a more realistic and meaningful model for measuring risk.

In accordance with the CAPM, the APT is concerned with the relationship between risk and return. Instead of indicating risk with one beta, the APT is based on the view that several sources of risk affect expected and realized returns. The APT risk factors are by nature not company specific and represent broad economic forces, therefore separating the systematic risk as applied within the CAPM into multiple systematic risk factors. Main advantage of the APT is that it has less restrictive assumptions than the CAPM, but the major point of discussion has proved to be that the theory does not specify the characteristics of the variables that should affect the returns. To use the CAPM, a market portfolio has to be identified, the APT eliminates this problem. However, two major areas of uncertainty arise, firstly, the identity of the macroeconomic variables that affect returns and, secondly, the risk premium for each variable and the measuring of the sensitivity of share returns to these factors (Middleton & Satchell, 2001).

Built upon the underlying theories of the Sharpe-Lintner CAPM, many multifactor advances in asset pricing models are developed (Celik, 2012). Among these developments are the Fama-French Three Factor Model (Fama & French, 1993) and, the International (Adler & Dumas, 1983; Solnik, 1974), the Three Moment (Kraus & Litzenberger, 1976; Rubinstein, 1973), the Four Moment (Dittmar, 2002; Fang & Lai, 1997), the Intertemporal (Merton, 1973), the Consumption Based (Breeden, 1979), the Production Based (Brock, 1982; Lucas, 1978), the Investment Based (Cochrane, 1991), the Liquidity Based (Acharya & Pedersen, 2005) and the Conditional (Jagannathan & Wang, 1996) capital asset pricing model.

The asset pricing models that are discussed in the preceding subsections are expressed as the sum of the equity risk premia plus the risk-free rate. Because the risk premium is not directly observable, it is inferred ex post from realized returns, which is problematic as the correlation between expected returns and realized returns is weak. This is demonstrated by Elton (1999), who observed that realized returns can deviate significantly from expected returns over a prolonged period of time. Moreover, Fama and French (1997) classify the cost of equity estimates, derived from the CAPM or the three-factor model, as ‘distressingly imprecise’. This criticism has led to attempts to infer the risk premium ex ante which are discussed in the next subsection.

2.2.3 Implied cost of equity capital: the ex-ante approach

The implied cost of equity capital (ICC) is defined as the internal rate of return that equates the current stock price to the present value of all future cash flows to common shareholders. The ICC estimates the rate of return that the market implicitly uses to discount the expected future cash flows of the firm. Around the turn of the century, the first studies regarding the implied cost of capital are published. Ever since, an extensive body of knowledge has emerged (e.g.: Ashton & Wang, 2013; Botosan & Plumlee, 2002; Claus & Thomas, 2001; Daske, Gebhardt, & Klein, 2006; Easton, 2004; Echterling et al., 2015; Gebhardt, Lee, & Swaminathan, 2001; Gode & Mohanram, 2003; Hou, van Dijk, & Zhang, 2012; Löthman & Pettersson, 2013; Ohlson & Juettner-Nauroth, 2000).

While the conventional asset pricing models use realized returns as a proxy for the expected market returns, the ICC approach uses analysts’ forecasting data. Main concern regarding the application of the ICC approach is associated with sluggish earnings revisions, specifically the slow updating of analyst forecasts as analysts do not update their earnings forecasts instantaneously in the occasion of large movements (Easton & Monahan, 2005; Echterling et al., 2015; and Li & Mohanra, 2014). On the other hand, the main advantage of the ICC is that it does not rely on noisy realized returns or on any specific asset pricing model. Instead, it derives expected return estimates directly from stock prices and cash flow forecasts (Hou et al., 2012).

Existing literature exhibits a variety of different models to compute the implied cost of capital at the firm- and portfolio-level[2]. Firm-level approaches calculate the cost of capital for each firm individually by using an accounting-based business valuation model. By inserting earnings/expected dividend and the current stock price, the discount factor can be determined representing the implied cost of capital (Echterling et al., 2015). In general, the firm-level

[2] This study focusses on the firm-level cost of equity estimates, therefore the portfolio-level approaches are not discussed. Echterling et al. (2015) can be consulted for an extensive overview.

approaches exibited in existing literature are the dividend discount model (Botosan & Plumlee, 2002), the residual income valuation model (Claus & Thomas, 2001; Daske et al., 2006; Gebhardt et al., 2001) and the abnormal earnings growth model (Easton, 2004; Ohlson & Juettner-Nauroth, 2005).

Although the implied cost of capital is a measure to estimate the cost of capital and future returns, the results are not the same. According to Hughes, Liu, and Liu (2009) the implied cost of capital is a function of the expected return on equity, leverage, growth, beta volatility, and cash flow volatility. However, Gebhardt et al. (2001) mention that the relationship between a firm's beta and the implied risk premium is 'surpisingly weak', concluding that beta is of limited importance in the market's assessment of a stock's systematic risk and therefore suggest a limited role for beta in a multi-factor framework. Furthermore, Lee, Ng, and Swaminathan (2009) and Gode and Mohanram (2003) mention size and book-to-market ratio as an important determinant of the implied cost of capital.

2.2.4 Empirical evidence

Within the existing literature, the cost of equity capital is a topic of great interest. An extensive body of empirical research illustrates a wide variety of results. This subsection discusses the most relevant empirical studies regarding the CAPM, the multifactor models and the implied cost of equity capital approach.

Accuracy of the estimations based on the CAPM and the multifactor models

The CAPM is a single-period ex ante model, since ex ante returns are unobservable, researchers rely on realized returns. The beta is usually obtained by estimating the security characteristic line that relates the excess return on a security to the excess return on an efficient market index (Galagedera, 2007). The estimated beta is then used as the explanatory variable.

Many studies have been published on the beta estimate. Fama and MacBeth (1973), Friend and Blume (1970), Jensen (1968), and Sharpe (1966) report that a higher systematic risk as measured by beta is associated with higher returns. Friend and Westerfield (1981), Friend, Westerfield, and Granito (1978), Jacob (1971), and Lintner (1969) conclude in their studies that, in conflict with the CAPM, a much stronger relationship was found between variance and returns than between beta and returns, implying that total risk explains returns better than systematic risk (beta). Considering beta as a measure of risk, it can be concluded that it is one, but not the only one, measure of risk in relation to return. Although the evidence is not strong enough to reject the CAPM, it does indicate that the CAPM is flawed.

Considering the stability of beta, Blume (1971) and Dimson and Marsh (1984) notice that the betas for individual shares are unstable but those of portfolios tend to be fairly stable over time. Levy (1971, 1974) confirms these results and add the notion that large portfolios with more than 25 shares and a forecast period of longer than 26 weeks provide historical betas that are good and stable predictors of future betas. Levitz (1974) supports these findings, although he found poor correlation between individual share's historical and actual betas, he found significant correlation for portfolios of only 10 shares. Alexander and Chervany (1980), and Meyers (1973) conclude that betas of well-diversified portfolios are relatively stable, but the relative advantage of diversifications decreases after having 10 shares. Concluding on these studies, betas of portfolios are relatively stable, while those of individual shares are much less stable. Therefore, the CAPM might be less useful in estimating returns on individual shares than in structuring investment portfolios.

Another stream of research regarding beta examines whether beta is the only factor that explains returns. Basu (1977) and Nicholson (1968) observed that low price-earnings portfolios yield higher returns than do high price-earnings portfolios. Arnott (1980) found that the market factor explains only about 30% of the variance of returns concluding that other factors such as an industry effect cannot be ignored. By relating a size effect with share returns, Banz (1981) found that shares of firms with large market values have, on average, lower returns compared to firms with small market values. Reinganum (1981) confirms these results concluding that the basic CAPM is misspecified, as it seems that the persistence of abnormal stock returns is caused by risk factors which are omitted from the CAPM. Furthermore, Fama and French (1995) observed that the two non-market risk factors SMB and HML, respectively the differences between small and large stock portfolios and low-book-to-market and high-book-to-market portfolios, are useful factors when explaining a cross-section of equity returns. To conclude, it seems that beta does not provide a full description of risk and that other risk measures are also important in explaining share returns, indicating that the CAPM might be misspecified.

The last stream of research regarding beta examines how to estimate it. Breen and Lerner (1972) examined the effect of having different choices of holding period when estimating beta and concluded that as the holding period lengthens, significant changes in individual beta values occur. Subsequent studies confirm that beta estimates differ when different estimation intervals are used (Hawawini, 1983; Levhari & Levy, 1977). Therefore, it seems that there is no consensus on how to correctly estimate beta using historical data.

Departing from the criticisms of Roll (1977), who argues that the CAPM can only realistically be tested if the composition of the true-mean variance efficient market containing all assets is known and used in the tests, a stream of research on the estimation of the market return emerged. Friend et al. (1978) found that the use of different indices provides different regression coefficients, concluding that the choice of index has a significant effect on the analysis. Mayers and Rice (1979) partially refuted Roll's critique showing that the CAPM can provide meaningful conclusions as long as the chosen market index consists of a high proportion of the total market value of shares. Concluding, this stream of research is a reminder that as long as there is no true security market line, the CAPM could not be tested truly.

Besides the empirical tests regarding CAPM and its beta, another stream of research focusses on the multifactor models and on comparing the CAPM with the multifactor models. In the first published test of the APT, Roll and Ross (1980) used factor analysis and daily share returns to estimate the number and importance of the factors, concluding in support with the theory that there is more than one factor which affect returns. Continuing on the number of factors topic, Brown and Weinstein (1983) found results consistent with a three-factor APT, concluding that there are few rather than many relevant APT factors. Whereas Chen (1983) and Reinganum (1981) found that at least three to four factors are important in explaining share returns. Kryzanowski and To (1983) mention that it seems reasonable to hypothesize that a factor structure of five factors is sufficient from an economic perspective. Furthermore, Dhrymes (1984), and Dhrymes, Friend, and Gultekin (1984) found that the number of significant factors is an increasing function of the sample analyzed, while Fogler (1982) found that different shares are affected differently by the priced factors implying different factor sensitivities. Therefore, it can be concluded that there is no consensus regarding the number and the nature of APT factors influencing share returns.

With respect to the testability and usefulness of the multifactor models, Litzenberger and Ramaswamy (1979) show that a multifactor model has better explanatory power than a single factor model. Shanken (1982) brings in a critique similar to that of Roll (1977), mentioning that the APT provides no guidance on the nature and magnitude of the factors suffering from the impossibility to test it truly, as is faced by the CAPM considering the identification of the market portfolio. In contrast, Dybvig and Ross (1985) note that the APT is testable and that the criticisms are not really relevant for actual empirical testing. Therefore, the testability and the usefulness of the multifactor models seems to be unclear.

Comparing the CAPM with the multifactor models, Brown and Warner (1980), and Brown and Weinstein (1983) state that there is no evidence that the more complex models outperform the more simple models. Reinganum (1981) mentions that both models cannot explain the return patterns related to the size effect. Nevertheless, Chen (1983) found that, in contrast to the CAPM, the APT is able to provide factors for the residual information related to returns. Bower, Bower, and Logue (1984) compared the CAPM with the multifactor models and concluded confirmative regarding the APT given that the standard deviations of the APT estimates are up to 50% lower than those of the CAPM estimates. So, although there is some conflicting evidence, it does seem that the literature renders greater support for the multifactor models. However, a more comprehensive comparison might provide stronger conclusions.

The previous subsections outlined the empirical evidence regarding the CAPM and the multifactor models. It can be concluded that the CAPM is flawed but the evidence is not strong enough to reject the theory. Furthermore, the CAPM seems to be more useful regarding the estimation of portfolio returns instead of single share returns. Nevertheless, the beta does not seem to be the only factor explaining risk. Therefore, a large body of literature emerged regarding multifactor models. Although it seems that the literature renders greater support for the multifactor models, the nature and the number of relevant factors to use within the multifactor models is still unclear. On top of that, the testability and the usefulness of the multifactor models is still unclear.

Empirical evidence regarding the implied cost of equity capital

Although the implied cost of capital is a more contemporary measure than the factor models, a decent body of empirical evidence has emerged the past two decades. Within the literature, there are two main streams of research that focus on the validity of the ICC. The first stream of research focusses on relating the ICC estimates to commonly assumed risk proxies, whereas the second stream of research relates the ICC estimates to future realized returns. Besides, a third area of research focusses on the limitations of the ICC as a factor explaining the varying ICC estimates among different ICC models. The upcoming subsections describe the empirical evidence structured among the different areas.

Several studies evaluate the implied cost of capital estimates by examining their relation with risk proxies such as firm size, analyst following, book-to-market ratio, growth, beta, and return volatility. Botosan (1997) observes a significant positive correlation between beta and the ICC, where Gebhardt et al. (2001) indicates a negative association between the ICC and beta. Gode and Mohanram (2003) find a positive significant correlation between the ICC and analysts' growth forecasts, but Gebhardt et al. (2001) observe a negative significant correlation. By using multiple risk factors as explanatory variables, Botosan and Plumlee (2005) conduct a comprehensive examination of the relationship between risk proxies and the ICC approaches. They find that the Target Pricing Method employed by Botosan and Plumlee (2002) and the Price-Earnings-to-Growth Method introduced by Easton (2004) are related to all risk proxies, whereas the approaches of Gordon and Gordon (1997), Ohlson and Juettner-Nauroth (2005), and Gebhardt et al. (2001) are not.

Several studies evaluate the ICC estimates by examining their relation with future realized returns. Gode and Mohanram (2003) and Gebhardt et al. (2001) document a positive relation between ICC ranked portfolios and average future portfolio stock returns. Easton and Monahan (2005) adopt an approach to consider the bias and noise in ex post realized returns and find that the ICC estimates have little ability to explain realized returns after controlling for cash flow news and return news. By adopting the same approach, but with using different proxies for cash flow news and return news, Botosan, Plumlee, and Wen (2011) are able to provide evidence for a significant relationship between ICC and realized returns for nearly all ICC approaches examined. Alternatively, after correcting for sluggishness in analysts' forecasts, the ICC measures developed by Claus and Thomas (2001), Gebhardt et al. (2001), and Gordon and Gordon (1997) lead to a positive and significant correlation between the implied cost of equity capital and future realized returns as the sluggishness problem in analysts' forecasts prevents the ICC from exhibiting a positive correlation with future annual returns (Guay, Kothari, & Shu, 2011). Therefore, it can be concluded that, after the necessary control and adjustment interventions, the ICC is positively related to future returns.

Estimating the ICC comes with errors stemmed from either the model implemented or the inputs in the model, or both. One of the most serious concerns regarding the ICC estimates is whether or not the assumed analysts' forecasts reflect the market expectations. Several studies indicate that analysts' forecasts are optimistically biased, associated with selection bias, analysts' incentives, firms' characteristics and asymmetries in reported earnings (e.g.: Abarbanell & Lehavy, 2003; Abarbanell, 1991; Brown, 1993; Doukas, Kim, & Pantzaliz, 2002; Dugar & Nathan, 1995; Francis & Philbrick, 1993; Hayes, 1998; Mendenhall, 1991; and O'Brien, 1988). Known as the 'degrees-of-freedom problem', another source of bias in ICC estimates lies in the short detailed planned period of certain models. As neglecting analysts' longer-term forecasts for the periods after the planned period introduces a bias in ICC estimates (Kryzanowski & Rahman, 2009). Especially in more complex valuation scenarios, for example high growth firms with losses, models with short planned period horizons are inadequate for valuation purposes (Ohlson & Juettner-Nauroth, 2005). Lastly, according to Lambert (2009), the least discussed assumption in the ICC literature, namely the assumption of a constant and deterministic cost of equity capital, accounts for the last mentioned bias. Hughes et al. (2009) explain that the ICC estimates differ from expected returns when expected returns are assumed to be stochastic.

Comparing the ICC models with the factor models, Frank and Shen (2015) conclude that in contrast to the CAPM, the ICC estimates are in line with prior theories. Lee et al. (2009) reports that, in favor of the ICC approach, expected returns based on ICC estimates are much less noisy than those based on realized returns. To conclude, Ferreira Savoia, Securato, Bergmann, and Lopes da Silva (2019), Li and Mohanram (2014), and Pastor, Sinha, and Swaminathan (2008) show that the ICC approach outperforms the CAPM in estimating future stock returns.

2.3 The impacts of cash flow volatility

"While accounting is the language of business, cash is the currency" (Leach & Melicher, 2018, p. 16). This quote adequately highlights the importance of cash. In the previous section, it became clear that risk plays a vital role in making business decisions. One of the main reasons is that, according to the modern portfolio theory, investors are mean-variance optimizers, seeking the lowest possible return variance for any given level of expected return. This suggests that the variance of an investment return, a measure of how dispersed its return outcomes are, is the appropriate measure of risk. Hiller, Grinblatt, and Titman (2011) recently confirmed this way of arguing by mentioning that although other measures of risk exist, the variance still is the predominant measure used by portfolio managers and corporate managers. Where risk is described as the variance of an investment return and the cash flow as the main matter of importance, the volatility of cash flows can be distilled as the critical outcome of risks that has to be managed. The following subsections describe the theory and empirical evidence regarding the importance of cash flow volatility.

In the extensive body of finance literature, the importance of cash flow volatility is theorized within the stream of risk management. Froot et al. (1994) built a risk management paradigm based on three basic premises; (1) the key to creating corporate value is making good investments, (2) the key to making good investments is generating enough cash internally to fund those investments; when companies do not generate enough cash, they tend to cut investment more drastically than their competitors do, and (3) cash flow can often be disrupted by movements in external factors (causing volatile cash flows). As is described in the pecking order theory section (section 2.1.3), financial markets are not perfect, making external financing of any form (be it debt or equity) more expensive than internally generated funds. This leads to the first theory regarding cash flow volatility, namely the credit rationing theory which is developed by Froot, Scharfstein, and Stein (1993). This theory states that cash flow volatility diminishes value to the extent that it causes shortages in internally generated funds available to take advantage of attractive investment opportunities.

The second relevant risk management theory is brought up by Demarzo and Duffie (1995) and is built upon the idea of signaling. Their theory states that when it is difficult for noncontrolling shareholders to assess the quality of management, higher quality managers hedge to mitigate the effect of external factors on the firm's performance. This way of reasoning suggests that external factors causing cash flow volatility has a signaling effect to shareholders, providing an unfavorable indication of risk. Via this way of reasoning, cash flow volatility can lower firm value as it lowers shareholders' appeal to invest.

As is mentioned in the trade-off theory section regarding capital structure, it is theorized that firms trade off the benefits of a tax shield with the cost of financial distress. Dolde (1993), Mayers and Smith (1982), Rawls and Smithson (1990), Smith and Stulz (1985), and Stulz (1996) argue that the expected costs of financial distress increase with leverage and cash flow volatility as both factors increase the probability of winding up in bankruptcy in the future. This implies that the present value of cash flow to the firm's claimholders decreases with volatility, ultimately reducing the value of the firm. Besides the cost of financial distress, Smith and Stulz (1985) illustrate that if taxes are a convex function of earnings, more volatile earnings stream leads to higher expected taxes than a less volatile earnings stream.

Based upon the previous described theories, a body of empirical studies regarding the impacts of cash flow volatility has emerged in the last decades. In line with the credit rationing theory of Froot et al. (1993), Deshmukh and Vogt (2005), Minton and Schrand (1999), and Sasaki (2016) conclude that cash flow volatility (hereafter interchangeably denoted as CFV) has a negative impact on firms' average investment levels as it increases the likelihood that a firm will need to access capital markets while it also increases the costs of doing so. Instead of smoothing their investment spending to cash flow fluctuations by using external funds, firms forgo investments permanently. Hirth and Viswanatha (2011) examine the CFV-investment relationship controlling for cash levels, exposing that the negative relation holds for low-cash firms. Cash-rich firms face a positive relation between CFV and average investment levels, they may invest more, even in less favorable projects, if they face less cash or more cash flow risk. Baum et al. (2009) extend the clarification of investment behavior of firms facing CFV by separating firm-level or intrinsic causes of CFV from market-level or extrinsic causes of CFV. They conclude that firms increase investment spending when firm-level factors increase CFV and decrease investment spending when market-level factors increase CFV.

Skipping the effect of CFV on average investment levels, another stream of research focusses on the effects of CFV on future stock returns and firm value directly. Campbell (2015), Huang (2009), and Palkar (2017) identify a negative relationship between CFV and future stock returns/firm value. Huang (2009) documents a strong negative relation between CFV and subsequent stock returns in the U.S. market. He shows that firms with low CFV outperform their high-risk counterparts by 1.35% per month. Palkar (2017) extends this analysis to international markets and shows that the negative relation holds, even after adjusting for market, size, book-to-market, and momentum factors. In addition, he reports evidence that shows an important role of financial constraints in the relation between cash flow volatility and return, emphasizing that volatile cash flows are more costly in the presence of capital market frictions as they impair the ability of firms to undertake all positive net present value projects, thereby leading to lower future returns.

Next, several studies show evidence of a positive relation between cash flow volatility and the cost of capital. (Deng et al., 2013; Douglas et al., 2016; Hung & Wakayama, 2005; Minton & Schrand, 1999). Minton and Schrand (1999) argue that a higher CFV is associated with higher yields-to-maturity, worse S&P bond ratings, lower dividend payout ratios, lower analyst following and a higher weighted average cost of capital. Douglas et al. (2016) highlights the importance of cash flow volatility by stating that cash flow volatility matters for pricing corporate bonds to a degree that merits stand-alone consideration. Hung and Wakayama (2005) argue that cash flow volatility is a sign of risk for creditors, wherefore a compensation is demanded that increases the cost of debt capital. Deng et al. (2013) show that firms facing CFV neither cut dividends nor cut investments but rather maintain a very high level of investment. To cover up the periods of internal cash flow shortfalls, firms use external financing as the major instrument, which ultimately increases financial distress and the cost of capital.

With respect to the detrimental impacts of cash flow volatility on future stock returns, firm value and the cost of capital, two lines of reasoning can be distilled. First, Minton and Schrand (1999) and Palkar (2017) argue that cash flow volatility causes shortfalls in internally generated funds which are costly in the presence of capital market imperfections. Because firms in periods of shortfalls either forgo valuable investments or fund the investment opportunities with more expensive external financing. Second, Hung and Wakayama (2005) and Huang (2009) argue that cash flow volatility is directly priced in the cost of capital as creditors interpret cash flow volatility as a sign of uncertainty for which they want to be compensated.

Lastly, Graham and Smith (1999) confirm the predictions of Smith and Stulz (1985) and found evidence of the disadvantage of cash flow volatility regarding the tax liabilities. The authors report that for a firm facing some form of tax progressivity, when taxable income is low, its effective marginal tax rate will be low; but when income is high, its tax rate will be high. If such a firm reduces its cash flow volatility, the tax increase in circumstances where income would have been low is smaller than the tax reduction in circumstances where income would have been high, thus lowering expected taxes.

Summarizing, within the studies of risk management, several theories regarding the impacts of cash flow volatility are developed. These theories focus on the impact of cash flow volatility on firm value, whether or not via intervening variables such as investments, tax liabilities or anticipating creditors. Empirical evidence shows that cash flow volatility has a negative impact on investment activity, share prices and firm value and shows a positive impact on the firm's cost of capital and tax liabilities. Whereas the firm's cost of capital is either measured as the cost of debt capital or proxies such as analysts' following, bond ratings or payout ratios.

2.4 The value of asset liquidity and its impact on the cost of capital

Real asset liquidity refers to the ease with which an asset can be converted into cash quickly and at a low cost[3] (Gopalan, Kadan, & Pevzner, 2012). Preliminary studies on asset liquidity focus primarily on the effects on capital structure, wherein asset liquidity is related to a firm's recovery rate (the dollar amount received upon firm liquidation per dollar lent out). More recently, additional empirical studies focus on the implied operating flexibility of firms with a high asset liquidity, wherein the advantages of asset liquidity are linked to voluntary asset sales. This subsection aims to describe both streams.

By incorporating the creditor's expected recovery rate in the event of default as a factor influencing the value of corporate debt, Merton (1974) paved the way for subsequent studies to examine the impacts of asset liquidity. From the perspective of structural models of credit risk (e.g.: Leland, 1994; Leland & Toft, 1996; and Merton, 1974; among others), asset liquidity can increase and decrease risk, depending on how it is argued. Higher asset liquidity on the one hand increases the expected recovery rate in case of default, consequently reducing creditors' risk, but on the other hand, liquid assets give managers the flexibility to use asset sales to transform the asset composition of the firm after debt has been issued, potentially increasing the debt's risk.

Williamson (1988) and Shleifer and Vishny (1992) both argue that a higher asset liquidity increases the firm's debt capacity and optimal leverage. Williamson (1988) argue that more liquid, or more "redeployable", assets should be financed with debt more often because public debt markets and banks incur lower costs from financing liquid assets. Wherein the author refers to the bondholders' cost of monitoring and liquidating liquid assets compared to illiquid assets. Therefore, higher asset liquidity decreases the cost of debt, increases the amount a firm can borrow and increases the optimal leverage. Shleifer and Vishny (1992) make a similar prediction about the relation between asset liquidity and capital structure, they argue that asset liquidity is related to the expected costs of financial distress because less liquid assets sell at higher discounts relative to their fair values, which increases the expected costs of asset liquidation in the event of financial distress. To avoid costly liquidation associated with illiquid assets, managers reduce leverage to lower the probability of default and reduce the expected costs of financial distress. On the other hand, higher asset liquidity decreases the expected costs of financial distress allowing companies to take on more debt which increases the optimal amount of debt. Both argumentations are in line with the trade-off theory that advocates the use of debt financing until the incremental costs of financial distress exceeds the incremental benefits of debt financing.

Several contrasting studies predict a relationship between asset liquidity and leverage that is negative. Morellec (2001) argues that the effect of asset liquidity on leverage depends on

[3] In this report, the terms 'real asset liquidity' and 'asset liquidity' are used interchangeably and refer to the liquidity of a firm's physical assets that have an intrinsic worth due to their substance and properties.

whether there are restrictions placed on the disposition of assets. Asset sales are more likely for more liquid assets because of the lower costs of selling assets and the higher liquidation values. In case of closure, asset sales reduce the value and the size of a firm's assets and therefore are bad for creditors. Restrictions on the firm's assets prevent asset sales and increases the expected liquidation value of assets in favor of creditors. Therefore, Morellec (2001) links the relationship between asset liquidity and leverage to the managers' discretion over assets, arguing that the relation is positive when assets serve as a colleteral for debt contracts and managers have no discretion over those assets. The relation is argued to be negative when the assets are not contractually agreed on as collateral. Myers and Rajan (1998) predict a similar relationship but argue that asset liquidity facilitates managers in expropriating value from investors, either by transforming firm's asset or by liquidating them. Therefore, higher asset liquidity is likely related to a reduction in managers' commitment to an investment strategy, which increases risk and therefore decreases optimal leverage levels.

Empirical results are in line with Shleifer and Vishny (1992) and show that high asset liquidity reduces the cost of debt capital and increases debt capacity. Pulvino (1998) shows that industry-specific assets have less value when firms liquidate them, as firms sell industry-specific assets at substantial discounts in times of distress. Examining the effect of asset liquidity on the capital structure, Kim (1998) finds that firms with higher asset liquidity increase their borrowing in times of distress whereas firms with low asset liquidity do not. Sibilkov (2009) investigates the relation between leverage and asset liquidity for a broad sample of U.S. public firms and shows that asset liquidity is positively related to leverage capacity. More recently, Ortiz-Molina and Phillips (2014) examine the relationship between asset liquidity and firms' cost of capital as measured with an implied cost of capital approach. Their results show that asset liquidity is negatively related to the cost of equity capital, because, as they conclude, high asset liquidity enhances a firm's operating flexibility.

On the topic of asset liquidity as a determinant of operating flexibility, researchers found that asset sales do not only occur to reduce financial distress. Voluntary asset sales are also used frequently for the purpose of corporate restructuring, improving operating efficiency by allocating inefficiently used resources to more productive firms (John & Ofek, 1995; Phillips & Maksimovic, 2001; Yang, 2008; among others). Moreover, several studies show that assets sales can be used as a method to obtain financing for new investments (Arnold et al., 2018; Edmans & Mann, 2012). Edmans and Mann (2012) even add their results to the pecking order theory, arguing that partial asset sales will not diminish the value of the firm to the same degree as equity issuances. Linking asset sales to the underinvestment problem mentioned in the cash flow volatility section, Borisova and Brown (2013), and Hovakimian and Titman (2006) show that firms invest more when they generate cash from asset sales.

Summarizing, real asset liquidity refers to the ease with which a firm's assets can be sold on a secondary market and has been studied for several decades. Asset liquidity is a determinant of operating flexibility and asset sales are often used for reasons other than solving financial distress. Recently, the relation between asset liquidity and the cost of capital has been studied, theories explain contradicting relations, but empirical evidence points towards a negative relation between asset liquidity and the cost of capital.

2.5 Theoretical framework and hypotheses

The previous sections outline the relevant theories related to this study. This section summarizes these theories and presents the theoretical framework and the hypotheses on which this research is built.

The assumptions underlying the Modigliani and Miller capital structure irrelevance principle and the key insights of the "postmodern" finance paradigm emphasize that financial markets are not perfect, making cash generated from external financing more expensive than internally generated cash. Shedding light on the importance of internally generated funds, a substantive body of literature emerged focusing on the consequences of cash flow volatility. Major consequences of cash flow volatility are related to the decrease in investment activity, future stock returns and firm value. Besides, empirical evidence suggests a positive relationship between cash flow volatility and the cost of capital. The reasoning underlying the impacts on the cost of capital are two-fold. On the one hand, cash flow volatility causes periods of shortages in internally generated funds that are costly in the presence of capital market frictions, which reduces the firm's ability to take advantage of positive net present value investments and ultimately reduces the firm's organisational performance, efficiency and returns. On the other hand, cash flow volatility is a sign of risk to investors for which they want to be compensated, directly increasing the cost of capital. Therefore, reasoned upon prior research, the first hypothesis states:

H1: *Historical cash flow volatility is positively related to the cost of equity capital.*

From the corporate finance perspective, asset liquidity is related to the firm's operating flexibility through the potential value of asset sales. As firms do utilize asset sales for the purpose of restructuring or to cover up liquidity needs. Recently, prior work describes asset sales as a way of attracting cash that is more appealing than debt or equity. Furthermore, firms with a higher asset liquidity provide a higher recovery rate in case of default, reducing investors' risk. Altogether, prior studies point toward a negative relation between asset liquidity and the cost of equity capital.

Concentrating on the advantages of asset liquidity, Schlingemann et al. (2002) argue that asset liquidity plays an important role if a firm has fundamental reasons to restructure, as asset liquidity can explain why some firms choose to divest a business segment while other similar firms choose not to. From Modigliani and Miller (1958) to Brealey et al. (2014) and many others, the common thread in corporate finance literature is the idea or goal of value maximization. In the light of capital structure, the trade-off theory postulates that value maximizing firms should work towards an optimal debt level. Over the optimal debt level, firms are facing a situation in which the marginal costs of the additional debt outweigh the marginal benefits, as the costs of financial distress increases. Caskey, Hughes and Liu (2012) examined the impacts of excess leverage and found a positive relation with the probability of financial distress. Following this line of reasoning, it is expected that firms who face relative larger levels of debt above the optimal debt level are more financially distressed and therefore do have a greater incentive to restructure. It is expected that the operating flexibility that comes with asset liquidity is more beneficial for firms that are closer to financial distress, as more asset liquidity provides more flexibility to cover up liquidity needs or to restructure. These expectations lead to the following second hypothesis:

H2: *Real asset liquidity is negatively related to the cost of equity capital, this effect is stronger for firms that are closer to financial distress.*

The proposed reasoning underlying the impact of cash flow volatility on the cost of capital suggest that the impact of cash flow volatility is partly determined by the extent to which firms can cover up shortfalls in internally generated funds. Asset liquidity is related to the value of asset sales as a pertinent source of funds alongside debt and equity. Therefore, it is expected that asset liquidity determines the extent to which a firm can cover up shortfalls in internally generated funds through asset sales. In this line of reasoning, asset liquidity increases the firm's operating flexibility and therefore increases the firm's ability to reduce the impact of cash flow volatility on the cost of capital. For the same reasons as in the second hypothesis, the advantages of asset liquidity are expected to be stronger for firms that are closer to financial distress. This leads to the following last hypothesis:

> ***H3:*** *Real asset liquidity reduces the effect of cash flow volatility on a firm's cost of equity capital, this effect is stronger for firms that are closer to financial distress.*

Figure 1 contains a visual representation of the theoretical framework. The next chapter elaborates the methodology applied to test the hypothesized relationships.

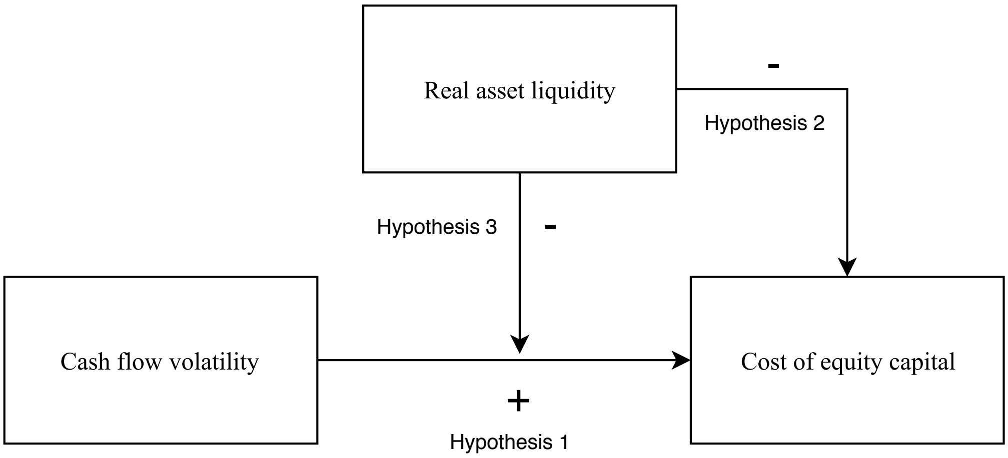

Figure 1: Theoretical framework applied within this study

3 Methodology

The methodology section aims to clarify the reasoning and underpinning of the selected research approach. Addressing the research approach decision involves the philosophical assumptions brought to the study, the research design and the specific research methods and is based on the nature of the research problem, in line with the philosophy of Cresswell (2014). The remainder of this chapter is structured according to this framework.

3.1 Research paradigm

According to Guba and Lincoln (1994), a research paradigm may be viewed as a set of basic beliefs that deals with ultimates of first principles and comprises three elements, namely, epistemology, ontology and methodology. Respectively concerned with what constitutes reality, what are the nature and forms of knowledge, and which methodology suit these assumptions (Scotland, 2012).

The objective of this study is to examine the (interaction) effect of cash flow volatility and asset liquidity on the cost of equity capital. To accomplish this objective, the goal is to verify a theory that is based on prior theoretical contributions. As this study emerged from prior literature, it holds several philosophical implications from these studies that are assumed to exist. For examples, it is believed; that truth or knowledge is 'out there to be discovered' by research, that cause and effect are distinguishable and analytically separable, that results of inquiry can be quantified, and that theory can be used to predict and to control outcomes. These examples, and the characteristics of the main articles underlying this study, are in line with the positivist paradigm as described by Kivunja and Bawa Kuyini (2017).

Research located in the positivist paradigm relies on deductive logic, formulation of hypotheses, testing those hypotheses, offering operational definitions and mathematical equations, calculations, extrapolations and expressions to derive conclusions. In terms of the elements of a paradigm, its epistemology is said to be objectivist, holding that human understanding is gained through the application of reason. Its ontology is said to be naïve realist, assuming there exists a world of material perception-independent objects with perception-independent properties. The methodology element is said to be experimental, meaning that the research will involve manipulation of one variable to determine whether changes in that variable cause changes in another variable Kivunja and Bawa Kuyini (2017).

To conclude, mostly adapted from the main prior studies underlying this research (e.g.: Deng et al., 2013; Huang, 2009; Minton & Schrand, 1999; Ortiz-Molina & Phillips, 2014), a positivist paradigm reflects the beliefs about the world that guides this research.

3.2 Research design

The aim of this study is to verify a theory by testing several hypotheses. Corresponding to the fundamental prior studies used to construct this study, a quantitative approach is used which is, according to Scotland (2012), in line with the positivist paradigm that is described in the previous subsection. This study tests three hypotheses related to the firm's cost of equity capital. All hypotheses test whether one or several factors are related to the firms' cost of equity capital. Moreover, this study aims to explain the variations in firms' cost of equity capital estimates caused by cash flow volatility and real asset liquidity.

Within this study, the essence is to examine whether a change in the relevant explanatory variable is related to a change in the relevant exploratory variable. In statistical terms, the aim is to examine whether there is a relationship between the independent and the dependent variable. Additionally, more important, when a relationship is found, the aim is to examine whether this relationship holds while controlling for alternative explanations. This type of research design corresponds to the approach that is known in literature as a relational research design (Cresswell, 2014). Applying this approach, the studies which are fundamental to this study use an ordinary least square regression model to analyze the data (e.g.: Minton & Schrand, 1999; Ortiz-Molina & Phillips, 2014). This quantitative approach permits specification of dependent and independent variables and allows for tightly controlled relationship measures.

3.2.1 Research model

The first hypothesis *'**H1**: Historical cash flow volatility is positively related to the cost of equity capital'* tests whether there is a relationship between cash flow volatility and the cost of equity capital. The following regression is employed to test the impact of cash flow volatility on the cost of equity capital:

$$FirmICC_i = \beta_0 + \beta_1 CFV_i + \beta_2 CONTROL_i + \varepsilon_i. \qquad (1)$$

In which $FirmICC_i$, firm i's implied cost of equity capital, is the dependent variable. β_0 is the intercept, β_1 explains the direction of the effect of firm i's cash flow volatility (CFV_i), β_2 explains the linear effect of firm i's control variables ($CONTROL_i$), and ε_i is the firm-specific error of firm i that accounts for the variability in the dependent variable which cannot be explained by the linear effect of the independent variables. The hypothesized direction of the relationship is positive, which suggest that the direction of the effect of cash flow volatility is presented by means of a positive beta coefficient β_1.

'***H2***: *Real asset liquidity is negatively related to the cost of equity capital, this effect is stronger for firms that are closer to financial distress'*, is the second hypothesis and tests whether there is a relationship between a firm's real asset liquidity and a firm's cost of equity capital. To test the hypothesis, the following regression is employed:

$$FirmICC_i = \beta_0 + \beta_1 RAL_i + \beta_2 CONTROL_i + \varepsilon_i. \qquad (2)$$

Within this equation, all variables are the same as in equation (1), except for β_1, which refers to the linear effect of firm i's real asset liquidity (RAL_i), and β_2 $CONTROL_i$, which is expanded with a measure of cash flow volatility. The hypothesized relationship between RAL_i and $FirmICC_i$ is negative, therefore it is expected that β_1 takes on a negative value and that this value is more distant from zero (lower) for firms that are closer to financial distress.

The last hypothesis tests the moderating effect of real asset liquidity on the relation between cash flow volatility and the cost of equity capital. The hypothesis is described as follows: '***H3***: *Real asset liquidity reduces the effect of cash flow volatility on a firm's cost of equity capital, this effect is stronger for firms that are closer to financial distress'.* The following regression model is employed to test this hypothesis:

$$FirmICC_i = \beta_0 + \beta_1 CFV_i + \beta_2 RAL_i + \beta_3 CFV_i \times RAL_i + \beta_4 CONTROL_i + \varepsilon_i. \qquad (3)$$

The variables are the same as in the previous models, except for coefficient β_3, that captures the linear interaction effect of cash flow volatility and real asset liquidity of firm i ($CFV_i \times RAL_i$) on firm i's cost of equity capital. Besides the specific effects of cash flow volatility and real asset liquidity, this model distinguishes the effect of the interaction. It is expected that the interaction term explains part of the variance in the implied cost of equity capital that was first explained by the individual cash flow volatility and real asset liquidity variables and that the interaction term adds explainability compared to the former models. Therefore, it is expected that incorporating the interaction term increases to overall explainability of the model and reduces the variance explained by the individual independent variables. It is expected that the beta coefficients and t-statistics are more distant from zero (that the effect is stronger) for firms that are closer to financial distress and that the beta coefficients for both subsamples are statistically significant different from each other. All variables employed are elaborated in the next section. The next subsection describes the data analysis methods employed in this study.

3.2.2 Data analysis

To test the hypotheses, this study utilized secondary data provided by Orbis. Orbis gathers data from a variety of sources; firm financial data are derived from annual reports and earnings per share estimates are taken from JCF International. The data is analyzed using a uni-, bi- and multivariate analysis.

The univariate analysis describes individual variables and provides descriptive statistics. The purpose is to detect outliers and to provide a data overview that can be compared with those of other studies. The univariate analysis presents the mean, median, quartiles and standard deviation of every variable before and after the outlier treatment. Furthermore, before any regression analysis is performed, a univariate quintile mean comparison illustrates any differences in mean values and reveals potential patterns with respect to the hypotheses.

The bivariate analysis is conducted to reveal the relationships between all individual variables. A correlation analysis shows the association between variables, ranging from -1 to 1 indicating whether there is an association and whether the association is negative or positive. Moreover, the correlation analysis is a prelude to the multivariate assumption tests.

Ideally, within a multiple regression analysis, there are a number of independent variables highly correlated with the dependent variable, but with little correlation among themselves. A high correlation among independent variables complicates the interpretation of the regression results. The correlation analysis addresses a first view on the issue of multicollinearity, by expressing the degree to which each independent variable is explained by the set of other independent variables. As elaborated in section 4.3.1, multicollinearity is tested with the variance inflation factor in which the common cutoff threshold of 10 is used. VIF values higher than 10 are considered as problematic (Hair, Black, Babin, & Anderson, 2009). As a cutoff threshold of 10 is somewhat high for financial studies, VIF values between 5 and 10 are further examined and elaborated in section 4.3.1.

As in prior studies examining the determinants of the cost of capital, the multivariate analysis consists of a regression model. Within this study, the independent and dependent variables are metric, therefore a linear regression model is applied. The linear regression attempts to model a relationship between the independent and the dependent variables by fitting a linear equation to the observed data. The model follows a particular form where the linearity comes from the parameters. The most common method, also applied in the prior studies regarding the cost of equity capital, for fitting a regression line is the method of least-square, called the ordinary least squares method (OLS). By minimizing the sum of squares of the vertical deviations from each data point to the line, this method calculates the best-fitting line. The most relevant information the OLS method provides is (1) the extent to which the independent variables explain the outcome of the dependent variable, (2) the degree to which variables in particular are significant predictors of the outcome variable, and (3) in what way the independent variables impact the outcome of the dependent variable. Therefore, in line with prior studies, the OLS method is an appropriate method to test the hypotheses.

3.3 Research measurements

The preceded section explains the research model and clarifies the approach taken to achieve this study's objectives. This section describes the variables and the underlying measures in more detail. Furthermore, it describes the methods and procedures applied for data collection and sampling.

3.3.1 Variables

Given the conceptual framework, the main variables are; the cost of equity capital as the dependent variable, and real asset liquidity and cash flow volatility as the independent variables. A set of control variables is used to isolate the relevant relations from potential alternative explanatory factors. Two grouping variables are used to split the sample to examine the economic mechanisms underlying the findings. This subsection elaborates the variables and the underlying measures.

Implied cost of equity capital

The cost of equity capital is the dependent variable, estimating the cost of equity capital is essential for studying the relation between firm level characteristics and expected returns. Within this study, the cost of equity capital is estimated with an implied cost of equity capital (ICC) measure which does not rely on noisy realized returns or on specific asset pricing models, outperforming traditional cost of equity capital measures (as elaborated in section 2.2). Broadly speaking there are three methods to calculate the implied cost of equity capital, the following three subsections briefly outline the different ICC methods, thereafter the method applied within this study is elaborated in more detail.

The first method to calculate the ICC is the dividend discount model (DDM), in this method the future dividends are equalized to the current stock price by discounting it with a discount rate (the ICC). This method is first employed by Malkiel (1979) who estimates the future dividends by multiplying the current dividend with the long term growth rate. As this method is very sensitive to the long-term growth rate, Botosan and Plumlee (2002), and Gordon and Gordon (1997) use a variant in which long-term dividend forecasts are used. Pastor et al. (2008) use a more refined dividend discount model to estimate the ICC. The authors estimate the forecasted dividends for a planned period of three years using explicit earnings forecasts and for year 4 to 15 using a mean-reverted growth rate derived from the planned period.

The second method to compute the implied cost of capital is the residual income model (RIM). This method is a developed version of the DDM, as the DDM is based on difficult to forecast dividends. The RIM is a version of the DDM that assumes clean surplus accounting. This model equates the current stock price with the book-value per share and the sum of discounted residual income. The residual income is defined as earnings per share minus the ICC times the book-value per share from the previous period. This model is developed by Gebhardt et al. (2001) who use an explicitly planned period of three years and a forecast period of 12 years. The RIM uses the book value of equity as a valuation hook and then adjusts this value according to future expected residual income (Easton & Sommers, 2007), overcoming the difficulty of forecasting future dividends.

The third method to calculate the ICC is the abnormal earnings growth model (AEG), which is based on the firm's value of capitalized earnings adjusted by the value of the expected abnormal growth in earnings. This method is developed by Easton et al. (2002) who uses a modified price-earnings-growth formula in which the growth in abnormal earnings is set to zero. This method requires the researcher to make assumptions regarding the long-term growth rate. To overcome this problem, the authors proposed to estimate the ICC and the long-term growth rate simultaneously for a portfolio of firms. By doing so, Easton et al. (2002) restate the RIM as a regression equation and then obtain the long-term growth rate and ICC values from the estimated regression coefficients. However, this method is only applicable on portfolio or market level. The extended version of this AEG model, developed by Nekrasov and Ogneva (2011), allows for firm level estimation. To accomplish the firm level estimation, a cross-sectional weighted least squares regression has to be employed in order to obtain market-level ICC and growth rate estimates. Using the weights from this regression, the company's market-to-book value, the company's risk and growth characteristics, and the average ICC and growth rate estimates, the firm level ICC can be computed.

The DDM method is the least complex one but relies on difficult to forecast dividends making the method less reliable. To overcome this problem, the other two methods assume clean surplus account and use earnings rather than dividends. The AEG model is originally developed to estimate the ICC on a portfolio or market level. The extended version of the AEG that is applicable on firm level is, compared to the RIM, more complex and tedious. Daske, van Halteren and Maug (2010) evaluate different firm- and market-level implied cost of equity capital methods and conclude that *"within the group of firm-level methods, residual income methods uniformly dominate abnormal earnings growth methods"* (p. 32). Therefore, based on the applicability of the model and on the performance in prior studies, the RIM as developed by Gebhardt et al. (2001) is used in this study to estimate the firm's implied cost of equity capital.

Gebhardt et al. (2001) defines the implied cost of equity capital for each firm as the internal rate of return that equates the present value of expected future cash flows to the current stock price. This requires forecasting cash flows up to a terminal period and the determination of an appropriate terminal value. Therefore, the residual income model, derived from the dividend discounting model, is used. According to the dividend discount model, the firm's stock price for year *t* is equal to the present value of its expected future dividends:

$$P_t = \sum_{i=1}^{\infty} \frac{E_t\,(D_{t+i})}{(1+r_e)^i}, \qquad (4)$$

where P_t is the current market stock price, $E_t\,(D_{t+i})$ is the expected future dividend for period $t+i$ conditional on information available at time t, and r_e is the cost of equity capital based on the information set at time t. This definition assumes a steady discount rate over time. Assuming 'clean-surplus' accounting (change in book equity equals net income minus dividends), equation (4) can be rewritten as the discounted residual income equity valuation model:

$$P_t = B_t + \sum_{i=1}^{\infty} \frac{E_t[(ROE_{t+i} - r_e)B_{t+i-1}]}{(1+r_e)^i}. \qquad (5)$$

where *ROE* is the return on equity and *B* is the book value of equity. This equation is identical to the dividend discount model but expresses firm value in terms of accounting numbers. This equation expresses the value of a firm in terms of an infinite series, whereas for practical purposes, a specified explicit forecast period is needed.

To estimate the intrinsic value using an explicit forecast period, following Gebhardt et al. (2001), a two-stage approach is used by calculating (1) earnings explicitly for the first three years and (2) earnings beyond year three implicitly by mean reverting the year 3 ROE to an industry median ROE. This expression is written as the following equation:

$$P_t = B_t + \frac{FROE_{t+1} - r_e}{(1+r_e)} B_t + \frac{FROE_{t+2} - r_e}{(1+r_e)^2} B_{t+1} + \sum_{i=3}^{T-1} \frac{FROE_{t+i} - r_e}{(1+r_e)^i} B_{t+i-1} + \frac{FROE_{t+T} - r_e}{r_e(1+r_e)^{T-1}} B_{t+T-1}. \quad (6)$$

in which P_t is the current market share price and B_t is the book value per share. $FROE_{t+i}$ is the forecasted return on equity, for the first three years calculated as $FEPS_{t+i}/B_{t+i-1}$, beyond year three, $FROE_{t+i}$ is calculated using a linear interpolation to the industry median ROE. B_{t+i} is calculated as B_{t+i-1} + $FEPS_{t+i}$ - $FDPS_{t+i}$, in which $FDPS_{t+i}$ is the forecasted dividend per share for year *t+1* estimated using the current dividend payout ratio *(k)*, assuming $FDPS_{t+i} = FEPS_{t+i} * k$.

As in Gebhardt et al. (2001), the earnings of the next 3 years are forecasted using the analysts' forecasts of earnings per share *(EPS)*. *EPS* estimates are taken from Orbis[4]. Earnings beyond year 3 are forecasted by mean reverting the period *t+3 ROE* to the median industry *ROE* by period *t+T*, the terminal value is estimated as the present value of period *T's* residual income as a perpetuity. As in Gebhardt et al. (2001) and Ortiz-Molina and Phillips (2014), *T* is set equal to 12 years. Although this time range seems very influential and subjective, Gebhardt et al. (2001) illustrates that computing the implied cost of equity capital using T=6, 9, 15, 18 or 21 results in very similar cross-sectional results. Following Gebhardt et al. (2001), the forecasts are obtained through linear interpolation between *ROE* at period *t+3* and the industry median *ROE* at time *t*. The mean reversion in *ROE* attempts to capture the long-term erosion of abnormal *ROE* over time and the conception that individual firms tend to become more like their industry peers in the long run. The industry median *ROE* is a moving median of the past 10 year *ROEs* from all public firms in the same 48 Fama and French (1997) industry, the median is used to control for the influence of outliers. The future book value of equity is forecasted using the forecasted future earnings assuming clean-surplus accounting and a constant dividend payout ratio. Dividend payout ratios of less than zero and more than one are winsorized to respectively zero and one. For firms with two years of *EPS* forecasts, the third year is forecasted by adding the year one to two growth rate to year two. Firms with less than two future years of *EPS* forecasts are removed from the sample. The implied cost if equity capital variable is denoted as *FirmICC.*

Easton and Monahan (2005), Echterling et al. (2015), and Li and Mohanram (2014) argue that biases or sluggish adjustments in analysts' earnings forecasts might affect the ICC and therefore is a potential cause of measurement error. Analysts' earnings forecasts are an imperfect proxy for the market's expectation of future earnings; accordingly, analysts often fail to update their earnings forecasts in a timely fashion relative to the information contained in recent stock price changes. Therefore, a robustness check allows analysts extra time to impound the information in recent price movements into their forecasts. Specifically, following Guay et al. (2011), the robustness check performs a similar analysis with implied cost of equity capital estimates generated using stock prices measured a month before the date at which the analysts' *EPS* consensus is obtained. This variable is denoted as *FirmICC_pm.*

[4] Orbis uses EPS estimates provided by JCF International. JCF calculates consensus using only those EPS estimates changed or actively validated within the last 75 days.

Real asset liquidity

Following Ortiz-Molina and Phillips (2014), two types of real asset liquidity measures are defined. The first type of measures capture the liquidity of real (fixed) assets at the industry level, these measures reflect the 'industry equilibrium' aspect as introduced by Shleifer and Vishny (1992) which states that firms can more easily sell its industry-specific assets to other firms in the industry with financial slack. The second type of measures are constructed at the firm level from firms' balance sheets and capture not only the liquidity of fixed asset but also the effect of how much cash or other (semi-)liquid assets the firm holds.

1. Real asset liquidity – industry-based measures

The first measures of a firm's real asset liquidity capture the 'industry equilibrium' and are inspired by Shleifer and Vishny (1992). They state that the liquidity of a firm's fixed assets is intimately related to the presence and financial ability of other firms in the industry (the natural buyers) to act as acquirers. The liquidity of a firm's real assets depends on the existence of other firms with enough financial slack to purchase it and the extent to which the asset is transferrable to other firms. The key source of asset liquidity is the firm's industry affiliation, assuming that most assets are transferable among firms in the same industry but much harder to transfer to firms outside the industry. The assumption is supported by the findings of Phillips and Maksimovic (2001) who found that the bulk of asset sales occur between firms in the same or closely related industries.

Three measures of real asset liquidity are constructed based on industry definitions at the 3-digit and 4-digit SIC level. The first measure captures the number of potential buyers for a firm's assets, *PotBuy_N,* and is defined for each firm as the number of rival firms within the industry as provided by Orbis. In Orbis, this number is defined as the 'standard peer group' and is based on the firm's industry code and size.

The second measure directly captures the financial slack of potential buyers and is denoted as *PotBuy_FS*. This measure is defined as one minus the average book leverage net of cash of rival firms in the industry, averaged over the last 5 years:

$$Industry\ average\ book\ leverage\ net\ of\ cash_i = 1 - \frac{\sum_{t-5}^{t} \frac{Liabilities_{i,t} - Cash_{i,t}}{Total\ Assets_{i,t}}}{5}. \quad (7)$$

In which a firm is denoted as a rival firm if the primary 4-digit US SIC code corresponds with the primary 4-digit US SIC code of the firm being studied. The measure is averaged over the last 5 years to minimize the impact of temporary changes in firms' financial situations. Total liabilities is calculated is the sum of all current and non-current liabilities.

The third measure captures the historical liquidity of a firm's assets using the value of merger and acquisition (M&A) activity in the firm's industry scaled by industry assets. The value of all completed M&A deals involving publicly traded targets are obtained in each 3-digit SIC industry and year from Orbis, including mergers, acquisitions and minority stake purchases. The value of transactions in the industry are scaled by the book value of assets in the industry, calculated as the sum of total assets of publicly listed firms in the same 3-digit SIC industry. This ratio is averaged over the past 5 years to smooth temporary ups and downs in M&A activity in order to better capture the salability of an industry's assets. The variable of total M&A activity is denoted as *Tot_MA*.

The real assets of a firm are more liquid for higher values of *PotBuy_N, PotBuy_FS,* and *Tot_MA. PotBuy_N* is linked to the studied firm as the peer group size of the firm provided by

Orbis. *PotBuy_FS* of the industry is linked to the studied firm using primary 4-digit SIC codes whereas the M&A activity measures are linked with 3-digit SIC codes. The 4-digit SIC code is used to capture the financial slack of potential asset buyers, in which asset buyers are seen as potentials only if they are as closely related to the firm's operations as possible. The 3-digit SIC is used regarding the M&A activity, assuming that M&A acquirers behave in a more premeditated fashion resulting in a larger scope of potential deals.

2. *Real asset liquidity – firm level measures*

Following Ortiz-Molina and Phillips (2014), as in Gopalan et al. (2012), four firm-level weighted measures of asset liquidity are constructed. The measures assign liquidity scores to each of the major asset classes in a firm's balance sheet from most liquid to non-liquid (holdings of cash and cash equivalents, other noncash current assets and tangible fixed assets). Each major asset class is weighted by the importance of each asset class in the total assets of the firm (as is done by Berger and Bouwman (2009)). The weighted asset liquidity (WAL) measures are described below, all measures in the denominator are lagged with 1 year:

$$WAL1 = \left(\frac{Cash\ \&\ Equiv}{Total\ Assets}\right), \tag{8}$$

$$WAL2 = \left[\left(\frac{Cash\ \&\ Equiv}{Total\ Assets}\right) + 0.5\left(\frac{Noncash\ CA}{Total\ Assets}\right)\right], \tag{9}$$

$$WAL3 = \left[\left(\frac{Cash\ \&\ Equiv}{Total\ Assets}\right) + 0.75\left(\frac{Noncash\ CA}{Total\ Assets}\right) + 0.5\left(\frac{Tangible\ Fixed\ Assets}{Total\ Assets}\right)\right], \tag{10}$$

$$Market\ WAL = \left[\left(\frac{Cash\ \&\ Equiv}{Market\ Assets}\right) + 0.75\left(\frac{Noncash\ CA}{Market\ Assets}\right) + 0.5\left(\frac{Tangible\ Fixed\ Assets}{Market\ Assets}\right)\right]. \tag{11}$$

The first measure values the proportion of cash and cash equivalent to the firm's lagged total assets as cash and equivalents are perfectly liquid. However, this measure leaves out information as it presumes that all assets other than cash and cash equivalents are perfectly illiquid. This isn't the case as noncash current assets (CA) are semiliquid. Therefore, in the second measure a weight of 0.5 is assigned to the proportion of noncash CA[5] to lagged total assets. Noncurrent assets can be divided broadly into intangible and tangible assets. Tangible assets (e.g.: plant, property and equipment) are more liquid that intangible assets (e.g.: goodwill, intellectual property, growth opportunities). Following this logic, a third measure incorporates this value by assigning a liquidity score of 1 for cash and cash equivalents, 0.75 for noncash CA and 0.5 for tangible fixed assets. To capture the liquidity of both assets in place and growth opportunities, the fourth

[5] Noncash current asset is calculated as the sum of all current assets (stocks + debtors (trade receivables form clients and customers only) + other CA such as receivables from other sources (taxes), short term investment of money and cash at bank and in hand) minus cash and cash equivalents (cash at bank and in the hand of the company).

measure scales assets in place to the market value of assets[6]. This measure will be lower for firms with a higher proportion of growth opportunities. The weighted average liquidity variables are respectively denoted as *WAL1, WAL2, WAL3* and *MWAL.*

Cash Flow Volatility

Within the corporate finance literature, there are a large number of closely related measures of CFV, but no one agreed upon measure (Keefe & Yaghoubi, 2016). Table 1[7] illustrates the broad use of the term CFV within the literature throughout the years.

Table 1: Literature review on cash flow volatility

Study	Cashflow Volatility Measure
Bradley, Jarell, and Han Kim (1984, p. 872)	"The standard deviation of the first difference in annual earnings before interest, depreciation and taxes over the period 1962 – 1981 divided by the average value of total assets over the same period."
Kane, Marcus, and McDonald (1985, p. 481)	"Instantaneous standard deviation of the rate of return of the market value of the unlevered assets."
Kim and Sorensen (1986, p. 138)	"The coefficient of variation in earnings before interest and taxes (EBIT) measured over the years 1970 to 1980."
Kester (1986, p. 12)	"OLS prediction of return on assets is calculated for each company using observations for the five preceding years. The sum of squared residuals from each of these regressions is used in the final regression as a proxy for the volatility, or risk, of return on assets."
Titman and Wessels (1988, p. 6-8)	"Standard deviation of the percentage change in operating income…. It was measured using all nine years in the sample in order to obtain as efficient a measure is possible."
Stohs and Mauer (1996, p. 295)	The ratio of the standard deviation of the first difference in earnings before interest, depreciation, and taxes to the average of assets over the period 1980-1989."
Minton and Schrand (1999, p. 428)	"Cash flow volatility is defined as the coefficient of variation in a firm's quarterly operating cash flow over the six-year period preceding each of the seven sample years from 1989 through 1995"
Antoniou et al. (2008, p. 88)	First difference of annual earnings (% change) minus average of the first differences, over 1987-2000."
Huang (2009, p. 411)	"I compute cashflow volatility as the rolling standard deviation of the standardized cashflow over the past sixteen quarters. I require at least eight non missing observations of cashflow within this estimation window."
Frank and Goyal (2009, p. 33)	"Variance of asset returns is the annual variance of asset returns that is obtained by leveraging the variance of equity returns, with other asset values assumed to be equal to their book values."
Lee and Moon (2011, p. 878)	"The standard deviation of return on sales with a minimum of 2 million sales over the prior five years, over the prior five years."
Dang (2013, p. 41)	"The absolute value of the difference between the annual % change in EBITDA and the average of this change over 1980-2007"
Strebulaev and Yang (2013, p. 21)	"Volatility of profitability calculated for the past 10 years."
Douglas et al. (2016, p. 428)	"Our main CFV measure is the standard deviation of the ratio of cash flow from operations plus interest expenses to the previously defined firm value or to the book value of assets, calculated over the past 12-quarter period"

The CFV measures differ among the definitions of volatility and cash flow. All volatility measures consist of a measure of deviation, standardized to a certain factor for cross-sectional aggregation purposes. As shown in the table above, the standard deviation is the most commonly

[6] The market value of assets is calculated as the sum of the book value of assets (total assets) and the market value of equity (market capitalization) less the book value of equity (total shareholder's equity book value) (following Gopalan, Kadan and Pevzner (2012)).
[7] This review is an extended version of the literature review provided by Keefe and Yaghoubi (2016).

used method to quantify the amount of variation or dispersion in cash flows. A useful characteristic of the standard deviation is that, unlike the variance, it is expressed in the same units as the data. For cross-sectional comparison, this means that the standard deviation needs to be scaled to a measure of firm size.

The most straightforward way to scale the standard deviation of cash flows to a measure of size is to calculate the coefficient of variation. The coefficient of variation is the ratio of the standard deviation to the mean, it shows the extent of variability in relation to the mean of the cash flows. The biggest advantage of using the coefficient of variation is its independence of the unit in which the measurement has been taken, which makes it a dimensionless number. A disadvantage in using the mean as the scalar is that when the mean is close to zero, the coefficient of variation will approach infinity and therefore is sensitive to small changes in the mean. Barnes (2002), Minton and Schrand (1999), and Minton, Schrand and Walther (2002) use the coefficient of variation in their studies of cash flow volatility. To overcome the disadvantage of using the cash flows mean (μ) as a scalar, they calculate the mean of the absolute cash flow values. Although the mean of the absolute values can differ from the original mean, it should be clarified that the mean, in the formula for the coefficient of variation, is used as a marker of the typical size of the variable rather than the marker of central tendency. Following the forgoing studies, the first measure of cash flow volatility applied in this study is the standard deviation of cash flows scaled to the absolute cash flow mean and is denoted as *CoVCFV*:

$$CoVCFV = \frac{\sigma_{CF\ t-9\ to\ t0}}{\mu|CF\ t-9\ to\ t0|}. \tag{12}$$

Previous studies highlight that the choice of scalar that incorporates firm size in the volatility calculation is still a topic of debate (Douglas et al., 2016; Huang, 2009; Keefe & Yaghoubi, 2016). Therefore, in line with Huang (2009) two alternative operating variables are used for robustness purposes. The variable *SalesCFV* measures the dispersion of cash flows to sales and the *BECFV* variable scales the dispersion in cash flows to the current book value of equity:

$$SalesCFV = \frac{\sigma_{CF\ t-9\ to\ t}}{Sales_t}, \tag{13}$$

$$BECFV = \frac{\sigma_{CF\ t-9\ to\ t0}}{Book\ Equity_t}. \tag{14}$$

The value of historical cash flows is a universal data point provided by Orbis, which is a sum of the profit/loss and depreciation. The advantage of this measure is that it reports the cash earnings apart from incidental cash flows such as capital expenditures or changes on working capital, emphasizing the real performance of the firm. The disadvantage is that this measure is an indicator net of taxes, implying that this measure can differ between firms that are exactly the same but operate in a different tax regime. This disadvantage induces only minor limitations to this study as this study focusses on the volatility of cash flows rather than the size of the cash flows. Corporate taxes do not change the variability of cash flows when all cash flows are positive but do amplify the relative magnitude of negative cash flows more for firms that face a higher tax bracket. Within the final sample of this study, partly due to the survivorship bias explained in section 3.3.2, negative cash flows are a rarity. Therefore, the potential bias induced by the use of this cash flow measure is assumed to be negligible.

Control Variables

The aim of the analyses is the capture the variability in the dependent variable caused by the relevant independent variables as close as possible. Therefore, a set of control variables is utilized to control for the variability caused by potential confounding variables. Based on the previous works of Ortiz-Molina and Phillips (2014), and Keefe and Yaghoubi (2016), the set of control variables is composed as follows:

I. *MarketToBook* is the ratio of market value of assets (market capitalization) to total assets as a proxy of growth opportunities,
II. *BookLev* is the firm's book leverage (total liabilities and debt / by total assets) to account for capital structure,
III. *FA/TA* refers to the asset tangibility and is the fixed assets scaled by total assets to control for asset tangibility,
IV. *FirmSize* is the natural log of the total assets of the firm, as a proxy of firm size
V. *ROE* is the return on equity (profit (loss) for period / shareholders' funds) * 100) as a measure of profitability,
VI. *RDexp* is the natural logarithm of one plus the research and development expenditures scaled by sales,
VII. *FirmAge* is computed as the number of years since the first listing of the firm.

Grouping variables

To better understand the economic mechanism underlying the findings, the variation across firms in the effect of asset liquidity on the cost of equity capital is explored on the basis of split samples. According to the predictions in hypothesis 2 and 3, the beneficial effect of asset liquidity on the cost of equity capital is stronger for firms that are closer to financial distress. Caskey et al. (2012) found, related to the trade-off theory, that excess leverage is positively related to the probability of financial distress. Therefore, the firm's closeness to financial distress is measured on the bases of leverage ratios.

Intuitively, a 0.8 leverage ratio for a large firm in a consolidated industry, such as steel manufacturer, has a completely different meaning than for a small firm in a high growth industry such as communications. To account for such differences, a relative leverage measure is employed. The relative leverage ratio is defined as the difference between the firm's leverage ratio and the industry median leverage ratio. The industry median rather than the mean ratio is used to reduce the impact of industry outliers. The sample is split into firms with low leverage ratios and firms with high leverage ratios, based on whether the distance of the firm's leverage ratio from the industry median is in the bottom or top half of the annual distribution across all firms. For robustness purposes, the leverage ratios are calculated on the basis of book leverage and market leverage. The ratios are calculated as follows:

I. Book leverage: total liabilities and debt divided by total assets,
II. Market leverage: total liabilities and debt divided by the sum of total liabilities and debt and the market value of equity (market capitalization).

The industry median leverage ratio is linked to the firm's leverage ratio by the firm's primary industry code and the corresponding industry according to the Fama and French 48 industry classification. Table 2 provides an overview of all variables used in this study.

Table 2: Overview of variables used in this study

Variable	Measure	Reference
Dependent variables		
FirmICC	The internal rate of return that equates the present value of expected future cash flows to the current stock price	Gebhardt et al. (2001)
FirmICC_pm	The internal rate of return that equates the present value of expected future cash flows to last month's stock price	Gebhardt et al. (2001) & following Guay et al. (2011),
Independent variables		
Real asset liquidity		
PotBuy_N	The number of rival firms with a debt rating within the industry	Shleifer and Vishny (1992), Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
PotBuyFS	One minus the average book leverage net of cash of rival firms in the industry, averaged over the last 5 years	Shleifer and Vishny (1992), Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
Tot_MA	The total 5-year average value of M&A activity in the firm's industry scaled by the industry's assets	Shleifer and Vishny (1992), Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
WAL1	Firm's weighted average liquidity considering cash and cash equivalents, scaled by total assets	Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
WAL2	Firm's weighted average liquidity considering cash, cash equivalents and non-cash current assets, scaled by total assets	Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
WAL3	Firm's weighted average liquidity considering all assets, scaled by total assets	Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
MWAL	Firm's weighted average liquidity considering all assets, scaled by market value total assets	Gopalan et al.(2012) Ortiz-Molina & Phillips (2014)
Cash flow volatility		
CoVCFV	The standard deviation of past 9 years' operating cash flow scaled by the absolute value of the mean over the period	Barnes (200), Minton and Schrand (1999), and Minton, Schrand and Walther (2002)
SalesCFV	Standard deviation of past 9 years' operating cash flow scaled by the firm's sales	Huang (2009)
BECFV	Standard deviation of past 9 years' operating cash flow scaled by the firm's book equity	Huang (2009)
Control variables		
M_to_Book	Market value of asset to total assets	Keefe and Yaghoubi (2016)
BookLev	Firm's total liabilities divided by total assets	Ortiz-Molina and Phillips (2014), Keefe and Yaghoubi (2016)
FA_to_TA	Firm's fixed assets divided by total assets	Ortiz-Molina and Phillips (2014), Keefe and Yaghoubi (2016)
FirmSize	Natural log of the firm's total assets	Keefe and Yaghoubi (2016)
ROE	Return on Equity	Ortiz-Molina and Phillips (2014)
RDexp	Natural logarithm of one plus R&D expenditures scaled by sales	Ortiz-Molina and Phillips (2014)
FirmAge	Number of years since the firm has been first listed	Keefe and Yaghoubi (2016)
Grouping variables		
Relative book leverage	Firms book leverage (total liabilities and debt / total assets) minus the industry median book leverage	
Relative market leverage	Firms market leverage (total liabilities and debt / total liabilities and debt + market capitalization) – industry median market leverage	

3.3.2 Sampling

The sample is drawn from worldwide listed companies for which data is available on Orbis. Orbis is an international database that has information of around 300 million companies from all countries. The database sources the information from over 160 different providers, adding value by standardizing the data to an Orbis format and linking it together. Orbis shows the most recent data available and has a large scale 10-year history.

The data is collected in may 2019, at that moment of time Orbis reports an amount of 1,881,042 companies. Following previous studies related to the area of corporate finance, firms that operate in the financial sector and utility firms are excluded from the sample. The firms are excluded based on Standard Industrial Classification (SIC) codes, 6000-6999 for financial firms and 4900-4999 for the utility industry. Firms from these sectors are excluded from the sample because variety within the estimates of the dependent variable are most likely caused by different determinants compared to non-financial/utility firms (Fama & French, 1992). This step in the sampling procedure results in a sample size of 1,445,675 firms. Next, firms are selected on a current market capitalization value of at least zero, which filters out firms with a negative market value of equity and reduces the sample to firms that are publicly listed at the moment of data collection, which is a necessity in order to calculate the firm's implied cost of equity capital. As most firms in Orbis are private firms, this filter reduces the sample size to 40,824. Furthermore, firms with negative book values of assets and negative values of sales, and firms with missing data on the last available amount of total assets, cash and cash equivalents, fixed assets, tangible fixed assets, current assets, total liabilities and debt, sales, R&D expenses and current share price are removed from the sample. This brings the sample size down to 20,808 firms. Data on historical cash flows is needed to calculate the amount of cash flow volatility, therefore firms are required to have non-missing values of cash flow for the last available year up to the last available year minus nine. This filter results in a dataset of 16,482 firms.

To calculate the implied cost of equity capital, one of the assumptions is that the (forecasted) book values per share are positive numbers to prevent the present values of forecasted earnings per share to turn negative (as the forecasted earnings per share is calculated as the forecasted return on equity multiplied by book value per share of the previous year). Besides the notion that a negative book value per share is a very unusual situation, it turns the implied cost of equity capital formula into an unsolvable equation. Another assumption to calculate the implied cost of equity capital is that an earnings per share estimate of the next two years is given and that the earnings per share for year three is given or calculated. Following Gebhardt et al. (2001), the *EPS* estimate of year three can only be calculated if the estimates of year one and two are positive (by applying the growth rate between year one and two to year two). Therefore, firms with negative (forecasted) book values per share and firms with missing values of earnings per share estimates for year one, two and three (either calculated or not), are removed from the sample. This step brings the sample size down to 6,034. Lastly, following Gode and Mohanram (2003), Guay et al. (2011), and Schlingemann, Stulz and Walkling (2002) the sample is restricted to firms with total assets of at least $100 million to ensure that very small firms do not disproportionately influence the results, setting the size of the final sample on 5,721 firms. Table 3 summarizes the outcome of the sample selection method.

Table 3: Sample selection method

Number of excluded firms	Criteria	Sample size
0	All active companies in Orbis	1,881,042
435,367	Financial and utility firms	1,445,675
1,404,851	Current market capitalization <0	40,824
20,016	Negative total assets or sales, or missing values	20,808
4,326	Missing historical values of cash flow	16,482
10,448	Negative (forecasted) book value per share, or missing values of one, two, or three-year ahead EPS estimates	6,034
313	Total assets <$100 million	5,721

Sample distribution

The research measurements applied in this study induce a sample restriction that is caused by the availability of earnings per share data. As can be derived from the sample selection method (table 3), this restriction reduces final sample size with 10,448 firms (approximately 63%). This subsection examines the distribution of the sample and examines the impact of the EPS data requirement on the sample distribution. The next subsection elaborates the limitations induced by this restriction.

Table 4 reports the distribution of the sample among the 48 industries as classified by Fama and French (1997). Column 1 reports the distribution of the final sample. Most firms are active in the business services industry (587 firms, 10.3%), followed by the electronic equipment industry (358 firms, 6.3%) and the machinery industry (321 firms, 5.6%). Apart from the industries that are removed from the sample by forehand, the industries with the smallest representation in the sample are the firms in the defense industry (2 firms, <0.1%), tobacco industry (13 firms, 0.2%) and the shipbuilding and railroad equipment industry (21 firms, 0.4%).

Column 3 reports how the sample has changed due to the restriction caused by the requirement of the EPS data. In a relative sense, this requirement reduces the number of firms in the sample the most for the firms in the textiles industry (87%), fabricated products industry (78%) and the defense industry (78%). These industries are characterized by the lowest availability of EPS data. The industries that are characterized by the highest availability of EPS data are the aircraft, precious metals and tobacco industries. The number of firms in these industries respectively are reduced by 38%, 42%, and 43% as a result of the EPS data requirement. From columns 1 and 2, it can be derived that the EPS data requirement slightly changes the distribution of the final sample. For example, the aircraft (textiles) industry represents 0.5% (1.1%) in the final sample, compared the 0.3% (3%) in the less restricted sample. Overall, the original distribution of the sampled firms across the different industries remains largely intact, which is visually presented by figure 2 and 3 in Appendix A.

Table 4: Sample distribution by industry

		(1) Final Sample		(2) Sample before EPS filters		(3) Change in sample	
Fama and French (1997) Industry Classification		Number	Percentage	Number	Percentage	Number	Percentage
1	Agriculture	63	1,1	268	1,6	-205	-76%
2	Food Products	186	3,3	598	3,6	-412	-69%
3	Candy & Soda	39	0,7	104	0,6	-65	-63%
4	Beer & Liqour	60	1	128	0,8	-68	-53%
5	Tobacco Products	13	0,2	23	0,1	-10	-43%
6	Recreation Products	47	0,8	145	0,9	-98	-68%
7	Entertainment Services	81	1,4	202	1,2	-121	-60%
8	Printing and Publishing	57	1	141	0,9	-84	-60%
9	Consumer Goods	150	2,6	456	2,8	-306	-67%
10	Apparel (clothes)	68	1,2	235	1,4	-167	-71%
11	Healthcare	50	0,9	131	0,8	-81	-62%
12	Medical Equipment	69	1,2	159	1	-90	-57%
13	Pharmaceutical Products	248	4,3	624	3,8	-376	-60%
14	Chemicals	288	5	870	5,3	-582	-67%
15	Rubber and Plastic Products	75	1,3	295	1,8	-220	-75%
16	Textiles	65	1,1	487	3	-422	-87%
17	Construction Materials	244	4,3	773	4,7	-529	-68%
18	Construction Services	211	3,7	638	3,9	-427	-67%
19	Steel Works	155	2,7	568	3,5	-413	-73%
20	Fabricated Products	25	0,4	113	0,7	-88	-78%
21	Machinery	321	5,6	851	5,2	-530	-62%
22	Electrical Equipment	112	2	363	2,2	-251	-69%
23	Automobiles and Trucks	178	3,1	459	2,8	-281	-61%
24	Aircraft	31	0,5	50	0,3	-19	-38%
25	Shipbuilding, Railroad Equipment	21	0,4	49	0,3	-28	-57%
26	Defense	2	0	9	0,1	-7	-78%
27	Precious Metals	72	1,3	125	0,8	-53	-42%
28	Non-Metallic and Industrial Metal Mining	91	1,6	193	1,2	-102	-53%
29	Coal	40	0,7	71	0,4	-31	-44%
30	Petroleum and Natural Gas	214	3,7	396	2,4	-182	-46%
31	Utilities	0	0	0	0	0	0%
32	Communication	208	3,6	435	2,6	-227	-52%
33	Personal Services	51	0,9	152	0,9	-101	-66%
34	Business Services	587	10,3	1,671	10,2	-1,084	-65%
35	Computers	89	1,6	335	2	-246	-73%
36	Electronic Equipment (Chips)	358	6,3	1,178	7,2	-820	-70%
37	Lab Measuring and Control Equipment	93	1,6	208	1,3	-115	-55%
38	Business Supplies	80	1,4	285	1,7	-205	-72%
39	Shipping Containers	26	0,5	107	0,7	-81	-76%
40	Transportation	293	5,1	627	3,8	-334	-53%
41	Wholesale	243	4,2	878	5,3	-635	-72%
42	Retail	293	5,1	608	3,7	-315	-52%
43	Restaurants, Hotels, Motels	110	1,9	370	2,3	-260	-70%
44	Banking	0	0	0	0	0	0%
45	Insurance	0	0	0	0	0	0%
46	Real Estate	0	0	0	0	0	0%
47	Financial Trading	0	0	0	0	0	0%
48	Others	14	0,2	62	0,4	-48	-77%
Total		5,721	100	16,440	100	-10,719	-65%

Notes: This table reports the distribution of the sampled firms among the 48 Fama and French (1997) industries. Column 1 reports the distribution of the final sample, column 2 reports the distribution of the sample before firms are filtered on the availability of EPS numbers, and column 3 reports the absolute and relative change in the number of firms per industry after adjusting for EPS availability as reported in section 3.3.2.

Sample limitations

All sample selection criteria induce potential bias, two methodological details merit discussion before proceeding. First, apart from firms with missing last year available values, 4,326 firms are omitted from the sample due to missing historical values of cash flow. Excluding these observations from the analysis could induce a potential survivorship bias. Survivorship bias is a form of selection bias caused by the logical error of concentrating on the firms that made it past the selection process and overlooking those that did not. Restricting to firms that are successful enough to be able to report cash flow values of the past nine years could induce the potential survivorship bias. Specifically, because non-survivors more likely are relatively poor performers which gets translated into more risk bearing investments for which investors want to be compensated, resulting in higher costs of equity capital estimates. Excluding these observations leads to a downward bias in implied cost of equity capital estimates to the extent that firms with more volatile cash flows or more illiquid assets drop out of the sample at a disproportionate rate. This pattern could bias the results in favor of finding less significant relationships between cash flow volatility and/or asset liquidity and the implied cost of equity capital. Moreover, the direction of the bias could weaken the results in finding effects of asset liquidity as natural hedge to the impact of cash flow volatility. However, according to Lakonishok, Shleifer and Robert (1994) and Porta (1996), survivorship biases should be less important for larger stocks. The reason for this is that “there is a strong inverse relationship between unfavorable mortality and size” (Queen & Roll, 2006, p.12). These theories are supported by studies similar to this one, which mention that adjusting for survivorship bias generates similar results (e.g.: Welch, 2004; McInnis, 2010).

Second, 10,444[8] firms are removed from the sample because of missing earnings per share forecasts, which means JCF/Orbis doesn’t cover *EPS* estimates for roughly two-third of the sampled firms. Previous studies relying on *EPS* estimates report similar limitations, mentioning that this phenomenon is partly due to the database missing information on some firms’ analysts, but that this mostly is a reflection of the reality that many firms are simply not covered by analysts (Hong, Lim, & Stein, 2000). Diether, Christopher and Scherbina (2002), Hong et al. (2000), Hou et al. (2012), and Porta (1996) mention that samples restricted to analyst coverage underrepresent small firms and firms that are financially distressed. As mentioned in the previous subsection, in line with previous studies, small firms are removed from the sample already, diminishing potential biases caused by analyst coverage due to firm size. However, the underrepresentation of financially distressed firms induces a potential bias in the results. Similar to survivorship bias mentioned before, this potential bias reduces the fraction of firms with higher cost of equity capital estimates. Moreover, financially distressed firms might suffer relatively hard from cash flow volatility as covering up shortages in internally generated funds is more difficult. These are the firms that might benefit the most from operating flexibility or asset liquidity, as is explained in the theoretical framework. Therefore, the potential bias caused by analyst coverage could weaken the results in finding significant relations in favor of the hypotheses.

To conclude, the sample selection method induces several potential biases as it leaves out firms with heterogeneous characteristics explaining the dependent variable. As explained, the biases are most likely to work against the results, which increases the likelihood that the bias would cause the results to be understated.

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[8] Table 3 reports 10,448 removed cases, 4 are removed due to yielding negative (forecasted) book value(s) per share

3.3.3 Data collection

To perform the previous described research approach, a vast amount of data is required. Therefore, this study exclusively utilizes secondary data as it is a time-efficient and accessible method for the collection of large datasets. The data is collected from Orbis, a database of Bureau Van Dijk which sources the data from over 160 providers using a multitude of data sources, typically national and/or local public institutions collecting data to fulfill administrative and/or legal requirements. The Orbis database organizes these public data from administrative sources and filters them into various standard formats to facilitate searching and company comparison. The Orbis database is used in a wide variety of global academic business studies that are published in leading economic journals (e.g.: Altman, Iwanicz-Drozdowska, Laitinen, & Suvas, 2017; Bloom, Mahajan, Mckenzie, & Roberts, 2010; Cavaco & Crifo, 2014; Croci, Doukas, & Gonenc, 2011; Dierkes, Erner, Langer, & Norden, 2013; Laitinen & Suvas, 2013; S. Li, Park, & Bao, 2014; Mateus, Hall, & Mateus, 2015; Paniagua, Rivelles, & Sapena, 2018). Within this study, Orbis is used to collect data that can be distinguished in three broad streams; (1) firm-specific financial activities and performance, (2) industry-wide financial activities and performance, and (3) firm-specific share performance and expectations.

The first stream of data, the firm-specific financial activities and performance, refers to all information that can be derived from firms' financial statements. Orbis sources these data points in published annual reports. This type of data is available for roughly all companies, whereas publicly listed companies are obliged to publish their annual reports at least once a year. To ensure uniformity and comparability between financial statements prepared by different companies, a set of international rules and guidelines are in use. It is clear that global comparability may be a problem when administrative firm-level data are pooled. While in administrative data the definition of variables is usually less harmonized, this is less of a problem in the Orbis database because of the common international format of balance sheets (Laitinen & Suvas, 2013). Therefore, Orbis provides a useful database for this study. The data from the database is randomly cross-checked in annual reports to ensure that the information is correct.

The second stream of data refers to industry-wide financial activities and performance, which can be divided in two substreams. Firstly, it refers to accumulative firm-specific data which is added together on the basis of 4-digit US SIC codes, 3-digit US SIC codes or the 48 industry classification of Fama and French (1997), depending on the variable for which it is calculated. As in the first stream of data, this dataset comes from annual reports and suffers from the same limitations. Secondly, industry-wide data is collected regarding M&A activity in the past five years. This data is collected from Orbis, which sources the data from Zephyr. Zephyr is a database describing worldwide mergers and acquisitions, IPOs, and private equity deals, currently filing over a million completed, announced and rumored deals. Historically, Thomson Reuters' Securities Data Company M&A (SDC) has been the reference database for empirical research in the field of mergers and acquisitions. Data in SDC dates back to 1965. Zephyr is a relative newcomer on the academic market, with a history of deals that goes back to 1997 (Bollaert & Delanghe, 2015). While Zephyr is less referenced in the M&A literature than SDC, it is used in recent papers published in top journals (e.g.: Bettinazzi & Zollo, 2017; Craninckx & Huyghebaert, 2011; De Beule & Duanmu, 2012; Dikova & Rao Sahib, 2013; Huyghebaert & Luypaert, 2010; von Eije & Wiegerinck, 2010). In this study, the Zephyr database is used as information can easily be acquired and combined with data from Orbis, as both databases are commercialized by Bureau Van Dijk.

The third stream of data refers to the firm-specific share performance and expectations, expressed in share prices and earnings per share estimates. This data is collected from Orbis, which sources the data from Factset JCF International (JCF). JCF is an internationally re-known platform used by the financial and banking industry and is a growing competitor for I/B/E/S (Lara, Osma, & Noguer, 2006). The company offers several products through which different types of analysts' forecasts data can be retrieved. To provide EPS forecasts, JCF gathers estimates and recommendations from analysts and calculates consensus using only those EPS estimates changed or actively validated within the last 75 days. Within the finance literature, IBES is considered as the normal research practice, however, JCF is used in recent academic finance studies (e.g.: Alves, Pope, & Young, 2009; Aubert, 2009; Aubert & Dumontier, 2011; Bessler, Becker, & Wagner, 2009; Bonini, Zanetti, Bianchini, & Salvi, 2010; Lara et al., 2006; Sahut, Gharbi, & Gharbi, 2011). This study utilizes the JCF database to collect firm-specific share performance and expectations data as this database is fully integrated in Orbis.

To summarize, all secondary data is collected from Orbis, which utilizes a variety of sources to gather this data. Orbis collects the firm-specific data used in this study from firm's annual reports, including firms' activity and performance data on industry level. Industry-specific M&A data used in this study is acquired by Orbis from Zephyr, an information solution containing M&A, IPO and private equity deals. Firm-specific share performance and expectations are provided by Orbis from JCF, which builds their forecasts on a consensus using EPS estimates changed or validated within the last 75 days.

4 Results

By testing three hypotheses, this study aims to answer the following research question *"To what extent does real asset liquidity moderate the effect of cash flow volatility on the cost of equity capital?"*. The previous chapter explains the research approach taken, in which the firm's implied cost of equity capital is the dependent variable. The independent variables are the firm's asset liquidity, the firm's cash flow volatility and a set of control variables. To present the results in a structured way, this chapter is divided in three parts. First, the univariate analysis provides an overview of the data used in the form of descriptive statistics, this part summarizes the data and elaborates the outlier treatment. Second, the bivariate analysis describes the individual relationships between the variables, supported by a correlation matrix. Third, the multivariate regression analysis presents the results of the OLS regressions. After presenting the assumption tests, this part reports the results of each hypothesis test individually after which several robustness checks follow.

4.1 Univariate analysis

After collecting the data and computing the data into the prescribed variables, the first step of the analysis is to check the univariate statistics and control for outliers. Appendix B reports the descriptive statistics of the variables before controlling for outliers. The upcoming subsections describe the outlier treatment and the descriptive statistics after controlling for outliers, which are summarized in table 5.

4.1.1 Outlier treatment

Underlying the question of how to treat outliers is the issue of whether a particular observation is an outlier. According to Hodge and Austin (2004), authors have proposed many definitions of an outlier with seemingly no universally accepted definition. Within this study, two definitions from prior literature are used to describe two types of outliers which are treated differently. First, the broad definition of Hawkins (1980) is used: *"An outlier is an observation which deviates so much from the other observations as to arouse suspicions that it was generated by a different mechanism"*. Secondly, the indication of Barnett and Lewis (1994) is used: *"an outlying observation, or outlier, is one that appears to deviate markedly from other members of the sample in which it occurs"*. Both definitions refer to points in the dataset that are considered an extreme value based on deviations from the sample. The difference between the definitions is that Hawkins (1980) explicitly mentions the suspicions that the deviation is caused by a different mechanism, which in this study is interpreted as a measurement error. The definition of Barnett and Lewis (1994) on the other hand purely focusses on the deviation, regardless of the underlying cause. The difference made here is essential as a suitable outlier treatment depends on the underlying cause. Within this study, a differentiation is made between two types of outliers, (1) outliers that are most likely caused by measurement errors or driven by mechanisms other than intended to measure and (2) outliers that are unlikely to be caused by measurement errors.

The first type of outlier is the outlier which is most likely caused by an error. This is the type of outlier that takes on a value which is unlikely or impossible to be legitimate, independent of the sample distribution. These are the values for which removal of the case is considered to be justified. Appendix B exhibits a summary of the descriptive statistics of the variables before the outlier treatment. The variables that are most likely to exhibit this type of outliers are the variables based on firm-specific data, whereas the variables based on industry data tend to average out extreme values. To check for the presence of this type of outliers, the minimum and maximum values of the variables are examined. Table 15 in Appendix B shows that the upper boundary of the balance sheet measures of liquidity and the upper boundary of the implied cost of equity measure captures values that are unlikely to be legitimate or most likely caused by mechanisms other than the variable intends to measure. For example, the maximum *WAL1*, which is a measure of cash and cash equivalents to last year's total assets, equals 1.753. This means that the amount of cash and cash equivalents is 1.753 times the amount of last year's total assets. Now, if the denominator was this year's total assets, this measure would surely be invalid. However, the denominator accounts for the amount of total assets the year prior to the year the cash and cash equivalents are measured. Therefore, the value 1.753 is either based on a measurement error or based on a case in which the firm grows so disproportionally fast that it distorts the intention of the variable to capture the asset structure. Another example is the implied cost of equity capital variable of which the highest value is equal to 1.21, implying a calculated estimate of the expected return on equity of 121%. Although extreme measures are not unusual in finance, an expected return on equity of 121% (even after mean reverting forecasted earnings per share) is most likely the outcome of a measurement error. Prior studies applying the formula of the implied cost of equity capital don't even search for values above 1 (100%). To account for these extreme values, most likely driven by errors or detrimental mechanisms, the variables *FirmICC, WAL1, WAL2, WAL3* and *MWAL* are trimmed at the 1st and 99th percentile. This method is believed to be the most suitable as it leaves the distribution from the 1st to the 99th percentile in tact while removing the most extreme outliers that don't capture the valid drivers.

The second group of outliers are the outliers that are less likely to be caused by measurement errors but are considered to be outliers purely based on the deviation from the sample. These are the values that are genuine but extreme, values of which Resnick (2007) points out to be not uncommon in finance. As these values are genuine, it is unjustified to remove them from the sample. However, OLS regressions are sensitive to outliers. As it is undesirable to let the regressions be determined by outliers, prior studies (e.g.: Gopalan et al., 2012; Guay et al., 2011; Huang, 2009; Keefe & Yaghoubi, 2016) are followed and all firm-specific accounting variables, apart from the variables that are already trimmed, are winsorized at the 0.1st and 99.9th percentile. Whereas prior studies differ in their decision of which cut-off point to choose, this study applies a wide cut-off point of 0.1%, as the most extreme cases are filtered out by forehand due to the minimum size filter and the trimming discussed above. This method allows the deviating values to retain their impact on the results but reduces the impact of the most extreme cases.

After controlling for outliers, the most extreme cases have been removed or limited by means of trimming and winsorizing. This has led to a set of variables which are comparable to findings in prior studies. The next subsection describes the univariate statistics in more detail and, in the light of outlier detection, compares the results with previous studies.

4.1.2 Descriptive statistics

The previous subsection outlined the outlier treatment, table 5 presents the summary statistics for the variables in the final sample after accounting for outliers. Table 5 reports the measures of central tendency (mean, median) and variability or spread (standard deviation, quartiles and min/max values). Consecutively, the dependent, independent and control variables are explained and compared to previous studies if available.

Table 5: Descriptive statistics after outlier treatment

Dependent variables	**Mean**	**SD**	**Min**	**Q1**	**Median**	**Q3**	**Max**	**N**
FirmICC	0.079	0.033	0.011	0.056	0.076	0.099	0.261	5519
FirmICC_pm	0.076	0.031	0.008	0.055	0.074	0.094	0.250	5519
Independent variables	**Mean**	**SD**	**Min**	**Q1**	**Median**	**Q3**	**Max**	**N**
Asset liquidity								
PotBuy_N	24922	51124	41	2167	5080	21606	319747	5519
PotBuy_FS	0.559	0.087	0.237	0.495	0.548	0.614	0.877	5519
Tot_MA	0.017	0.033	0.000	0.008	0.013	0.019	0.759	5519
WAL1	0.133	0.117	0.000	0.048	0.099	0.182	0.700	5519
WAL2	0.318	0.157	0.020	0.199	0.304	0.419	0.915	5519
WAL3	0.560	0.173	0.103	0.447	0.565	0.677	1.177	5519
MWAL	0.385	0.205	0.042	0.223	0.357	0.514	1.167	5519
Cash flow volatility								
CoVCFV	0.520	0.328	0.062	0.280	0.433	0.673	2.147	5519
SalesCFV	0.063	0.131	0.002	0.020	0.034	0.065	2.587	5519
BECFV	0.089	0.168	0.008	0.035	0.055	0.090	3.726	5519
Control Variables	**Mean**	**SD**	**Min**	**Q1**	**Median**	**Q3**	**Max**	**N**
BookLev	0.496	0.186	0.009	0.357	0.502	0.631	0.997	5519
FA_to_TA	0.535	0.206	0.004	0.387	0.534	0.695	0.979	5519
FirmSize	21.352	1.574	18.421	20.163	21.232	22.392	27.000	5519
M_to_Book	2.661	3.976	0.092	1.009	1.656	2.980	66.685	5519
ROE	12.186	20.691	-168.706	5.724	10.430	16.681	314.422	5519
RDexp	0.018	0.045	0	0	0	0.013	0.597	5519

Notes: This table reports the summary statistics for the measures of cost of equity capital, asset liquidity, cash flow volatility and the control variables after outlier treatment. The summary statistics before outlier treatment can be found in Appendix B. The sample covers the position of listed firms as is measured in may 2019 and excludes both financial firms and utilities. Firms with missing values, firms for which the ICC cannot be calculated and firms with total assets < $100m are excluded from the sample. All variable definitions are listed in table 2.

The main variable within this study is the implied cost of equity capital *(FirmICC)*, a continuous variable that functions as the dependent variable. The mean *FirmICC* is 0.079 which indicates an implied cost of equity capital, or estimated return on equity, of 7.9%. Ortiz-Molina and Phillips (2014) reports an implied cost of equity capital of 0.099, based on a sample that spans the period 1984-2006. Although the mean of this study's sample is somewhat lower than the mean measured by Ortiz-Molina and Phillips (2014), it is perfectly in line with the implied cost of equity capital as presented by Groenendijk, Engelbrecht and Van Baardwijk (2018) on behalf of KPMG International Cooperative[9]. Groenendijk et al. (2018) report the implied equity returns for a number of major equity markets over time. Appendix C contains the graph as presented by Groenendijk et al. (2018) showing a downward trend in implied equity returns from approximately 9% in 2006 to approximately 8% in December 2018, which fits both, the mean *FirmICC* in this study and in the study of Ortiz-Molina and Phillips (2014). Furthermore, the standard deviation of *FirmICC* in this study (0.033) also is, in line with the mean value, somewhat lower compared to Ortiz-Molina and Phillips (2014). The medians (0.076 and 0.107) are in both studies close to the mean values, indicating a fairly symmetrical distribution. The mean (0.076), median (0.074) and standard deviation (0.031) values of the implied cost of equity capital using the stock price measured a month earlier *(FirmICC_pm)*, to correct for potential measurement errors due to sluggish analyst forecast revisions, are comparable with the *FirmICC* values.

Next, a set of seven variables are computed to estimate the liquidity of a firm's assets. The first three variables are estimates based on values of the industry the firm is active in. The first measure, *PotBuy_N*, captures the number of potential buyers for a firm's assets as indicated by the peer group size of the firm. This is a continuous variable with a mean value of 24,921, indicating that, on average, a firm has 24,921 potential asset buyers. The median and standard deviation are respectively 5,080 and 51,123, indicating a right skewed distribution. The second measure, denoted as *PotBuy_FS*, is a continuous variable that captures the financial slack of potential buyers, as defined by the average book leverage net of cash, averaged over the past 5 years. The mean *PotBuy_FS* value is 0.559, indicating that the average potential buyer of the sampled firm has a book leverage net of cash of 55.9%. The median and the standard deviation are respectively 0.548 and 0.087, indicating a fairly symmetrical distribution. Lastly, *Tot_MA* captures the historical liquidity of a firm's assets using the value of M&A activity in the firm's industry scaled by industry assets. The mean *Tot_MA* value is 0.017, indicating that, averaged over all firms in the sample, the value of completed mergers, acquisitions and minority stakes in the firm's industry averaged over the last 5 year equals 1.68% of the 5-year-average total value of the industry's assets. With a median value of 0.013 and a standard deviation of 0.033 the distribution is skewed to the right.

The latter four variables that measure the liquidity of a firm's assets are firm-level balance sheet measures. Based on their liquidity level, a liquidity score is assigned to the fraction of different types of assets as scaled to the lagged value of total assets. The variables are *WAL1, WAL2, WAL3,* and *MWAL*, and are of a continuous nature. The first variable, *WAL1,* has a mean value of 0.133, indicating that on average the fraction of a firm's cash and cash equivalents as denoted in the balance sheet is 13.3% of the lagged value of total assets. The median is 0.099 and the standard deviation is 0.117. Gopalan et al. (2012) reports a mean value of 0.142 with a median of 0.065 and a standard deviation of 0.196. In this study, the mean and median are somewhat

[9] KPMG is one of the 'Big Four' accounting organizations, with headquarters in Switzerland and the Netherlands, and is organized in three service lines: financial audit (39%), advisory (39%) and tax (22%).

higher and relatively closer to each other, besides, the standard deviation is somewhat smaller in an absolute and relative sense. Therefore, although the mean values are not very different, the median and standard deviation indicate a distribution that still is right skewed but at a lower rate than Gopalan et al. (2012) reported. The mean value of *WAL2* is 0.318 with a median of 0.304 and a standard deviation of 0.157. These values are almost similar to the values reported by Gopalan et al. (2012), who respectively report values of 0.322, 0.301 and 0.236. The standard deviation in this study is somewhat smaller which indicates a smaller dispersion around the mean. With *WAL3* mean, median and standard deviation values of respectively 0.560, 0.565 and 0.173, *WAL3* is similarly related to the results of Gopalan et al. (2012) as *WAL2,* who respectively report values of 0.664, 0.640 and 0.237. Both studies report values that indicate a virtually normal distribution. The *MWAL* variable is a measure of weighted liquid assets scaled to the lagged market value of total assets. The mean value is 0.385, the median is 0.357 and the standard deviation is 0.205. Gopalan et al. (2012) respectively reports values of 0.507, 0.501 and 0.237, which are somewhat higher than the values in this study. Both studies show a distribution that is slightly skewed to the right and both studies report a standard deviation that approximates half the size of the mean value.

The second set of independent variables aim to measure the volatility of cash flows. The variables *CoVCFV, SalesCFV,* and *BECFV,* are all measures of cash flow volatility, calculated as the standard deviation of past nine years annual cash flows scaled to a factor of firm size. The first measure, *CoVCFV,* scales the standard deviations of cash flow to the absolute cash flow mean, which is an application of the coefficient of variation technique. The mean value is 0.520, which indicates that on average the standard deviation of the past nine years cash flows equals 52% of the absolute mean value of the cash flows. The median is 0.433 and the standard deviation is 0.328, which indicates a right skewed distribution. The variable *SalesCFV* applies the value of sales as a proxy for firm size. The mean value is 0.063, the median is 0.035 and the standard deviation is 0.131. On average the standard deviation of the past nine years' cash flows equals 6.26% of the total amount of sales, the distribution is right skewed and has, compared to the *CoVCFV* variable, a wider dispersion around the mean. *BECFV* proxies the firm size by the book value of equity. The mean value of *BECFV* is 0.089, the median is 0.055 and the standard deviation is 0.168. Similar to the variables *SalesCFV, BECFV* is more right skewed and has a wider dispersion around the mean than *CoVCFV.* Although the descriptive statistics are incomparable with the closest related previous studies, as Minton and Schrand (1999) do not report the statistics and Huang (2009) only reports statistics based on quarterly winsorized and industry adjusted *(BECFV)* cash flows over a longer period, dispersion and skewness (as indicated by mean to standard deviation and mean to median ratios) of the of cash flow volatility measures as reported by Huang (2009) and Keefe and Yaghoubi (2016) mostly are comparable with the dispersion and skewness noticed in this study's sample. For example, the standard deviation of cash flow volatility scaled to sales as reported by Huang (2009) is 4.4 times the variable's mean value, whereas this study reports a standard deviation to mean ratio for *SalesCFV* of 4.8.

Next, to separate the effects of potential confounding variables from those of the independent variables of interest, a set of control variables is taken into account. The first variable, *BookLev,* captures the book leverage to account for the effects of capital structure. The mean value is 0.496 which is close to the mean value of Schlingemann et al. (2002) who report a mean of 0.540, the median is 0.502 and the standard deviation is 0.186, indicating a virtually normal distribution around the mean. The *FA_to_TA* variable accounts for the degree of asset tangibility indicated by the ratio of fixed assets to total assets. The mean value is 0.535 indicating that the average firm has an asset structure consisting of 53.5% fixed assets and 46.5% non-fixed assets. The median is 0.534 and the standard deviation is 0.206, indicating a normal distribution among the sample. The mean value is somewhat higher than reported by Ortiz-Molina and Phillips (2014), who report a value of 0.3. This might be due to the sampling strategy as Ortiz-Molina and Phillips (2014) do not restrict the sample to firm size, allowing the smallest firms to take part in the analysis. In this study's sample, smaller firms tend to have smaller *FA_to_TA* ratios, therefore it is reasonable that the mean value is lower compared to the mean reported by Ortiz-Molina and Phillips (2014). *FirmSize* is the subsequent variable with a mean of 21.35, a median of 21.23 and a standard deviation of 1.57, this is a continuous variable measured as the natural logarithm of firm size. The natural logarithm is used to deemphasize the relatively larger values in the regression. The values are unexplainably higher than reported by Keefe and Yaghoubi (2016), who are used as the source of this variable, reporting values of respectively 4.642, 4.500 and 2.060. Comparing the values with another study using the natural logarithm of total assets as a proxy for firm size, Doğan (2013) reports values of respectively 19.57, 19.37 and 1.516. These values are somewhat lower than the values in this study, probably due to the firm size restriction applied in this study. Nevertheless, in both studies the mean is slightly higher than the median and the standard deviations account for approximately 7.5% of the mean value. The mean market-to-book value is slightly higher than reported by Keefe and Yaghoubi (2016) and Huang (2009). With a value of 2.661, a median value of 1.656 and a standard deviation of 3.975, most firms have a higher market value than book value which is an indication for growth opportunities. After winsorisation, the minimum market-to-book value is 0.092 and the maximum is 66.685. Although these numbers seem exceptional compared to the mean value, they are ordinary when comparing them with prior studies such as Huang (2009) who report minimum and maximum market-to-book values of respectively 0.00 and 2283.28. The *ROE* measure is a proxy for profitability. The mean value is 12.186, the median is 10.430 and the standard deviation is 20.691, indicating that the average firm in the sample has an annual net income equal to 12.19% of the value of equity. The minimum and maximum *ROE* values are respectively -168.706 and 314.422, which is approximately -14 and 26 times the mean value. These high values are usual when the comparison is made with prior studies as, for example, Huang (2009) denotes minimum and maximum profitability values which are -40 and 66 times the mean value. Resnick (2007) emphasizes that extreme values are not uncommon in finance. Lastly, the mean value of the natural logarithm of one plus the research and development expenses is 0.018, with a median of 0 and a standard deviation of 0.045. The median is 0 as most firms (59.2%) do not have any (reported) R&D expenses.

4.2 Bivariate analysis

To provide an overview of the data and find patters in relationships among various variables, table 6 shows the results of the Pearson correlation matrix. This section outlines (1) the relationships between the independent variables and the dependent variables, (2) the relationships between variables within the following variable groups; dependent variables, asset liquidity variables, cash flow volatility variables and control variables, lastly, this section reports (3) strong or remarkable relationships between any variables that are worth mentioning.

Table 6: Correlation matrix

	Variables	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
1	*FirmICC*	1																		
2	*FirmICC_pm*	.975**	1																	
3	*PotBuy_N*	-.068**	-.069**	1																
4	*PotBuy_FS*	-.145**	-.141**	-.171**	1															
5	*Tot_MA*	-.066**	-.064**	.047**	.110**	1														
6	*WAL1*	-.131**	-.139**	.052**	.187**	.050**	1													
7	*WAL2*	-.080**	-.090**	.030*	.157**	.022	.765**	1												
8	*WAL3*	.022	.007	-.032*	.026	-.021	.528**	.799**	1											
9	*MWAL*	.551**	.561**	-.056**	-.152**	-.082**	.117**	.274**	.471**	1										
10	*CoVCFV*	.125**	.117**	-.055**	.074**	.044**	.054**	.045**	.029*	.030*	1									
11	*SalesCFV*	.070**	.069**	-.072**	.059**	.028*	.003	-.134**	-.101**	-.035**	.396**	1								
12	*BECFV*	.045**	.025	.002	-.050**	-.007	-.032*	-.068**	-.070**	-.087**	.325**	.301**	1							
13	*BookLev*	.123**	.122**	.092**	-.253**	-.060**	-.274**	-.186**	-.158**	.038**	.024	-.109**	.271**	1						
14	*FA_to_TA*	.030*	.040**	-.015	-.105**	-.006	-.484**	-.890**	-.689**	-.287**	-.003	.187**	.049**	.116**	1					
15	*FirmSize*	.076**	.083**	-.047**	-.144**	-.083**	-.180**	-.279**	-.275**	-.005	-.156**	-.042**	.015	.339**	.281**	1				
16	*FirmAge*	.001	.000	-.014	-.055**	-.059**	-.045**	-.024	-.006	.130**	-.180**	-.068**	-.027*	.028*	.007	.190**	1			
17	*M_to_Book*	-.334**	-.338**	.080**	.065**	.044**	.106**	.099**	.032*	-.384**	-.041**	-.028*	.412**	.155**	-.060**	-.030*	-.035*	1		
18	*ROE*	-.179**	-.180**	.049**	-.015	.003	.080**	.090**	.076**	-.205**	-.065**	-.048**	.207**	.086**	-.052**	.047**	.008	.509**	1	
19	*RDexp*	-.103**	-.105**	-.095**	.338**	.065**	.152**	.127**	-.012	-.158**	.090**	.108**	.007	-.134**	-.085**	.025	.039**	.098**	-.043**	1

Notes: This table reports the correlations between the key variables used in the analysis. Coefficients marked with two asterisks (**) are significant at the 1% level, coefficients marked with one asterisk are significant at the 5% level (both 2-tailed). The sample covers the position of listed firms as is measured in may 2019 and excludes both financial firms and utilities. Firms with missing values, firms for which the ICC cannot be calculated and firms with total assets < $100m are excluded from the sample. All variables are listed in table 2.

Starting with the relationships between the independent variables and the dependent variables, some results are more surprising than others. First, the variables that measure cash flow volatility (*CoVCFV, SalesCFV and BECFV)* show a weak positive relationship with the implied cost of equity capital (*FirmICC)* that is significant at the 1% level and in line with hypothesis 1. Two out of three relationships remain similar after replacing the dependent variable with the implied cost of equity measured with the stock price of one month before *(FirmICC_pm), BECFV* turns insignificant.

Second, 5 out of 7 variables that capture the liquidity of a firm's assets are, in line with hypothesis 2, negatively correlated with the implied cost of equity capital. The variables that are negatively correlated with the implied cost of equity capital are *PotBuy_N, PotBuy_FS, Tot_MA, WAL1,* and, *WAL2,* and all show a weak negative correlation that is significant at the 1% level. The relationship between *WAL3* and the implied cost of equity capital is insignificant and the relationship between *MWAL* and the implied cost of equity capital is moderate positive and significant at the 1% level. Among the book-value-based asset liquidity measures *(WAL1, 2 and 3)*, there is a pattern showing that an increase in the value added to less liquid assets results in a decrease in the strength of the relationship with the implied cost of equity capital. This pattern ultimately leads to the insignificant relationship between *WAL3*, that attaches the most value to the lesser liquid assets, and the implied cost of equity capital. The relationship between *MWAL* and the implied cost of capital *(FirmICC)* is driven by the market valuation of assets as both show a moderate negative relationship with the market-to-book ratio *(M_To_Book)*[10].

Third, the control variables vary in the type, strength and significance among the relationships with the dependent variable. *BookLev* and *FirmSize* show a weak positive relationship with the implied cost of equity capital at the 1% significance level. The measure of asset tangibility *(FA_to_TA)* shows a very weak positive relationship with the dependent variable at the 5% significance level. Firm age is unrelated to the implied cost of equity capital. The market-to-book ratio, *(M_to_Book),* R&D expenditures *(RDexp),* and the return on equity *(ROE)* measures are all weak to moderate-weak and negatively related to the implied cost of equity capital *(FirmICC)* at a 1% significance level.

Next, continuing with the relationships among variables within the different groups of variables, this study utilizes two dependent variables *(FirmICC and FirmICC_pm)*. Both variables are, unsurprisingly, strong and positively correlated at the 1% significance level. Regarding the liquidity of assets, this study utilizes seven variables, of which three are industry-based and four are balance sheet-based. The industry-based measures of asset liquidity measure liquidity on the basis of contrasting aspects, which is confirmed by the data in showing weak relationships among each other. *PotBuy_N* shows a negative and weak correlation with *PotBuy_FS* and a weak positive correlation with *Tot_MA*, both at the 1% significance level. *PotBuy_FS* is weak and positively correlated with *Tot_MA* at the 1% significance level. The relationships among the balance sheet-based measures of asset liquidity are stronger as these variables measure asset liquidity on the basis of overlapping aspects. The three book value-based measures *(WAL1, 2, and 3)* are highly correlated with each other. *MWAL* is less correlated with the other measures, especially with *WAL1,* as a large fraction of the variation in *MWAL* is from changes in the market-to-book ratio as discussed above. Between the industry-based and balance sheet-based measures, the correlations vary. *WAL1* shows a weak positive correlation and *MWAL*

[10] Since a lot of variation in the market value measure of asset liquidity *(MWAL)* is driven by changes in market value of equity, more weight is put on the results with the book value measures.

shows a weak negative correlation with the industry-based measures, all at the 1% significance level. *WAL2* and *WAL3* show weak relations with the industry-based asset liquidity measures varying in type and significance.

Regarding the measures of cash flow volatility, there is less difference between the relationship among variables. All measures are moderate-weak positively correlated among each other at the 1% significance level, justifying the need to test the first hypothesis using different scalars as a proxy for firm size to estimate a comparable measure of cash flow volatility.

Within the group of control variables, almost all variables show a weak to moderate relationship. The variables that show the strongest correlations are *M_to_Book* and *ROE* (r=.509**), *FirmSize* and *BookLev* (r=.339**), and *Firmsize* and *FA_to_TA* (r=.281**). Remarkably, there appears to be a positive relationship between *BookLev* and *M_to_Book* (r=.155**), and *RDexp* is insignificantly correlated with *FirmSize* (r=.025).

With respect to the relationships between variables among different groups, there appears to be a pattern in correlations between balance sheet asset liquidity variables and cash flow volatility variables. When measured as the coefficient of variation *(CoVCFV)*, the relationship with balance sheet asset liquidity measures *(WAL1, WAL2, WAL3, and MWAL)* is consistently very weak and positive at a 1% or 5% significance level. When scaled to the firm's total sales or book value of equity *(SalesCFV, BECFV),* cash flow volatility appears to be stronger but negatively related with the balance sheet asset liquidity measures at the 1% significance level (except for the relationship with *WAL1,* which is insignificant *(SalesCFV)* or significant at the 5% significance level *(BECFV))*. Adding on this finding, the balances sheet structure control variables, *BookLev* and *FA_to_TA,* are significantly related to both, the balance sheet asset liquidity measures and the variables *SalesCFV* and *BECFV*. Whereas *CoVCFV* is exclusively related to the measures of asset liquidity rather than asset liquidity, asset tangibility and book leverage.

4.3 Multivariate regression analysis

The previous subsection outlines the bivariate relationships between all variables. To examine whether the relationships between the independent variables and the dependent variables hold while controlling for potential confounding variables, a multivariate regression technique is applied to test the hypotheses. As is outlined by Hair et al. (2009), the validity of the hypothesis tests depends on the extent to which the model's assumptions are met. Therefore, before elaborating the hypothesis tests, the next subsection describes the extent to which the assumptions are met. Subsequently, structured along the stated hypotheses, the results of the multivariate analyses are reported. Lastly, to identify whether the results change when assumptions change, several robustness tests are elaborated.

4.3.1 OLS Regression assumptions

Multivariate techniques are all based on a fundamental set of assumptions representing the requirements of the underlying statistical theory. Hair et al. (2009) mention the assumptions to be met are (1) the linearity of the phenomenon measured, (2) the normality of the error term distribution, (3) the lack of perfect multicollinearity and (4) the constant variance of the error terms.

The first assumption refers to the relationship between the independent and dependent variables and represents the degree to which the change in the dependent variable is associated with the independent variable. The assumption of linearity is checked by individually plotting the independent variables and the dependent variables in a scatterplot. From the visual examination, it becomes clear that there appears to be no relationship between *FirmAge* and *FirmICC*. The nonlinearity is robust for the use of the natural logarithm of *FirmAge.* Therefore, the variable *FirmAge* is not taken into account in the regression analyses. The relationships between the other independent variables and the dependent variables are linear. For the sake of brevity, the scatterplots are not reported.

The normality of the error term distribution, the second assumption, refers to the restriction that the residuals of the regression should follow a normal distribution. According the Hair et al. (2009), this assumption can either be tested by plotting a histogram of the residuals or by the application of a normal predicted probability (P-P) plot. Appendix D contains both the histogram and the normal P-P plot of the error term distribution in the multivariate regression in which *WAL1*, *CoVCFV* and all control variables are taken into account. The histogram shows a distribution that has the desired bell-shape, the normal P-P plot shows a distribution conform the normality line indicated in the plot. Therefore, it can be concluded that the assumption of normality is met. The histogram and the P-P plot remain similar after substituting *WAL1* and *CoVCFV* for any other asset liquidity or cash flow volatility measure, for brevity purposes only the first histogram and P-P plot are presented in appendix D.

The third assumption, the lack of perfect multicollinearity, refers to the correlation among the independent variables as a key issue in interpreting the regression variate. Multicollinearity reduces the impact of any single independent variable's predictive power by the extent to which it is associated with the other independent variables. Hair et al. (2009) elaborate several ways to identify multicollinearity. First, the most obvious way is to examine the correlation matrix for the independent variables. The presence of high correlations (generally .90 and higher) is the first indication of collinearity. From table 6 it becomes clear that apart from the correlation between *FA_to_TA* and *WAL2* (r=0.890**), no signs of multicollinearity are present. Second, by assessing a measure of multiple variable collinearity, the outcome can be compared with a common cutoff threshold. The variance inflation factor (VIF), is such a measure and is calculated as the inverse of the tolerance value, which is the amount of variability of the selected independent variable not explained by the other independent variables. Hair et al. (2009) mention a common cutoff threshold of 10, indicating that a VIF value higher than 10 is considered to be problematic. Appendix D reports the VIF values attached to the independent variables in all regressions applied, showing that the highest VIF score is just above 5 for the variables *FA_to_TA* and *WAL2*. Therefore, multicollinearity is not considered to be a problem. Nevertheless, it raises the question whether or not to retain asset tangibility *(FA_to_TA)* as a regressor, as *WAL2* measures partly the same. The goal of this study is to value the liquidity of a firm's assets as an explanatory measure of the implied cost of equity capital, in order to do this as accurate as possible, it is desirable to separate the effect of asset liquidity from asset structure. Therefore, despite the debatability considering the higher VIF values, the *FA_to_TA* is kept in the analysis.

Next, the fourth assumption refers to the term homoscedasticity, which is the assumption that the variance of the residuals is homogeneous across levels of the predicted values. According to Hair et al. (2009), this assumption can be checked by plotting the predicted values and residuals on a scatterplot. Any patterns on the scatterplot indicate heteroscedasticity, which is the circumstance of unequal variability of residuals across predicted values. Thus, heteroscedasticity is the absence of homoscedasticity, which is a violation of the OLS assumption. Appendix D contains the visual representation of the relationship between the predicted values and the residuals of the regression analysis in the form of a scatterplot. The scatterplot reports the results of *FirmICC* regressed on the *WAL1, CoVCFV* and control variables. Substituting the independent variables for other measures of asset liquidity or cash flow volatility yield similar results. As can be derived from the graph, there is a pattern in the relation between the predicted values and the residuals. Therefore, it can be concluded that the fourth assumption is violated.

According to Hayes and Cai (2007), White (1980) and Wooldridge (2012), violations of the homoscedasticity assumption can invalidate statistical inferences. The extend of the problem produced by heteroscedasticity depends on both the form and the severity of it. Heteroscedastic errors cause ordinary least squares estimates to be biased and inconsistent (Hayes & Cai, 2007). The net result is a type I error inflation or reduced statistical power for tests of hypotheses involving the regression coefficients, and inaccuracy of the estimates of the confidence intervals. Heteroscedasticity can take on different forms of patterns of errors and can be the result of a misspecified model or the modeling of bounded or limited outcome variables (Downs & Rocke, 1979; Perry, 1986). Lewis and Linzer (2005) elaborated on these findings, they state that quantities estimated from auxiliary data sets used as dependent variables, denoted as estimated dependent variables (EDV), often induce heteroscedasticity. The authors show that the most common approach to this problem, the weighted least squares, will usually lead to inefficient estimates and underestimated standard errors. Moreover, they show that ordinary least squares regressions with heteroscedastic consistent standard errors yield better results.

Reducing the effects of heteroscedasticity on inference by employing a heteroscedasticity-consistent standard error (HCSE) estimator of OLS parameter estimates is, according to Hayes and Cai (2007), a 'highly appealing' method. With this approach, the regression model is estimated using ordinary least squares, but an alternative method of estimating the standard errors is employed that does not assume homoscedasticity. The advantage of this method is that it requires neither knowledge about, nor a model of, the functional form of the heteroscedasticity (Hayes & Cai, 2007). Wooldridge (2012) even states that the use of an HCSE estimator in the OLS regression means that *'we can report new statistics that work regardless of the kind of heteroskedasticity present in the population'* (p. 269). Hayes and Cai (2007) elaborates the several HCSE estimators that are built upon the earlier work of White (1980), HC0 to HC4. Using both the OLS estimator and the four HC methods, Cribari-Neto, Ferrari and Oliveira (2005) and Long and Ervin (2000) evaluate the empirical power functions of the t-tests of the regression coefficients and suggest the superiority of the HC3 over its predecessors because '*it can keep the test size at the nominal level regardless of the presence or absence of heteroskedasticity'*, while there is only a neglectable loss of power associated with HC3 when the errors are indeed homoscedastic (Hayes & Cai, 2007).

Within this study, the heteroscedasticity is considered to be an impediment to valid inference. The heteroscedasticity is potentially caused by the fact that the dependent variable is partly estimated on the basis of industry median returns, making the model a multilevel model with an estimated dependent variable that generally exhibits heteroscedasticity, as is elaborated by Lewis and Linzer (2005). To overcome the heteroscedasticity, the HC3 heteroscedasticity-consistent standard error estimator, as developed by Hayes and Cai (2007), is utilized.

4.3.2 Main empirical results

The aim of this study is to provide an answer to the research question by testing three hypotheses. The hypotheses are (1) "Historical cash flow volatility is positively related to the cost of equity capital", (2) "Real asset liquidity is negatively related to the cost of equity capital, this effect is stronger for firms that are closer to financial distress", and (3) "Real asset liquidity reduces the effect of cash flow volatility on a firm's cost of equity capital, this effect is stronger for firms that are closer to financial distress". The hypotheses are tested by using heteroscedastic-consistent OLS regressions. Before applying the tests, informal univariate mean comparisons clarify the relevant association before the multivariate regressions are applied. The following subsections are structured among the three hypotheses and report the results of the hypothesis tests.

Cash flow volatility and the implied cost of equity capital

The first hypothesis tests whether cash flow volatility is related to the firm's implied cost of equity capital and whether this relationship has the expected positive sign. The main cash flow volatility measure utilized in this study is the standard deviation of past nine years' cash flows scaled to mean value of absolute cash flows (*CoVCFV*). Alternatively, two different scalars are applied to examine whether the relationship holds for alternative firm size proxies (*SalesCFV* and *BECFV*). The dependent variable is the firm's implied cost of equity capital, measured as the internal rate of return that equates the present value of expected future cash flows to the current stock price.

Before employing the multivariate regression analysis, the quintile mean comparison illustrates the first signs of a pattern or relationship on a univariate basis. Table 7 relates the firm's implied cost of equity capital to cash flow volatility using univariate tests. Firms are sorted into quintile portfolios based on the cash flow volatility measure, where Q1 denotes the low and Q5 denotes the high cash flow volatility quintiles. For each quintile, the average implied cost of equity capital is computed. The second to last column reports the difference in the implied cost of equity capital of the highest and lowest cash flow volatility quintiles. The last column reports p-values corresponding to the independent sample t-tests of the difference in means between Q5 and Q1.

Table 7: Cash flow volatility and the implied cost of equity capital: A mean comparison

Implied cost of equity capital for quintiles sorted on CFV measures

Sorted on:	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q5-Q1**	**p-value**
CoVCFV	7.50%	7.53%	7.89%	8.10%	8.60%	1.11%	0.000
SalesCFV	8.33%	7.66%	7.70%	7.69%	8.23%	-0.11%	0.469
BECFV	8.26%	7.90%	7.59%	7.75%	8.12%	-0.14%	0.326

Notes: This table reports the average cost of equity capital for quintile portfolios of firms formed using the three measures of cash flow volatility defined in table 2 (CoVCFV, SalesCFV, BECFV). Q1 denotes the least cash flow volatile firms and Q5 denotes the most cash flow volatile firms. The last column reports the p-value corresponding to the independent sample t-test of the difference between Q5 and Q1.

Table 7 shows different patterns among the cash flow volatility measures. For the *CoVCFV* measure, there is a monotonically increasing pattern in the *FirmICC* when moving from Q1 to Q5. The mean implied cost of equity capital for the firms in the lowest cash flow volatility quintile is 7.50%, this number increases monotonically to 8.60% for the highest cash flow volatility quintile. The difference of 1.11% is significant with $p < 0.001$. The *SalesCFV* and *BECFV* show different, less obvious patterns. For both, the lowest cash flow volatility quintile shows the highest *FirmICC*, then, moving along the quintiles, the implied cost of equity capital first reduces slightly and then increases again. The differences between Q5 and Q1 are respectively -0.11% and -0.14% and are not significant with p-values of respectively 0.469 and

0.325. Multivariate regressions should point out whether the observed patterns hold after interacting with potential confounding variables.

Table 8 reports the results of the HCSE OLS regression models of the cash flow volatility measures together with the control variables regressed on the firm's implied cost of equity capital. The first model shows the regression with only the control variables. The model successfully explains 14.6% of the variance in *FirmICC* estimates *($R^2 = 0.146$, $p < 0.001$)*. *BookLev (t = 11.672)* is positively related to the *FirmICC* at the 1% significance level, *M_to_Book (t = -5.563)* and *RDexp (t = -3.604)* are both significant negative predictors of the implied cost of equity capital at the 1% significance level. Model 2 adds the variable *CoVCFV* to the regression and explains 15.9% of the variance in the *FirmICC* at the 1% level *($R^2 = 0.159$, $p < 0.001$)*. With β = 0.012 and t = 9.003, *CoVCFV* is positively related to the implied cost of equity capital at the 1% significance level. Adding the *CoVCFV* variable, *FA_to_TA (t = -1.822)* and *FirmSize (t = 2.433)* both become, respectively negative and positive, significant at the 5% level. Model 3 regresses *SalesCFV* together with the control variables on the implied cost of equity capital. The model successfully explains 15.4% of the variance in the *FirmICC*. *SalesCFV* is significant and positively related to the implied cost of equity capital with t = 4.211 and β = 0.024. Regarding the control variables, *FirmSize (t = 1.393)* turns insignificant and *FA_to_TA (t = -2.836)* turns significant at the 1% level. The other variables show virtually similar results. Lastly, in model 4, *BECFV* is the independent variable. The model explains 17.4% of the variance in the *FirmICC* at the 1% level. For *BECFV,* β = 0.037 and t = 5.368. Compared with model 1, *FA_to_TA* turns significant at the 5% level and *FirmSize* becomes significant at the 10% level.

To conclude, the mean comparison illustrates that, on a univariate basis, there is a clear positive pattern between *CoVCFV* and *FirmICC.* The pattern is less clear between *SalesCFV* and *BECFV* and *FirmICC*. The multivariate analyses show that when the measures of cash flow volatility interact with confounding variables, the cash flow volatility measures are positively and significantly related to the implied cost of equity capital. Therefore, the first hypothesis is confirmed.

Table 8: Cash flow volatility and the implied cost of equity capital: Multivariate analysis

Variables	**Exp sign**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Intercept		0.068***	0.051***	0.064***	0.065***
		(9.482)	(6.939)	(8.944)	(9.958)
CoVCFV	+		0.012***		
			(9.003)		
SalesCFV	+			0.024***	
				(4.211)	
BECFV	+				0.037***
					(5.368)
BookLev		0.030***	0.0278***	0.032***	0.023***
		(11.672)	(10.669)	(12.202)	(8.288)
FA_to_TA		-0.003	-0.004*	-0.007***	-0.005**
		(-1.398)	(-1.822)	(-2.836)	(-2.309)
FirmSize		0.001	0.001**	0.001	0.001*
		(0.957)	(2.433)	(1.393)	(1.897)
M_to_Book		-0.003***	-0.003***	-0.003***	-0.004***
		(-5.563)	(-5.530)	(-5.596)	(-7.411)
ROE		-0.000	-0.000	-0.000	-0.000
		(-0.483)	(-0.419)	(-0.454)	(-0.573)
RDexp		-0.037***	-0.047***	-0.045***	-0.038***
		(-3.604)	(-4.625)	(-4.093)	(-3.786)
N		5519	5519	5519	5519
Adjusted R^2		0.146	0.159	0.154	0.174
F-statistic		49.531***	58.694***	45.745***	44.136***

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital (FirmICC) on the three measures of cash flow volatility (CoVCFV, SalesCFV, and BECFV) and the set of control variables. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in table 2.*

Real asset liquidity and the implied cost of equity capital

The second hypothesis refers to a negative relationship between the liquidity of a firm's assets and the firm's implied cost of equity capital. The firm's asset liquidity is measured with seven variables, three industry-based measures *(PotBuy_N, PotBuy_FS, and Tot_MA)* and four firm-level measures *(WAL1, WAL2, WAL3 and MWAL)*. Table 9 reports the average implied cost of equity capital for quintile portfolios sorted on the basis of the seven asset liquidity measures. Q1 denotes the quintile with the lowest asset liquidity and Q5 denotes the quintile with the highest asset liquidity. The second to last column reports the difference in the average implied cost of equity capital of the highest and lowest asset liquidity quintiles. The last column reports the p-value of the corresponding independent sample t-test that tests the differences between Q1 and Q5.

Table 9: Asset liquidity and the implied cost of equity capital: A mean comparison

Implied cost of equity capital for quintiles sorted on asset liquidity measures

Sorted on:	Q1	Q2	Q3	Q4	Q5	Q5-Q1	p-value
PotBuy_N	8.20%	8.23%	7.95%	7.53%	7.71%	-0.48%	.000
PotBuy_FS	8.34%	8.20%	8.21%	7.67%	7.19%	-1.14%	.000
Tot_MA	8.81%	7.87%	7.86%	7.89%	7.17%	-1.65%	.000
WAL1	8.26%	8.17%	8.13%	7.90%	7.16%	-1.11%	.000
WAL2	8.17%	8.00%	8.06%	7.92%	7.46%	-0.71%	.000
WAL3	7.42%	8.15%	8.28%	7.98%	7.80%	0.38%	.007
MWAL	5.40%	6.70%	7.85%	9.02%	10.63%	5.23%	.000

Notes: This table reports the average cost of equity capital for quintile portfolios of firms formed using the seven measures of asset liquidity defined in table 2 (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, WAL2, WAL3, and MWAL). Q1 denotes the lowest asset liquidity firms and Q5 denotes the highest asset liquidity firms. The last column reports the p-value corresponding to the independent sample t-test of the difference between Q5 and Q1.

The industry-based measures of asset liquidity all show a negative pattern, the implied cost of equity capital decreases as the liquidity of the firm's asset increases. For *PotBuy_N* the implied cost of equity capital is 0.48% lower in the highest asset liquidity quintile than in the lowest asset liquidity quintile. For *PotBuy_FS,* the difference between Q1 and Q5 is -1.14% and for *Tot_MA,* the difference is -1.65%. For all measures, the differences between Q1 and Q5 are significant with a p-value lower than 0.001.

The firm-level measures of asset liquidity show mixed results. For *WAL1*, the pattern is monotonically decreasing. For *WAL2,* the pattern is decreasing but less smooth. For *WAL3*, the implied cost of equity capital first increases and decreases in the last two quintiles and the *MWAL* quintiles show a monotonically negative pattern in the relation with the implied cost of equity capital. The patterns are somewhat reflected in the Q5-Q1 column. For *WAL1*, the difference is -1.11% with $p < 0.001$, for *WAL2*, the difference is -0.71% with $p < 0.001$, *WAL3* shows a difference of 0.38% with $p = 0.007$ and the difference in *MWAL* is 5.23% with $p < 0.001$.

Table 10 report the results of the HCSE OLS regressions models with the different measures of asset liquidity as the independent variable, the firm's implied cost of equity capital as the dependent variable and the set of control variables. The previous subsection illustrates that cash flow volatility is significantly related to the firm's implied cost of equity capital, therefore

CoVCFV is added to the set of control variables. The variable *CoVCFV* is chosen in favor of the other cash flow volatility variables as *CoVCFV* shows the smoothest pattern in table 7 and the highest t-statistic in table 8.

In models 2 to 8, the adjusted R^2 is higher than in the base model (1), indicating that asset liquidity affects the implied cost of equity capital. Models 2, 3, and 4, representing the industry-based asset liquidity measures, explain between 16.1% and 16.5% of the variance in the implied cost of equity capital at the 1% significance level. The variables *PotBuy_N, PotBuy_FS* and *Tot_MA* are all significant negatively related to the implied cost of equity capital, with regression coefficients of respectively $\beta = -0.001$, $\beta = -0.031$ and $\beta = -0.041$, and t-statistics of respectively $t = -4.102$, $t = -5.517$ and $t = -3.802$. The control variables behave approximately similar to the base model.

Models 5 and 6 yield almost similar results. Model 5 reports an adjusted R^2 of 16.3% while model 6 explains 16.2% of the variance in the implied cost of equity capital. In both models, *BookLev* and *CoVCFV* are positively related to *FirmICC* at the 1% significance level, while *FirmSize* is positively related at the 1% significance level in model 5 and at the 5% significance level in model 6. *FA_to_TA* and *RDexp* are both significant and negatively related to *FirmICC* at the 1% significance level. In both models, the measures of asset liquidity are negatively related to the implied cost of equity capital. *WAL1* shows a regression coefficient of $\beta = -0.022$ with $t = -5.079$ and *WAL2* shows a regression coefficient of $\beta = -0.027$ with $t = -4.051$.

Model 7 shows an adjusted R^2 of 0.164 at the 1% significance level. *WAL3* is significant and positively related to the implied cost of equity capital *($\beta = 0.018$, $t = 5.009$)* and *FA_to_TA* shows a positive relationship at the 10% significance level *($\beta = 0.006$, $t = 1.933$)*. Model 8, lastly, shows an adjusted R^2 of 0.373. *MWAL* is significant and positively related to the implied cost of equity capital *($\beta = 0.089$, $t = 32.754$)*. *FA_to_TA* is positively related at the 1% significance level, while *FirmSize* and *RDexp* both turned insignificant.

To conclude, the patterns found in the univariate mean comparison are confirmed in the multivariate context. The three industry-based asset liquidity measures are all significant and negatively related to the implied cost of equity capital. From the balance sheet-based measures of asset liquidity, *WAL1* and *WAL2* are significant and negatively related to *FirmICC,* while *WAL3* and *MWAL* are significant and positively related to *FirmICC.* These findings indicate that when incorporating a weighted value of less liquid assets or a market valuation of total assets, the direction of the relationship changes.

To better understand the economic mechanism underlying the findings, a split sample analysis is conducted to explore what drives the variation across firms in the effect of asset liquidity on the cost of equity capital. Hypothesis 2 states that the effect of asset liquidity on the cost of equity capital is stronger for firms that are closer to financial distress. Table 11 shows the results of the multivariate regressions similar to the previous analyses, but with the sample split in low and high relative book- and market leverage ratios, based on whether the distance of firm's leverage ratio from the industry median is in the bottom or top half of the annual distribution across all firms.

Indicated by beta coefficients that are more distant from zero and p-values that are below to common threshold of 0.05, models 1 and 2 show that the effect of asset liquidity on the implied cost of equity capital is stronger for firms with a higher relative book leverage when asset liquidity is measured with the *PotBuy_N, WAL1* and *WAL2* measure. These findings solely hold for the asset liquidity measure of *PotBuy_N* when firms are sorted on the basis of their relative market leverage ratio.

In line with hypothesis 2, asset liquidity is negatively related to the implied cost of equity capital for the *PotBuy_N, PotBuy_FS, Tot_MA, WAL1,* and *WAL2* measure of asset liquidity, and for the *PotBuy_N, WAL1,* and *WAL2* measure of asset liquidity this effect is stronger for firms with a higher relative book leverage. Therefore, hypothesis 2 is confirmed with the notion that the hypothesis does not hold when fixed assets are (partially) acknowledged as liquid *(WAL3),* when market values are applied as a benchmark in calculating the liquidity of an asset (*MWAL),* and when a relative market leverage ratio is applied to define the closeness to financial distress.

Table 10: Asset liquidity and the implied cost of equity capital: Multivariate analysis

Variables	Exp sign	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant		0.051***	0.054***	0.072***	0.053***	0.057***	0.069***	0.033***	0.015**
		(6.939)	(7.356)	(9.229)	(7.238)	(7.857)	(8.840)	(3.992)	(2.412)
PotBuy_N	-		-0.001***						
			(-4.102)						
PotBuy_FS	-			-0.031***					
				(-5.817)					
Tot_MA	-				-0.041***				
					(-3.802)				
WAL1	-					-0.022***			
						(-5.079)			
WAL2	-						-0.027***		
							(-4.051)		
WAL3	-							0.018***	
								(5.009)	
MWAL	-								0.089***
									(32.754)
CoVCFV		0.012***	0.012***	0.013***	0.012***	0.013***	0.013***	0.012***	0.01***
		(9.003)	(8.785)	(9.290)	(9.086)	(9.353)	(9.356)	(8.835)	(8.703)
BookLev		0.028***	0.029***	0.025***	0.028***	0.024***	0.026***	0.029***	0.018***
		(10.669)	(11.056)	(9.283)	(10.561)	(8.809)	(9.561)	(11.073)	(7.410)
FA_to_TA		-0.004*	-0.004*	-0.005**	-0.004*	-0.010***	-0.022***	0.006*	0.027***
		(-1.822)	(-1.854)	(-2.031)	(-1.748)	(-3.803)	(-4.398)	(1.933)	(12.452)
FirmSize		0.001**	0.001**	0.001**	0.001**	0.001***	0.001**	0.001***	0.000
		(2.433)	(2.182)	(2.139)	(2.271)	(2.618)	(2.476)	(2.764)	(0.679)
M_to_Book		-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.001***
		(-5.530)	(-5.504)	(-5.502)	(-5.516)	(-5.442)	(-5.482)	(-5.506)	(-3.515)
ROE		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		(-0.419)	(-0.417)	(-0.457)	(-0.429)	(-0.366)	(-0.328)	(-0.541)	(0.209)
RDexp		-0.047***	-0.050***	-0.029***	-0.046***	-0.044***	-0.044***	-0.042***	0.011
		(-4.625)	(-4.869)	(-2.873)	(-4.476)	(-4.416)	(-4.444)	(-4.053)	(1.146)
N		5519	5519	5519	5519	5519	5519	5519	5519
Adjusted R^2		0.159	0.162	0.165	0.161	0.163	0.162	0.164	0.373
F-statistic		58.694***	53.0745***	60.782***	54.366***	58.557***	57.060***	53.476***	350.984***

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital (FirmICC) on the seven measures of asset liquidity (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, WAL2, WAL3, and MWAL) and the set of control variables. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in table 2.*

Table 11: Asset liquidity and the implied cost of equity capital: Multivariate split sample analysis

Variables	**Model 1** **Low BL**	**Model 2** **High BL**	**Model 3** **Low ML**	**Model 4** **High ML**
PotBuy_N	-0.001	-0.001***	-0.001	-0.001***
	(-0.508)	(-5.385)	(-1.285)	(-2.898)
P-value difference		.048		.032
Adjusted R	0.334	0.144	0.111	0.094
PotBuy_FS	-0.017***	-0.026***	-0.019***	-0.019**
	(-2.734)	(-3.208)	(-3.283)	(-2.376)
P-value difference		.309		.918
Adjusted R	0.336	0.139	0.114	0.093
Tot_MA	-0.025**	-0.046***	-0.020**	-0.036**
	(-2.081)	(-2.860)	(-1.981)	(-1.845)
P-value difference		.966		.289
Adjusted R	0.335	0.138	0.111	0.091
WAL1	-0.013***	-0.027***	-0.016***	-0.021***
	(-2.788)	(-3.327)	(-3.529)	(-2.853)
P-value difference		.013		.214
Adjusted R	0.336	0.140	0.115	0.093
WAL2	-0.006	-0.027**	-0.019**	-0.022**
	(-0.954)	(-2.532)	(-2.538)	(-2.105)
P-value difference		.000		.313
Adjusted R	0.334	0.139	0.113	0.092
WAL3	0.024***	0.021***	0.010**	0.015***
	(5.379)	(4.012)	(2.451)	(2.683)
P-value difference		.000		.569
Adjusted R	0.342	0.142	0.112	0.094
MWAL	0.069***	0.099***	0.076	0.075
	(20.694)	(24.148)	(20.701)	(16.269)
P-value difference		.000		.796
Adjusted R	0.469	0.329	0.311	0.223
N	2759	2760	2759	2760

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital (FirmICC) on the seven measures of asset liquidity (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, WAL2, WAL3, and MWAL) and the set of control variables. The following control variables are included but not reported: BookLev, FA_to_TA, FirmSize, M_to_Book, ROE, RDexp, and CoVCFV. Model 1(3) and 2(4) split the sample into low and high book (market) leverage based on whether the distance of a firm's book leverage from the industry median is in the bottom or top half of the annual distribution across all firms, respectively. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Model 2 (4) reports the p-value of the statistical significance of the difference between the beta coefficients of the low and high book (market) leverage subsamples. All variables are defined in table 2.*

The moderating effect of asset liquidity

The first hypothesis is confirmed as cash flow volatility *(CoVCFV)* is significant and positively related to the implied cost of equity capital, next the second hypothesis is confirmed as five asset liquidity measures are significant and negatively related to the implied cost of equity capital. The third hypothesis tests whether the liquidity of a firm's assets, as indicated by those five measures, reduces the impact of the volatility of the firm's cash flows on the firm's implied cost of equity capital. Put differently, it tests the moderating effect of asset liquidity on the cash flow volatility – implied cost of equity capital relationship, or with respect to the regression analysis, it tests whether the interaction effect between cash flow volatility and asset liquidity is significantly related to the implied cost of equity capital. Similar to the previous hypothesis tests, a univariate quintile mean comparison reveals the first patterns of the hypothesized relationships. Thereafter, a multivariate HCSE OLS regression clarifies whether the observed patterns hold after controlling for confounding variables.

Table 12 relates cash flow volatility and asset liquidity to the implied cost of equity capital, resulting in a 5x5 quantile portfolio table sorted on the basis of asset liquidity and cash flow volatility. The sample is first sorted on the basis of cash flow volatility levels, subsequently the firms are, per cash flow volatility quintile, sorted on asset liquidity levels. The asset liquidity quintiles are vertically sorted per row, the cash flow volatility quintiles are horizontally sorted per column. The last two rows and columns respectively report quintile averages and the differences between the lowest and the highest quintile.

Panel A: Firm ICC for quintiles sorted on the CoVCFV and PotBuy_N variables

Sorted on:	*CoVCFV*						
PotBuy_N	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Average**	**Q5-Q1**
Q1	7.37%	7.94%	8.24%	8.74%	8.64%	8.20%	1.27%
Q2	7.30%	7.72%	8.45%	8.28%	9.37%	8.23%	2.07%
Q3	7.73%	7.45%	7.79%	8.01%	8.56%	7.95%	0.83%
Q4	7.35%	7.27%	7.35%	7.54%	8.26%	7.53%	0.91%
Q5	7.74%	7.32%	7.55%	7.91%	8.10%	7.71%	0.36%
Average	7.50%	7.53%	7.89%	8.10%	8.60%	7.92%	1.11%
Q5-Q1	0.38%	-0.62%	-0.69%	-0.83%	-0.54%	-0.48%	

Panel B: Firm ICC for quintiles sorted on the CoVCFV and PotBuy_FS variables

Sorted on:	*CoVCFV*						
PotBuy_FS	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Average**	**Q5-Q1**
Q1	7.65%	8.06%	8.12%	8.70%	9.09%	8.34%	1.44%
Q2	7.79%	7.78%	8.27%	8.38%	8.97%	8.20%	1.18%
Q3	7.47%	7.90%	8.48%	8.33%	9.27%	8.21%	1.80%
Q4	7.29%	7.26%	7.57%	7.72%	8.37%	7.67%	1.09%
Q5	7.16%	6.65%	6.96%	7.36%	7.72%	7.19%	0.55%
Average	7.50%	7.53%	7.89%	8.10%	8.60%	7.92%	1.11%
Q5-Q1	-0.49%	-1.41%	-1.16%	-1.33%	-1.38%	-1.14%	

Panel C: Firm ICC for quintiles sorted on the CoVCFV and Tot_MA variables

Sorted on:	*CoVCFV*						
Tot_MA	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Average**	**Q5-Q1**
Q1	8.13%	9.00%	8.79%	8.78%	9.42%	8.81%	1.28%
Q2	7.56%	7.14%	7.91%	8.34%	8.59%	7.87%	1.03%
Q3	7.82%	7.48%	7.72%	7.98%	8.24%	7.86%	0.42%
Q4	7.13%	7.43%	7.98%	7.94%	9.23%	7.89%	2.10%
Q5	6.75%	6.64%	7.00%	7.42%	7.84%	7.17%	1.08%
Average	7.50%	7.53%	7.89%	8.10%	8.60%	7.92%	1.11%
Q5-Q1	-1.38%	-2.36%	-1.79%	-1.36%	-1.58%	-1.65%	

Panel D: Firm ICC for quintiles sorted on the CoVCFV and WAL1 variables

Sorted on:	*CoVCFV*						
WAL1	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Average**	**Q5-Q1**
Q1	7.74%	7.70%	8.14%	8.64%	9.36%	8.26%	1.61%
Q2	7.32%	7.83%	8.48%	8.35%	8.98%	8.17%	1.66%
Q3	7.87%	7.61%	7.83%	8.16%	9.03%	8.13%	1.16%
Q4	7.52%	7.72%	7.91%	8.07%	8.25%	7.90%	0.73%
Q5	6.91%	6.74%	7.00%	7.37%	7.63%	7.16%	0.72%
Average	7.50%	7.53%	7.89%	8.10%	8.60%	7.92%	1.11%
Q5-Q1	-0.84%	-0.96%	-1.14%	-1.26%	-1.73%	-1.11%	

Panel E: Firm ICC for quintiles sorted on the CoVCFV and WAL2 variables

Sorted on:	*CoVCFV*						
WAL2	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Average**	**Q5-Q1**
Q1	7.41%	7.57%	7.85%	8.67%	9.32%	8.17%	1.91%
Q2	7.37%	7.66%	8.02%	8.25%	8.83%	8.00%	1.45%
Q3	7.73%	7.68%	8.29%	7.87%	8.87%	8.06%	1.14%
Q4	7.65%	7.69%	7.88%	8.26%	8.16%	7.92%	0.51%
Q5	7.26%	6.98%	7.38%	7.56%	7.94%	7.46%	0.67%
Average	7.50%	7.53%	7.89%	8.10%	8.60%	7.92%	1.11%
Q5-Q1	-0.15%	-0.59%	-0.47%	-1.12%	-1.39%	-0.71%	

Notes: This table reports the average cost of equity capital for quintile portfolios of firms formed using the five relevant measures of asset liquidity and the cash flow volatility measure CoVCFV. Q1 denotes the lowest cash flow volatility and asset liquidity firms, Q5 denotes the highest cash flow volatility and asset liquidity firms.

The first three panels report the results regarding the industry-based asset liquidity measures. Panel A reports the mean values for *PotBuy_N* quintiles and *CoVCFV* quintiles. The last column reports the differences in *FirmICC* between the lowest and highest *CoVCFV* quintile per *PotBuy_N* quintile. From this column it can be derived that, although not perfectly monotonically, the differences between the highest and the lowest *CoVCFV* quintile tend to decrease among the *PotBuy_N* quintiles. This is a first indication that the implied cost of equity capital increases more for cash flow volatile firms with lower asset liquidity. The implied cost of equity capital increases with 1.27% for the lowest *PotBuy_N* quintile and increases with 0.36% for the highest *PotBuy_N* quintile. The difference between the lowest and the highest asset liquidity quintile is 0.38% in the lowest cash flow volatility quintile, the difference changes to -0.54% which indicates a divergent effect of cash flow volatility on the implied cost of equity capital among the asset liquidity quintiles. In panel B the *PotBuy_FS* measure of asset liquidity is employed. The resulting mean changes of the implied cost of equity capital are comparable to panel A. Difference in *FirmICC* between the most and the least cash flow volatile firms are highest for the least asset liquidity firms (1.44%) and lowest for the most asset liquid firms (0.55%). Again, a divergent effect is noticeable with a *FirmICC* difference between the lowest *PotBuy_FS* and the highest *PotBuy_FS* of -0.49% for the least cash flow volatile firms and a difference of -1.38% for the most cash flow volatile firms. In panel C the results are less obvious. The implied cost of equity capital is higher for firms with more volatile cash flows and for firms with a lower asset liquidity, however the difference in *FirmICC* among the lowest and highest *CoVCFV* quintiles is not visibly related to the asset liquidity quintiles.

Panels D and E show the results when asset liquidity is measured with the balance sheet measures. Panel D shows that for firms with the lowest asset liquidity, the implied cost of equity capital increases with 1.61% from the lowest to the highest cash flow volatility quintile. For firms with the highest asset liquidity, the implied cost of equity capital increases from 6.91% in the lowest cash flow volatility quintile to 7.63% in the highest cash flow volatility quintile, a difference of 0.72%. Moreover, the difference between the lowest and the highest asset liquidity quintile is -0.84% in the lowest cash flow volatility quintile and -1.73% in the highest cash flow volatility quintile, indicating a moderating effect. Panel E reports results that are close to the results of panel D. Panel E illustrates a stronger difference between the lowest and the highest asset liquidity quintile among the cash flow volatility quintiles. In the lowest asset liquidity quintile, the implied cost of equity capital increases with 1.91% from the lowest to the highest cash flow volatility quintile, for the highest asset liquidity quintile, this difference is only 0.67%.

Panels A, B, D and E report results that indicate a moderating effect of asset liquidity on the *CoVCFV – FirmICC* relationship, where the effects of the balance sheet measure are most obvious. Panel C reports results in which an interaction effect is not directly visible. In the next subsection, the multivariate regressions point out whether the observed patterns hold while controlling for confounding variables.

Table 13 report the results of the HCSE OLS regression with the control variables, the cash flow volatility variable, the asset liquidity variable and the interaction term as the independent variables and the implied cost of equity capital as the dependent variable. This table exclusively reports the regressions with the interaction terms, the regressions without are threated in the previous subsection.

Table 13: Asset liquidity, cash flow volatility and the implied cost of equity capital: Multivariate analysis

Variables	**Exp sign**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant		0.054***	0.065***	0.055***	0.055***	0.063***
		(-7.263)	(7.371)	(7.401)	(7.365)	(7.524)
PotBuy_N		-0.001				
		(-1.267)				
PotBuy_N x CoVCFV	-	-0.001				
		(-1.365)				
PotBuy_FS			-0.018**			
			(-1.991)			
PotBuy_FS x CoVCFV	-		-0.025*			
			(-1.836)			
Tot_MA				-0.100***		
				(-3.484)		
Tot_MA x CoVCFV	-			0.089**		
				(2.180)		
WAL1					-0.008	
					(-1.184)	
WAL1 x CoVCFV	-				-0.025**	
					(-2.319)	
WAL2						-0.011
						(-1.302)
WAL2 x CoVCFV	-					-0.025***
						(-3.045)
CoVCFV		0.013***	0.027***	0.011***	0.016***	0.021***
		(8.304)	(3.328)	(6.899)	(7.581)	(6.473)
BookLev		0.029***	0.025***	0.027***	0.025***	0.026***
		(11.065)	(9.262)	(10.554)	(8.872)	(9.762)
FA_to_TA		-0.004*	-0.005*	-0.004*	-0.009***	-0.021***
		(-1.929)	(-1.958)	(-1.789)	(-3.758)	(-4.122)
FirmSize		0.001**	0.001**	0.001**	0.001***	0.001***
		(2.213)	(2.112)	(2.278)	(2.678)	(2.599)
M_to_Book		-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
		(-5.505)	(-5.508)	(-5.508)	(-5.447)	(-5.503)
ROE		-0.000	-0.000	-0.000	-0.000	-0.000
		(-0.421)	(-0.457)	(-0.412)	(-0.356)	(-0.285)
RDexp		-0.051***	-0.028***	-0.047***	-0.042***	-0.042***
		(-4.882)	(-2.759)	(-4.575)	(-4.279)	(-4.291)
N		5519	5519	5519	5519	5519
Adjusted R^2		0.162	0.165	0.161	0.164	0.164
F-statistic		47.135***	53.935***	49.147***	52.691***	51.358***

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital (FirmICC) on the relevant measures of asset liquidity (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, and WAL2), the relevant measure of cash flow volatility (CoVCFV), the interaction effect of the asset liquidity and cash flow volatility measures, and the set of control variables. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in table 2.*

The first three models report the regressions with the industry-based asset liquidity measures. With a t-value of t = -1.365, the interaction effect of asset liquidity as measured by *PotBuy_N* on the *CoVCFV – FirmICC* relationship is insignificant. The model successfully explains 16.2% of the variance in the *FirmICC*, which is 0.03% more than the base model without the interaction term. Model 2 reports the results with the *PotBuy_FS* measure of asset liquidity. In model 2 the interaction term is negative *(β = -0.025)* and significant with a t-value of t = -1.836. The model successfully explains 16.5% of the variance in the implied cost of equity capital, which is 0.05% more than the model without the interaction term. The coefficients of *CoVCFV* and *PotBuy_FS* remain significant and in the same direction, but at the 5% significance level. The third model reports the results with the *Tot_MA* measure, adding the interaction term adds 0.05% of variance explained in the implied cost of equity capital *($R^2 = 0.161$)*. The interaction term is significant at the 5% level, however, compared to the other models, the coefficient has a positive sign *(β = 0.089, t = 2.180)*. The other variables in the third model retain the same significance level and direction as in the model without the interaction term.

Next, the last two models report the regression with the balance sheet-based asset liquidity measures and the interaction terms. In model 4, the interaction term including *WAL1* is significant and in the expected direction *(β = -0.025, t = -2.319)*. The model successfully explains 16.4% of the variance in the dependent variable. The control variables retain the same direction at the same significance level after adding the interaction term. The last model reports the results when using the asset liquidity measure *WAL2*. The interaction effect of *WAL2* and *CoVCFV* is negative and significant at the 1% level *(β = -0.025, t = -3.045)*, which is in line with the observed patterns in table 12 and with the hypothesis. The significance of *FirmSize* changes to the 5% level *(β = 0.001, t = 2.599)*. Adding the interaction term increases the adjusted R^2 from 0.162 to 0.164.

To conclude, the pattern found between *PotBuy_N, CoVCFV* and *FirmICC* in table 12, panel A, turns out to be insignificant when regressed in a multivariate regression model with confounding independent variables. Panel C in table 12 barely shows any pattern, the multivariate analysis points out that there is a slight moderating pattern of asset liquidity that turns out to be significant and positive. Moreover, panels B, D and E in table 12 show a pattern that indicates a negative moderating effect of asset liquidity on the positive effect of cash flow volatility on the implied cost of equity capital. The multivariate regression analyses confirm the patterns observed in panels B, D and E, revealing that asset liquidity, as measured by the average financial slack of potential buyers *(PotBuy_FS)* and by the balance sheet measures *WAL1* and *WAL2*, reduces the impact of cash flow volatility *(CoVCFV)* on the implied cost of equity capital *(FirmICC)*.

The second part of the third hypothesis contains the expectation that the interaction effect of asset liquidity and cash flow volatility on the implied cost of equity capital is stronger for firms that are closer to financial distress. As is explained in section 3.3.1, closeness to financial distress is measured by the distance between the firm's book and market leverage ratio and the consecutive industry median ratios. Table 14 shows the results of the multivariate regressions similar to the previous regressions but with the sample split, based on whether the distance between the firm and industry leverage ratios fall within the top or bottom half of the annual distribution across all firms.

Table 14: Asset liquidity, cash flow volatility and the implied cost of equity capital: Multivariate split sample analysis

Variables	**Model 1 Low BL**	**Model 2 High BL**	**Model 3 Low ML**	**Model 4 High ML**
PotBuy_N x CoVCFV	-0.001	-0.001	-0.001	-0.001
	(-1.451)	(-0.235)	(-1.348)	(-0.859)
P-value difference		.991		.156
Adjusted R	0.335	0.144	0.111	0.094
PotBuy_FS x CoVCFV	-0.010	-0.034**	-0.021	-0.049**
	(-0.590)	(-1.838)	(-1.269)	(-2.058)
P-value difference		.003		.218
Adjusted R	0.336	0.140	0.114	0.094
Tot_MA x CoVCFV	0.052	0.139*	0.018	0.112
	(1.009)	(1.787)	(0.517)	(1.069)
P-value difference		.546		.365
Adjusted R	0.335	0.139	0.111	0.092
WAL1 x CoVCFV	-0.111	-0.018	-0.020	-0.026
	(-0.906)	(-0.932)	(-1.565)	(-1.406)
P-value difference		.001		.112
Adjusted R	0.336	0.141	0.116	0.094
WAL2 x CoVCFV	-0.006	-0.039***	-0.018**	-0.029**
	(-0.518)	(3.123)	(-1.819)	(-2.263)
P-value difference		.000		.081
Adjusted R	0.334	0.142	0.114	0.094
N	2759	2760	2759	2760

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital (FirmICC) on the relevant measures of asset liquidity (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, and WAL2), the relevant measure of cash flow volatility (CoVCFV), the interaction effect of the asset liquidity and cash flow volatility measures, and the set of control variables. The following control variables are included but not reported: BookLev, FA_to_TA, FirmSize, M_to_Book, ROE, RDexp. Model 1(3) and 2(4) split the sample into low and high book (market) leverage based on whether the distance of a firm's book leverage from the industry median is in the bottom or top half of the annual distribution across all firms, respectively. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Model 2 (4) reports the p-value of the statistical significance of the difference between the beta coefficients of the low and high book (market) leverage subsamples. All variables are defined in table 2.*

Models 1 and 2 show that, when measured with *PotBuy_FS* and the *WAL2* measure of asset liquidity, the interaction effect of asset liquidity and cash flow volatility is stronger for firms with a higher relative book leverage. This is indicated by the beta coefficients that are significant and more distant from zero in model 2 compared to model 1, the p-value indicates that the differences between the beta coefficients is statistically significant. When measured with the *PotBuy_N* and *WAL1* measure of asset liquidity, the interaction effect of asset liquidity and cash flow volatility is insignificant for both subsamples. When asset liquidity is measured with the *Tot_MA* measure, the difference between the beta coefficients of the interaction effects in both models is statistically insignificant.

Models 3 and 4 show the results of the multivariate regression with the sample split in halve on the basis of relative market leverage. The results show that the observed differences between the beta coefficients of the interaction effects in both models are statistically not significantly different as the p-values are all above 0.05, except when asset liquidity is measured with the *WAL2* measure. This indicates that the interaction effect of asset liquidity and cash flow volatility is significantly stronger for firms with a higher relative market leverage ratio, when asset liquidity is measured with the *WAL2* measure.

Overall, as is shown in table 13, the interaction effect of asset liquidity and cash flow volatility is significant and in the hypothesized direction when asset liquidity is measured with the *PotBuy_FS, WAL1,* and *WAL2* measure. This effect is stronger for firms with a higher relative book leverage when asset liquidity is measured with the *PotBuy_FS* and *WAL2* measure and is stronger for firms with a higher relative market leverage when asset liquidity is measured with the *WAL2* measure. Therefore, although not sovereign for all measures of asset liquidity, the third hypothesis is confirmed.

4.3.3 Robustness tests

In the preceded section, the hypothesis tests are reported. The hypotheses are tested on the basis of three cash flow volatility variables, seven asset liquidity variables, a set of control variables and one dependent variable. Given the number of independent variables, some robustness is already intertwined in the research model. However, so far, all hypothesis tests are based on the application of one single dependent variable which functions as the estimation of the cost of equity capital. As is argued by Guay et al. (2011), Easton and Monahan (2005), Echterling et al. (2015), and Li and Mohanram (2014), analysts' forecasts are subject to timeliness and bias problems that might adversely affect the accuracy of the implied cost of equity capital approach. The authors suggest that the sluggishness is a characteristic of analysts' forecasts, illustrating that if analysts fail to quickly revise their forecasts with stock price changes, analysts' earnings forecasts will be a poor proxy for the market's expectation of earnings. As a result, an error will be induced in the cost of equity capital estimates that is correlated with past stock price performance.

To account for potential measurement error induced by analysts' sluggish revisions of their forecasts, an alternative estimation procedure for the cost of equity capital is applied. In this method, the implied cost of equity capital is calculated on the basis of stock prices of one month ago. Instead of using the current stock price, this procedure allows analysts extra time to impound the information in recent price movements into their forecasts. The alternative implied cost of equity capital measure is denoted as *FirmICC_pm.* All HCSE OLS regression analyses that are performed in the hypothesis tests are repeated with the alternative dependent variable. The results are shown in appendix E.

Comparing the results of the robustness tests with original regression results, there are differences. First of all, there are differences in β-values and t-values for the control variables. For example, the second model in the first table reports $\beta = -0.003$ and $t = -1.239$ for *FA_to_TA,* which differs from the value in the original model *($\beta = -0.004$, $t = -1.822$)* indicating that *FA_to_TA* explains less of the variance in *FirmICC_pm* than in *FirmICC* and occasionally turns insignificant. For all variables of interest, the variables related to cash flow volatility, asset liquidity and the interaction effect, regression coefficient's directions and the corresponding level of significance are similar except for the interaction effect of *CoVCFV* and *PotBuy_FS*. The interaction effect of *CoVCFV* and *PotBuy_FS* turns insignificant when the implied cost of equity capital is calculated on the basis of one-month-before stock prices (from t = -1.836 to t = -0.946).

5 Discussion and conclusion

The previous chapter presents the results of this study. This final chapter starts with an interpretation of the results in relation to the hypotheses, previous empirical studies, and the relevant theories. Subsequently, the limitations of this study are described, and based upon, recommendations for further research are provided. Lastly, given the discussion of the results and the limitations of this study, the final subsection gives an overall conclusion on this study and emphasizes the most relevant research implications.

5.1 Discussion

The most important findings of this study are related to three areas: (1) the relationship between cash flow volatility and the implied cost of equity capital, (2) the relationship between asset liquidity and the implied cost of equity capital, and (3) the moderating effect of asset liquidity on the impact of cash flow volatility on the implied cost of equity capital.

The results regarding the first area of research indicate that cash flow volatility has a positive impact on the implied cost of equity capital. This relationship holds after controlling for a set of potential confounding explanatory factors. The univariate mean comparison (table 7) reveals that this relationship is most obvious for cash flow volatility measured as the coefficient of variance, which emphasizes the potential advantage of this standardized measure of cash flow volatility. This study confirms the notion that cash flow volatility has an economic impact. The results are in line with Deng et al. (2013), Douglas et al. (2016), Hung and Wakayama (2005), and Minton and Schrand (1999), who found a positive relationship between cash flow volatility and the cost of capital. Whereas Minton and Schrand (1999) base their conclusions on cost of equity capital proxies such as analysts' following, bond ratings or payout ratios, and the other studies measure the cost of capital as the cost of debt, this study adds to the literature by providing evidence that the relationship holds when the cost of equity capital is estimated using a contemporary forward-looking cost of equity capital estimation approach. The findings indicate that higher cash flow volatility increases the uncertainty about future cash flows, which results in investors' inclination to pay less for the expected returns, ultimately suppressing firm value.

Asset liquidity refers to the ease with which a firm's assets can be sold on a secondary market. The second important finding of this study refers to the relationship between asset liquidity and the implied cost of equity capital. The results indicate that asset liquidity is negatively related to the implied cost of equity capital and that this effect is stronger for firms that are closer to financial distress when financial distress is measured on the basis of book values. The results are in line with the theory and results of Ortiz-Molina and Phillips (2014). Ortiz-Molina and Phillips (2014) theorize that asset liquidity facilitates firm's restructuring processes as asset sales plays an important role in firms' responses to changing economic condition and sales of liquid assets fetch smaller price discounts, hence asset liquidity as a proxy for operating flexibility reduces the equity risk borne by investors.

Regarding asset liquidity, this study utilizes seven measures, three industry-based measures capture the 'industry equilibrium' aspect of asset liquidity, and four measures capture asset liquidity based on asset structure. The first three balance-sheet measures of asset liquidity *(WAL1, WAL2,* and *WAL3)* increasingly value less liquid assets in ascending order. As a consequence, *WAL2* shows a less obvious pattern and less significant relationship when related to the implied cost of equity capital than *WAL1.* Moreover, consequently, *WAL3* is positively related to the implied cost of equity capital. These finding raise the question whether or not, in an attempt to capture the liquidity of less liquid assets, the more comprehensive measures of asset liquidity over-weigh less liquid assets and measure asset illiquidity instead. The fourth balance-sheet measure, *MWAL,* shows a weak correlation with the other asset liquidity measure and is strongly related to the market-to-book ratio, indicating that a lot of variation in the market value measure is driven by changes in the market value of equity. This result is in line with Gopalan et al. (2012) who consequently put more weight on the results with the book value measures.

Concluding on the relationship between asset liquidity and the implied cost of equity capital. The results confirm the hypothesis and are in line with prior theories and results stating that asset liquidity as a proxy for operating flexibility reduces the implied cost of equity capital. However, the question emerges whether the more comprehensive asset liquidity measures and the market value liquidity measure accurately capture asset liquidity as a proxy for operating flexibility.

Lastly and most important, this study poses results regarding the moderation effect of asset liquidity on the relationship between cash flow volatility and the implied cost of equity capital. The results confirm that asset liquidity, in line with the third hypothesis, reduces the impact of cash flow volatility on the implied cost of equity capital. This effect is stronger for firms that are closer to financial distress and therefore are more incentivized to restructure. The hypothesis is confirmed as the moderating effects hold for the purest measures of asset liquidity *(PotBuy_FS, WAL1,* and *WAL2)*. *PotBuy_FS* can be considered as the purest industry-based measure as it captures the degree to which related firms have the potential to buy the firm's assets. The *WAL1* and *WAL2* measures do capture only the most liquid assets of a firm, not incorporating a weighted fixed value of fixed assets or a market value of total assets and can therefore be considered as more accurate. The findings are in line with several theories. First, the credit rationing theory as is developed by Froot et al. (1994), which states that cash flow volatility diminishes value as it causes shortages in internally generated funds available to take advantage of attractive investment opportunities. The finding that operating flexibility as measured by asset liquidity reduces the impact of cash flow volatility on the implied cost of equity capital, indicates that the result is in line with the credit rationing theory when operating flexibility is related to the ability of a firm to cover up shortages in internally generated funds caused by cash flow volatility. Second, the results fit the prediction of Shleifer and Vishny (1992) who argue that the financial condition of industry participants *(PotBuy_FS)* is the main driver in the liquidation of assets, as the interaction effect *PotBuy_FS* and *CoVCFV* is the industry-based variable that remains significant in the multivariate analysis.

5.2 Limitations and recommendations

Before the final conclusions can be drawn, it is important to emphasize that this study is subject to several limitations. The most important limitations refer to the applied measurements in relation to the required data and the data availability. This subsection outlines the limitations of this study and proposes several recommendations for further research.

First of all, three limitations regarding the selected sample require further explanation. In order to calculate the cash flow volatility measures, firms are required to have historical cash flows of at least nine years. This requirement induces a potential survivorship bias as firms that are not successful enough to report a nine years operating history are excluded from the sample. Next, for the purposes of implied cost of equity capital calculations, earnings per share estimates are required. The final sample size is decreased by approximately two-third because of missing earnings per share forecasts. Although this number seems abnormally large, it approaches the numbers of Hong, Lim and Stein (2000), who report that, varying among the studied years, the percentage of firms within the sample that is not followed by analysts is between 36.9% and 77.3%. Lastly, the sample is restricted to one firm-year examination. Orbis exclusively provides earnings per share forecast for the upcoming years, restricting this study to current year implied cost of equity capital estimates. Previous studies (e.g.: McInnis, 2010; Ortiz-Molina and Phillips, 2014) study samples of equal size in terms of unique firms, however, by examining multiple firm-year observations their sample size drastically increase.

The limitations regarding the selected sample do have an impact on the overall findings of this study. The main focus of this study is put on the relation between asset liquidity and the implied cost of equity capital. The implied cost of equity capital is related to the equity risk investors bear, which decreases as the liquidity of a firm's assets increase. Non-surviving firms more likely are relatively poor performers, which implies a higher cost of equity capital. Moreover, non-survivors potentially are the firms that could benefit the most from asset liquidity as higher asset liquidity increases the firm's recovery rate. Therefore, the potential survivorship bias most likely works against the results of this study. Next, restricting the sample to firms with analyst's coverage affects the results of this study in the same direction. As is argued in the sample limitations section (section 3.3.2), samples restricted to analyst coverage underrepresent small firms and firms that are financially distressed. Now, this study already excludes small firms (total assets <$100m), however, the underrepresentation of financially distressed firms does affect the results. The degree of financial distress describes the extent to which firms are unable to meet or pay its financial obligations. Especially for firms that encounter to a larger extent difficulty to meet or pay their financial obligations, asset liquidity can be relatively more beneficial and could play a more important role as a buffer to cover up the shortages in internally generated funds caused by cash flow volatility. Therefore, the analyst coverage restriction most probably works against the results of this study, resulting in understated findings. Lastly, the findings in this study are based on cross-sectional results. Besides the lower amount of firm-year observations, the disadvantage of a cross-sectional study relative to a longitudinal study is that changes over time cannot be taken into account. For example, an important piece of information that is not taken into account due to this research approach is the state of the economy. The credit rationing theory (elaborated in section 2.3) states that cash flow volatility diminishes value to the extent that it causes shortages in internally generated funds available to take advantage of attractive investment opportunities. The availability of attractive investment opportunities is in all probability linked to the state of the economy, emphasizing the likelihood that the role asset liquidity on its own and in the interaction with cash flow volatility changes among varying economic situations.

The limitations regarding the selected sample expose several opportunities for further research on this topic. First, to reduce the potential survivorship bias, subsequent research could mitigate this problem by including delisted companies in a longitudinal setting. Second, this study utilizes earnings per share estimates available on Orbis (as is provided by JCF International), which downsizes the sample to one-third of its size. Using a more comprehensive database such as IBES might reduce the measurement error induced by analyst coverage. Utilizing data from a variety of databases might bring down the induced measurement error to a negligible size. Third, a study over time that incorporates longitudinal data paves the way for a better understanding of the interaction of the current findings with time-varying effects such as the state of the economy.

Above, the limitations and recommendations regarding the selected sample are discussed. The next set of limitations relate to the variables used in this study. First, the dependent variable, the implied cost of equity capital, induces some measurement error. The empirical implementation of this discounted cash flow valuation model involves simplifying assumptions, most importantly regarding earnings forecasts, dividend payout ratios and terminal value calculations. The implied cost of equity capital calculation as applied in this study assumes a fixed 12-year forecast horizon and a terminal value for the period beyond year 12 for all firms in the sample. If this fixed horizon is too short (long) for growth (mature) firms, the implied cost of equity capital estimates are underestimated for growth firms and overestimated for mature firms. Another assumption in this valuation approach refers to the dividend payout ratio. The expected dividend payout ratios are based on prior years' payout patterns. Theoretically, besides dividend payouts, new equity issues and share repurchases that can be anticipated in advance should be included in the payout estimates as this information is included in stock prices and earnings per share estimates as well. Lastly, the ICC valuation approach assumes that firms' return on equity mean revert toward the median return on equity of the industry. Using an industry estimate instead of a general estimate intends to capture accounting differences and risk that are more likely to be homogenous within each industry. However, certain types of firms might deserve a specific treatment as they interact different with changes in the external environment (e.g.: market leaders, protected firms, firms with monopolistic characteristics).

The impact of the different limitations that come with the use of the implied cost of equity capital approach on the findings of this study vary. The first limitation, the fixed horizon, suppresses the outcomes in exposing significant findings in line with the hypotheses, as cost of equity capital estimates for growth and mature firms are biased toward the mean values, their impact on the results is reduced. The second limitation, the procedure to estimate actual payout ratios, may understate actual payout ratios of firms with persistent share repurchase plans and may overstate actual payout ratios of firms that issue equity on a regular basis. To a certain extent, these effects are averaged out in the large sample, if not, the error in dividend payout estimates lead to minor changes in implied cost of equity capital estimates. The third limitation refers to firms that perform unlike their industry peers. This bias affects both, over- and underperforming companies and therefore most probably averages out.

As Gebhardt et al. (2001) mention that using either 6, 9, 12, 15, 18, or 21 years fixed forecasts horizons yield similar results, a potential area for further research is to examine whether there are more reliable ways to incorporate the long-term growth rates in the implied cost of equity capital approach used in this study. The same recommendation holds with respect to dividend payout estimation approach, prior literature does not provide a reliable technique to incorporate persistent share repurchases or equity issuances in the implied cost of capital calculation yet. This is a potential area for further research. Lastly, the incorporation of more accurate firm- or industry-specific long-term growth rates remain an area for further research. More reliable techniques for the estimation of long-term growth rates reduces the potential measurement error in the implied cost of equity capital estimates.

Next, the second limitation induced by the variables used in this study relates to the measures of asset liquidity. The last three decades, a limited stream of research has focused on the estimation of asset liquidity which resulted in three industry-based measures and four balance-sheet measures. This study applies the most recent developments by utilizing all seven measures. However, the measures are alternates and cannot be applied complementary, which implies that asset liquidity is either a function of the asset structure or a function of the industry composition or activity. These measures are rather practical and limit the generalizability of this study. This finding leaves space for future research to develop an asset liquidity measure that captures both the balance sheet component and the industry component of asset liquidity in one variable.

Incorporating both aspects in one variable could greatly increase the reliability and the generalizability of research related to asset liquidity.

Lastly, the final limitation of this study is related to the assumptions of the OLS regression. As is reported in section 4.3.1, the assumption regarding homoscedasticity is violated, implying that the regression results suffer from heteroscedasticity if no preventive efforts are undertaken. To overcome this violation, the OLS regression is performed with heteroscedasticity consistent standard errors, a method that is proven to be valid. However, this validation only holds if the heteroscedasticity exclusively is an impediment to valid inference rather than the consequence of a misspecified model. On the basis of Lewis and Linzer (2005), who report that an estimated variable generally exhibits heteroscedasticity, the assumption is made that the heteroscedasticity is solely an impediment to valid inference and not caused by a misspecified model. This assumption is made as the model is (1) based on prior research that is distilled from an extensive literature study, and (2) no signs of a model misspecification are found in the examination of the other assumptions and the relevant scatterplots. Although the assumption is made on a legitimate basis, it does not fully exclude the possibility that the applied model is misspecified. As an exclusion of the conception that the heteroscedasticity is caused by a misspecifed model lays beyond the scope of this study, there is room for further research to examine the legitimacy of the assumptions made.

The above subsections include several recommendations based on this study's limitations. Before going to the conclusion and implications, two recommendations based on the results are worth mentioning. First of all, the split sample analyses show that the beneficial effects of asset liquidity are stronger for firms that have a higher relative book leverage ratio, which is in line with the hypotheses. However, these findings barely hold when the sample is split on the bases of relative market leverage ratios. The question is why this is the case, an opportunity for further research is to clarify the extent to which relative book and market leverage ratios truly measure a firm's financial distress and constrainment and why the observed difference occurred. Next, the *Tot_MA* variable captures the historical liquidity of a firm's assets using the value of merger and acquisition activity in the firm's industry. As is observed in table 13, the interaction effect of *Tot_MA* and *CoVCFV* is positively related to the implied cost of equity capital, which is against the hypothesis. Apparently, firms with a higher cash flow volatility become a riskier investment when historical M&A activity increases, which works against the theory that historical M&A activity is a form of asset liquidity that increases a firm's operating flexibility and thereby reduces risk. Therefore, a recommendation for further research is to examine the economic mechanisms underlying cash flow volatility, historical M&A activity and the cost of equity capital.

5.3 Conclusion and implications

The perfect capital market does not exist. The "postmodern" view of financial policy accepts the law of conservation of value and goes further by treating financial policy as critical in enabling companies to make valuable investments, emphasizing the importance to understand the underlying mechanisms of capital structure. This research studies the cost of equity capital and relates it to the firm's cash flow smoothness and the liquidity of the firm's assets. This study examines whether a more volatile cash flow leads to a higher cost of equity capital and whether having relatively more liquid assets, which directly increases operating flexibility, leads to a lower cost of equity capital. Moreover, this study examines whether asset liquidity reduces the positive effect of cash flow volatility on the cost of equity capital. The research is guided by the following research question: *"To what extent does real asset liquidity moderate the effect of cash flow volatility on the cost of equity capital?"*.

Using measures that capture the volatility of cash flows relative to the size of the firm, the first finding shows that cash flow volatility does increase the cost of equity capital. The cost of equity capital is estimated using a distinctive contemporary forward looking discounted residual income valuation approach. The second finding shows that, using both, measures of asset liquidity that capture the industry equilibrium and measures that capture firm specific asset liquidity, asset liquidity is negatively related to the cost of equity capital. The main finding of this study shows that asset liquidity does reduce the impact of cash flow volatility on the cost of equity capital. Additional analyses clarify that this effect is stronger for firms that are closer to financial distress and therefore have a greater incentive to restructure. The findings are of economic importance as the average cost of equity increases with 1.11% from the smallest to the largest cash flow volatility quintile, while the increase is approximately 1.65% for firms in the lowest asset liquidity quintile and 0.6% for firms in the highest asset liquidity quintile. The difference between the lowest and highest asset liquidity quintile of over 1% exposes the considerable economic impact of asset liquidity on the cost of equity capital.

This study adds to the literature in several ways. First, it is the first study that reveals the interaction effect of cash flow volatility and asset liquidity on the implied cost of equity capital. Second, it confirms the previous findings about the impact of cash flow volatility on the cost of capital by utilizing a contemporary forward-looking cost of equity capital estimation approach. Last, returning to the first sentence of the introduction, this study adds a contribution to what Brealey et al. (2014) called 'one of the top ten unsolved problems in the world of finance'; identifying the value of liquidity.

Finally, this study has several implications for corporate managers and investment professionals. For corporate managers who pursue overall profitability and thereby incorporate the cost of equity capital, this study helps to clarify the impact and guide the application of investment decisions. For professional investors, this study adds value as it provides an additional piece of knowledge on how cash flow volatility and asset liquidity impact the firm's expected returns and share price.

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Appendix A: Sample distribution by industry

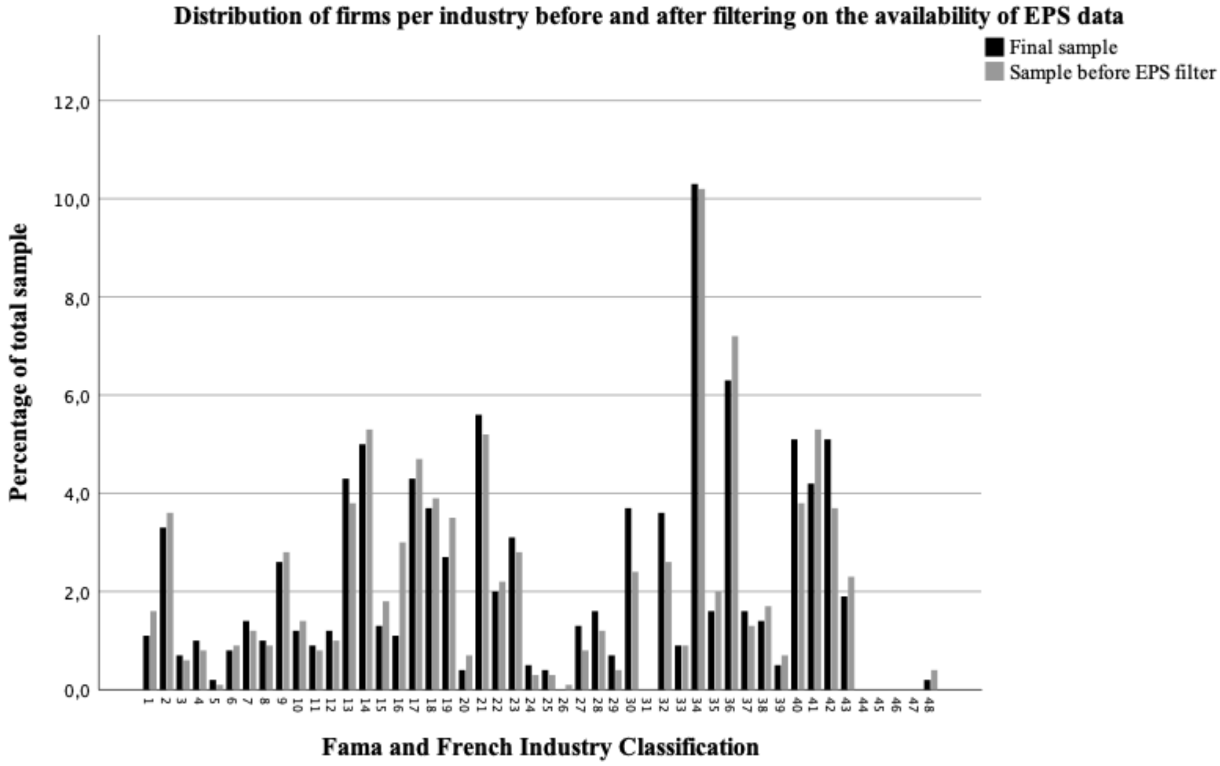


Figure 2: Distribution of sampled firms across industries

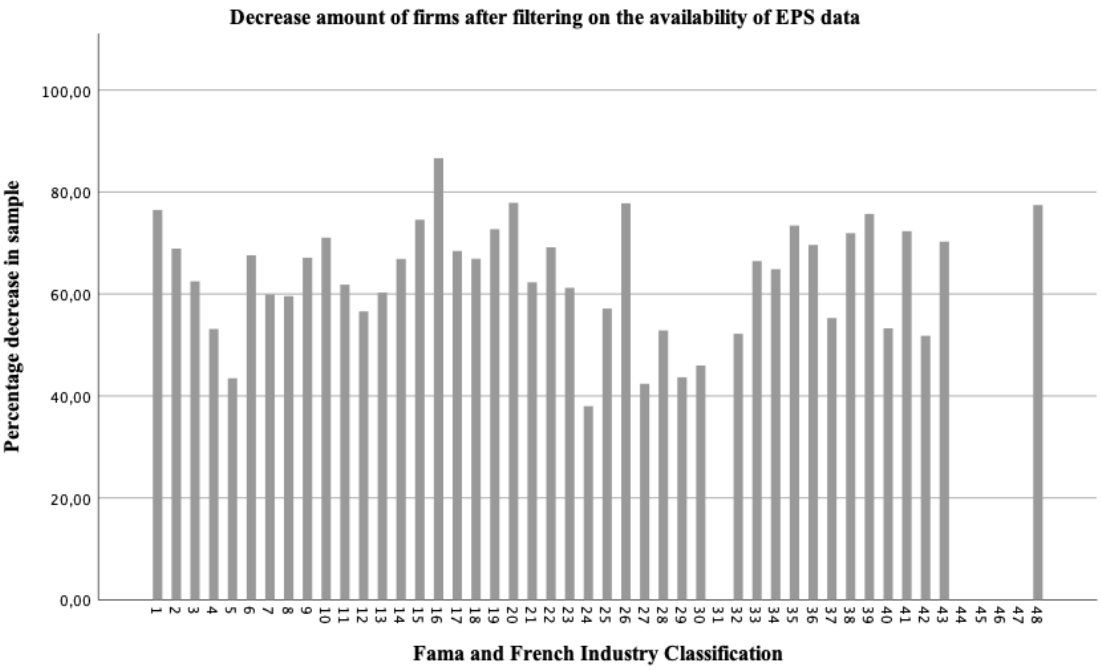


Figure 3: Change in sample size per industry due to EPS restriction

Appendix B: Descriptive statistics before outlier treatment

On the next page, table 15 presents the descriptive statistics before any adjustments to control for outliers.

Table 15: Descriptive statistics before outlier treatment

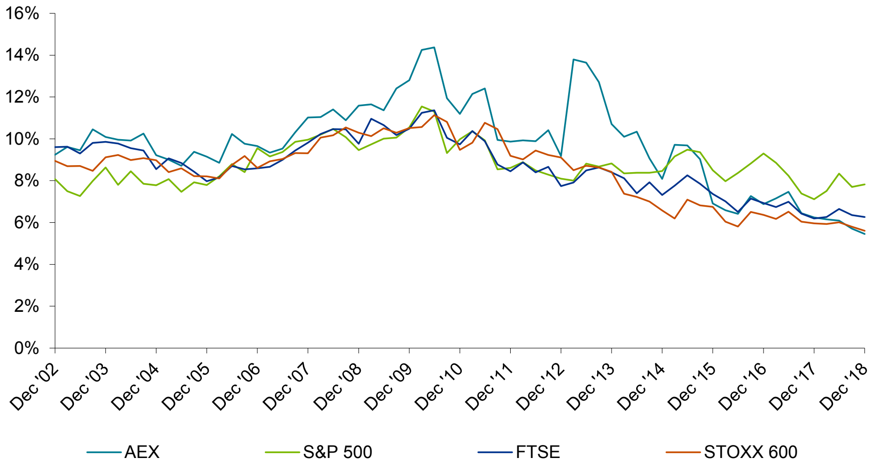
Dependent variables	**Mean**	**SD**	**Min**	**Q1**	**Median**	**Q3**	**Max**	**N**
FirmICC	0.081	0.046	0.000	0.056	0.076	0.099	1.215	5721
FirmICC_pm	0.078	0.046	0.000	0.054	0.074	0.095	1.516	5721

Independent variables	**Mean**	**SD**	**Min**	**Q1**	**Median**	**Q3**	**Max**	**N**
Asset liquidity								
PotBuy_N	24990	51543	41	2167	5080	21606	319747	5721
PotBuy_FS	0.559	0.087	0.237	0.495	0.548	0.614	0.877	5721
Tot_MA	0.017	0.033	0.000	0.008	0.013	0.019	0.759	5721
WAL1	0.136	0.132	0.000	0.046	0.098	0.183	1.753	5721
WAL2	0.321	0.185	0.004	0.196	0.303	0.421	5.431	5721
WAL3	0.565	0.218	0.006	0.445	0.565	0.680	8.453	5721
MWAL	0.390	0.241	0.002	0.220	0.356	0.518	5.540	5721
Cash flow volatility								
CoVCFV	0.526	0.334	0.062	0.282	0.436	0.679	2.147	5721
SalesCFV	0.068	0.161	0.002	0.020	0.035	0.067	2.587	5721
BECFV	0.095	0.204	0.008	0.035	0.056	0.092	3.726	5721

Control Variables	**Mean**	**SD**	**Min**	**Q1**	**Median**	**Q3**	**Max**	**N**
BookLev	0.495	0.188	0.009	0.355	0.502	0.632	0.997	5721
FA_to_TA	0.538	0.211	0.004	0.385	0.536	0.701	0.995	5721
FirmSize	21.344	1.581	18.421	20.148	21.225	22.391	27.000	5721
M_to_Book	3.028	11.094	0.015	1.001	1.657	3.020	540.245	5721
ROE	12.478	26.124	-602.726	5.632	10.438	16.791	518.081	5721
RDexp	0.019	0.064	0	0	0	0.013	2.520	5721

Notes: This table reports the summary statistics for the measures of cost of equity capital, asset liquidity, cash flow volatility and the control variables before outlier treatment. The sample covers the position of listed firms as is measured in may 2019 and excludes both financial firms and utilities. Firms with missing values, firms for which the ICC cannot be calculated and firms with total assets < $100m are excluded from the sample. All variables are listed in table 2.

Appendix C: Implied equity returns major equity markets



Notes: This graph illustrates the movement in the implied equity returns for a number of major equity markets over time (AEX, S&P500, FTSE, and STOXXX 600) as reported by Groenendijk et al. (2018).

Figure 4: Implied equity returns over time (Groenendijk et al. (2018)

Appendix D: Assumptions OLS regression

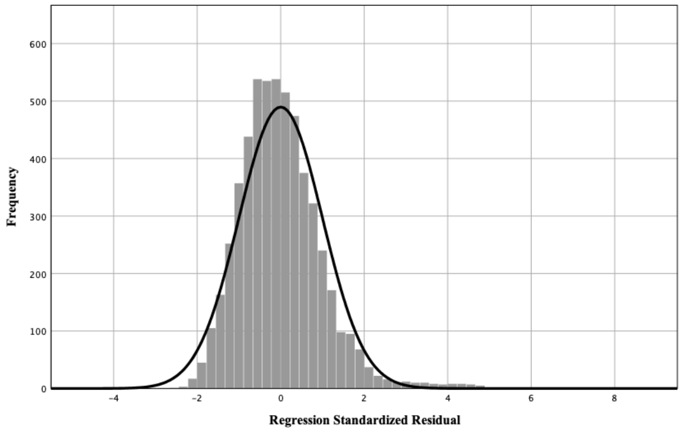


Figure 5: Histogram of residuals: FirmICC, WAL1, CoVCFV and control variables

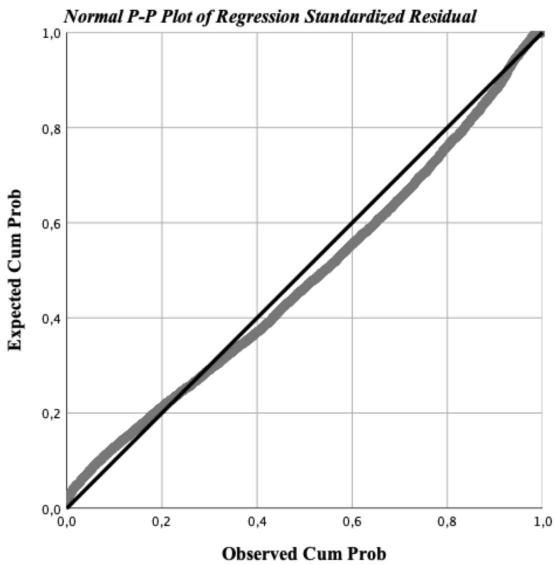


Figure 6: Normal P-P plot: FirmICC, WAL1, CoVCFV and control variables

Table 16: VIF-values of FirmICC on cash flow volatility regressions

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
CoVCFV		1.054		
SalesCFV			1.075	
BECFV				1.282
BookLev	1.204	1.219	1.213	1.272
FA_to_TA	1.102	1.105	1.158	1.108
FirmSize	1.243	1.291	1.249	1.249
M_to_Book	1.432	1.436	1.432	1.614
ROE	1.380	1.381	1.380	1.380
RDexp	1.065	1.080	1.075	1.065

Notes: This table reports the VIF-values corresponding to the independent variables applied in the regressions reported in table 8.

Table 17: VIF-values of FirmICC on asset liquidity regressions

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
PotBuy_N		1.031						
PotBuy_FS			1.208					
Tot_MA				1.015				
WAL1					1.441			
WAL2						5.168		
WAL3							1.978	
MWAL								1.395
CoVCFV	1.054	1.058	1.056	1.055	1.060	1.065	1.056	1.055
BookLev	1.219	1.230	1.266	1.221	1.306	1.263	1.230	1.233
FA_to_TA	1.105	1.105	1.106	1.105	1.401	5.043	1.990	1.278
FirmSize	1.291	1.298	1.296	1.296	1.293	1.291	1.298	1.296
M_to_Book	1.436	1.440	1.442	1.439	1.450	1.445	1.437	1.638
ROE	1.381	1.381	1.381	1.381	1.382	1.387	1.388	1.384
RDexp	1.080	1.087	1.188	1.083	1.086	1.086	1.091	1.109

Notes: This table reports the VIF-values corresponding to the independent variables applied in the regressions reported in table 10.

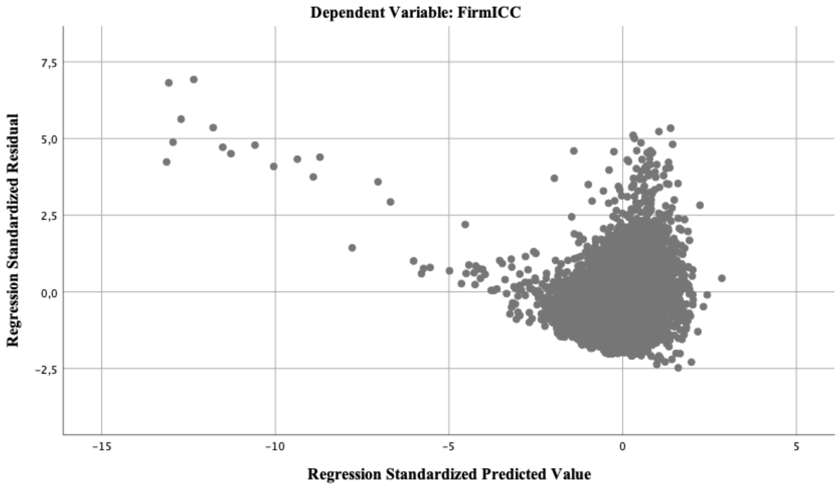


Figure 7: Scatterplot predicted values and residuals regression analysis

Appendix E: Robustness tests

Table 18: Multivariate robustness tests hypothesis 1

Variables	Model 1	Model 2	Model 3	Model 4
Intercept		0.047***	0.059***	0.060***
		(6.947)	(8.803)	(9.693)
CoVCFV		0.011***		
		(8.546)		
SalesCFV			0.022***	
			(4.266)	
BECFV				0.031***
				(4.507)
BookLev	0.028***	0.025***	0.029***	0.021***
	(11.482)	(10.533)	(11.986)	(8.308)
FA_to_TA	-0.002	-0.003	-0.005**	-0.004
	(-0.848)	(-1.239)	(-2.255)	(-1.629)
FirmSize	0.001	0.001***	0.001*	0.001**
	(1.307)	(2.668)	(1.729)	(2.129)
M_to_Book	-0.003***	-0.003***	-0.003***	-0.004***
	(-5.641)	(-5.621)	(-5.685)	(-7.224)
ROE	-0.000	-0.000	-0.000	-0.000
	(-0.456)	(-0.395)	(-0.427)	(-0.534)
RDexp	-0.036***	-0.045***	-0.043***	-0.037***
	(-3.673)	(-4.631)	(4.247)	(-3.833)
N	5519	5519	5519	5519
Adjusted R	0.149	0.160	0.156	0.169
F-statistic	49.702***	57.132***	46.094***	43.086***

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital, calculated with past month stock prices (FirmICC_pm), on the three measures of cash flow volatility (CoVCFV, SalesCFV, and BECFV) and the set of control variables. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in table 2.*

Table 19: Multivariate robustness tests hypothesis 2

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Constant	0.047***	0.051***	0.067***	0.050***	0.054***	0.067***	0.034***	0.013**
	(6.947)	(7.365)	(8.971)	(7.227)	(7.905)	(8.957)	(4.386)	(2.329)
PotBuy_N		0.001***						
		(-4.130)						
PotBuy_FS			-0.027***					
			(-5.379)					
Tot_MA				-0.035***				
				(-3.118)				
WAL1					-0.022***			
					(-5.293)			
WAL2						-0.027***		
						(-4.368)		
WAL3							0.014***	
							(4.216)	
MWAL								0.085***
								(33.103)
CoVCFV	0.011***	0.010***	0.011***	0.011***	0.011***	0.011***	0.010***	0.009***
	(8.546)	(8.311)	(8.787)	(8.625)	(8.927)	(8.958)	(8.396)	(8.123)
BookLev	0.025***	0.026***	0.023***	0.025***	0.022***	0.023***	0.026***	0.016***
	(10.533)	(10.912)	(9.230)	(10.430)	(8.593)	(9.373)	(10.865)	(7.177)
FA_to_TA	-0.003	-0.003	-0.003	-0.003	-0.008***	-0.020***	0.005*	0.027***
	(-1.239)	(-1.268)	(-1.427)	(-1.168)	(-3.398)	(-4.399)	(1.838)	(13.669)
FirmSize	0.001***	0.001**	0.001**	0.001**	0.001***	0.001***	0.001***	0.001
	(2.668)	(2.413)	(2.402)	(2.521)	(2.865)	(2.717)	(2.937)	(0.934)
M_to_Book	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.001***
	(-5.621)	(-5.595)	(-5.593)	(-5.606)	(-5.529)	(-5.572)	(-5.601)	(-3.579)
ROE	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.395)	(-0.392)	(-0.430)	(-0.405)	(-0.338)	(-0.294)	(-0.498)	(0.296)
RDexp	-0.045***	-0.048***	-0.029***	-0.044***	-0.041***	-0.042***	-0.041***	0.011
	(-4.631)	(-4.871)	(-3.079)	(-4.476)	(-4.412)	(-4.444)	(-4.173)	(1.223)
N	5519	5519	5519	5519	5519	5519	5519	5519
Adjusted R	0.160	0.163	0.165	0.162	0.165	0.164	0.163	0.386
F-statistic	57.132***	51.612***	58.741***	51.803***	57.586***	56.411***	51.395***	344.758***

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital, calculated with past month stock prices (FirmICC_pm), on the seven measures of asset liquidity (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, WAL2, WAL3, and MWAL) and the set of control variables. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in table 2.*

Table 20: Multivariate robustness tests hypothesis 3

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	0.051***	0.063***	0.052***	0.052***	0.061***
	(7.301)	(7.587)	(7.439)	(7.458)	(7.727)
PotBuy_N	-0.001*				
	(-1.692)				
PotBuy_N x CoVCFV	-0.001				
	(-0.875)				
PotBuy_FS		-0.020**			
		(-2.432)			
PotBuy_FS x CoVCFV		-0.012*			
		(-0.946)			
Tot_MA			-0.107***		
			(-3.557)		
Tot_MA x CoVCFV			0.108**		
			(2.483)		
WAL1				-0.011	
				(-1.585)	
WAL1 x CoVCFV				-0.020**	
				(-2.073)	
WAL2					-0.0138*
					(-1.708)
WAL2 x CoVCFV					-0.022***
					(-2.902)
CoVCFV	0.011***	0.018**	0.009***	0.014***	0.018***
	(7.703)	(2.402)	(6.010)	(7.191)	(6.241)
BookLev	0.026***	0.023***	0.025***	0.022***	0.024***
	(10.915)	(9.216)	(10.422)	(8.647)	(9.552)
FA_to_TA	-0.003	-0.003*	-0.003	-0.008***	-0.019***
	(-1.315)	(-1.389)	(-1.221)	(-3.358)	(-4.146)
FirmSize	0.001**	0.001**	0.001**	0.001***	0.001***
	(2.439)	(2.388)	(2.465)	(2.916)	(2.828)
M_to_Book	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(-5.595)	(-5.595)	(-5.597)	(-5.533)	(-5.592)
ROE	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.395)	(-0.429)	(-0.382)	(-0.329)	(-0.254)
RDexp	-0.048***	-0.029***	-0.046***	-0.039***	-0.039***
	(-4.884)	(-3.019)	(-4.670)	(-4.287)	(-4.299)
N	5519	5519	5519	5519	5519
Adjusted R	0.163	0.165	0.163	0.165	0.165
F-statistic	45.856***	52.176***	47.555***	51.824***	50.765***

*Notes: This table reports the results from the OLS regression with heteroscedasticity consistent standard errors of the implied cost of equity capital, calculated with past month stock prices (FirmICC_pm), on the relevant measures of asset liquidity (PotBuy_N, PotBuy_FS, Tot_MA, WAL1, and WAL2), the relevant measure of cash flow volatility (CoVCFV), the interaction effect of the asset liquidity and cash flow volatility measures, and the set of control variables. The absolute values of the t-statistics are reported in the parentheses below each estimate. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in table 2.*