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Norwegian School of Economics
Bergen, Spring 2023

The interaction between leverage and cash-balance dynamics

An empirical study of time-series variation in leverage and cash-balance ratios in publicly listed firms in the Nordics

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Master thesis, Economics and Business Administration

Major: Financial Economics

Norwegian School of Economics

Acknowledgements

This master thesis marks the completion of our Master of Science in Economics and Business Administration at the Norwegian School of Economics (NHH). The process of writing this thesis has been both challenging and frustrating at times. However, it has given us valuable insights and experience, and we have made use of knowledge acquired during our studies at NHH, as well as knowledge acquired during the process.

We want to thank our supervisor, Carsten Bienz, for his excellent guidance, support, and engagement. He has assisted us throughout the entire project by challenging our perspectives and providing us with helpful insight whenever needed.

Furthermore, we would like to extend our gratitude to Stafkom which has made our five years at NHH to the best.

Norwegian School of Economics

Bergen, Spring 2023

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Abstract

This paper investigates whether time-series variation in leverage can be linked to hypothetical cash-balance squeezes for Nordic firms. The methodology in this paper is based on the article by DeAngelo, H., Gonçalves, A. S., & Stulz, A. S. (2022). We uncover that high time-series variation in leverage and cash-balance ratios is the norm for firms facing hypothetical cash squeezes in the period January 2000 to December 2021. Capital expenditures are found to be the main users of funds and the primary driver of time-series variation in leverage ratios.

Overall, we document an empirical link between leverage and cash-balance dynamics. Over extended time periods, cash ratios display wide variations that closely resemble and complement the dynamics of capital structure. The interactions between leverage and cash dynamics align with the predictions of the internal-versus-external funding regime outlined in Myers & Majluf (1984). When cash ratios remain stable, leverage tends to be highly volatile, and vice versa. Net-debt ratios are almost always volatile. As internal funds (cash balances) become scarce, most firms significantly increase their leverage. The latter is especially true for firms delisted due to bankruptcy or liquidation.

In sum, we report that there exists an interaction between leverage and cash balances. Consequently, researchers and companies should start to consider the two financial items as co-dependent rather than univariate variables. The research in this paper is placed in the intersection between the research fields of capital structures and cash balances, providing valuable insights to the small research field of leverage and cash dynamics.

Key words: Capital structure, Cash-balances, Time-series variation in leverage, Pecking-order theory

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1 Introduction

Capital structure decisions are like a puzzle – firms must balance their need for funds with the costs and risks of different financing sources. Two key pieces of this puzzle are leverage and cash balances. Both leverage and cash ratios vary over time, and understanding how they interact is crucial for firms to manage their financial risk and performance. Cash and debt can be viewed as substitutes regarding liquidity purposes, whether it concerns covering current expenses, investments, or payout policies. Some companies generate sufficient cash flows from their operations to cover financial needs, but theories argue that having a certain level of debt is favourable for various reasons. Consequently, several firms strive to achieve a leverage target, which represents the optimal mix between debt and equity for a particular company. Conversely, companies that do not generate sufficient financial strength from their operations are forced to seek liquidity in external markets.

Several researchers have sought to understand the time-series variation in leverage and cash through two main theories: the target-based and the funding-related explanations. The target-based explanation focuses on the use of leverage, while the funding-related highlights the need for cash. However, the two prevailing theories do not directly consider how leverage and cash balances are co-dependent. DeAngelo et al. (2022) documents how the unexplored relationship between these two financial items can be understood through the assessment of a hypothetical cash-balance squeeze. The results in their new research have motivated us to seek an answer to the following main research question:

Can time-series variation in leverage be linked to hypothetical cash-balance squeezes for publicly listed firms in the Nordics in the period 2000 to 2021?

A negative hypothetical cash-balance signifies a firm's dependence on additional external financing to cover current operations and/or planned financial policy. Hence, failing to secure the needed funds may compel a firm to adjust its financial policy to avoid financial distress. External financing can be obtained through equity and/or debt markets. The study by DeAngelo et al. (2022) documents that most firms facing a cash-squeeze resolve the situation by taking on additional debt. However, continuous increase of debt is not risk-free, and traditional literature (Beaver, W. H. (1966); Ohlson, J. A. (1980)) suggest that high levels of leverage serve as a reliable predictor of bankruptcy. Yet, these univariate one-period models do not account for how leverage can vary over time. Recent research by DeAngelo et al. (2022) reveals that firms with negative hypothetical cash balances experience larger increases in leverage. Hence, it can be hypothesized that firms exhibiting greater time-series variation in leverage are more likely to face financial distress, and subsequently a higher risk of delisting due to bankruptcy or liquidation. To investigate the empirical support for this relationship, we have developed the following supporting research question:

Is the time-series variation in leverage and cash-balance ratios significantly higher for firms being delisted due to financial distress in the period from 2000 to 2021?

Our full sample includes firms that are delisted throughout the entire period for various reasons, including liquidations and bankruptcies. A closer examination of these financial distressed firms will provide further insight on leverage and cash-balance dynamics. By obtaining time-series characteristics linked to listing status, we can analyze whether these delisted firms are subject to other characteristics compared to firms in the listed sample. The analysis of delisted versus listed firms deviates from the research conducted by DeAngelo et al. (2022).

Although time-series variation in leverage and cash-balance ratios might be linked to specific group characteristics, the traditional literature primarily focuses on the aforementioned target-based explanation and the funding-related explanation. However, dynamic capital structure models have proven that the target-based theory does not hold due to slow Speed of Adjustment [1]. Thus, it is interesting to examine the extent to which the funding-related theory finds empirical support. To explore this, we aim to answer the following supporting research question:

Can capital expenditures and equity payouts be used as primary explanatory variables for the depth of a cash-squeeze for publicly listed firms in the Nordics in the period 2000 to 2021?

[1] Speed of Adjustment (SoA) is the elapsed time between movement from initial leverage ratio to target leverage ratio (DeAngelo, H., DeAngelo, L., & Whited, T. (2011)).

To analyze both the main and supporting research questions, we construct a hypothetical cash-balance based on the methodology developed by DeAngelo (2022). The data is retrieved from Compustat database and covers the period January 2000 to December 2021. Our analyses indicate that firms facing a cash-squeeze exhibit greater time-series variation in leverage and cash-balance ratios, reflected in a negative hypothetical cash-balance. These findings are significant at 5% significance level. Our analyses reveal an inverse relationship between time-series variation in leverage ratios and cash-balance ratios. This suggests that high variation in one ratio is accompanied by lower variation in the other, and vice versa. Our analyses also uncover that time-series variation in leverage and cash balances can be linked to firms' listing status. We have sorted the sample into two groups: delisted firms that go bankrupt or get liquidated, and non-delisted firms. Firms in the former group are subject to greater time-series variation in leverage and cash ratios. This can be linked to the findings on the hypothetical cash-balance, as it is reasonable to assume that financial distressed firms are more likely to have strongly negative hypothetical cash balances. Further analyses report that capital expenditures are the main user funds, and thus the main driver of the uncovered time-series variation in cash and leverage.

Our findings reveal clear interaction between leverage and cash balances – a dynamic that has not been much emphasized in the corporate finance literature so far. Although there is a near understood relation between leverage and cash, the research fields of capital structure and cash balances have been highly isolated for a long time. Few researchers have examined how these two large fields interact. The main descriptive studies of factors affecting capital structures are not considering cash balances as one of the main factors. The studies by Rajan, R. & Zingales, L. (1995), Titman, S., & Wessels, R. (1988), Lemmon, M., Roberts, M., & Zender, J. (2008), and Frank, M. Z., & Goyal, V. K. (2009) are only analyzing leverage in terms of gross debt, such the effect of cash through net-debt is excluded. Moreover, studies that seek to explain the dynamics of cash balances only include leverage as a control variable (Opler et al. (1999); Almeida, H., Campello, M., & Weisbach, M. (2004); Bates, T. W., Kahle, K. M., & Stulz, R. M (2009); Dittmar, A., & Duchin, R. (2010)). With other words, studies who seek to explain the time-series variation in leverage and cash-balance ratios do not consider the trivial fact that the variations in leverage and cash can be co-dependent.

The interactions between leverage and cash-balance ratios are barely considered in a few, and moreover relatively new, studies. DeAngelo, H., & Roll, R. (2015) document how leverage ratios tend to vary widely over extended horizons, just as DeAngelo et al. (2022) find for cash-balance ratios. The latter article (DeAngelo et al. (2022)) also documents how time-series variation in leverage depends strongly on cash balances and vice versa, that cash balances depend strongly on the time-series variation in leverage ratios. Studies by Acharya, V., Almeida, H., & Campello, M. (2007) and DeAngelo, H., Gonçalves, A. S., & Stulz, A. S. (2018) also focus on the interaction between leverage and cash and find that firms deleverage by paying down debt and increasing cash. Studies by DeAngelo, H., DeAngelo, L., & Stulz, R. (2010) , Denis, D., & McKeon, S. B. (2012), and Huang, R., & Ritter, J. R. (2009) also emphasize the interaction between the two financial items and find that firms that issue securities often would have run out of cash without the issuance proceeds. This finding holds to some extent in the paper written by DeAngelo et al. (2022). The article addresses the amount of external financing a firm raises facing a cash-squeeze. In brief, the paper reports widespread use of external debt financing to handle cash squeezes, but a substantial fraction of firms issue only equity. The latter is also documented by Almeido, H., & Campello, M. (2010) and contradicts Myers and Majluf's famous pecking order theory (Myers, S., & Majluf, N. (1984)).

As the literature empirically documents that leverage and cash ratios both exhibit substantial time-series variation when viewed on a univariate basis, it leaves us with the question of how these two major components interact. If we are to continue with the separate research silo approach, we must be confident that leverage and cash holdings decisions depend on separate aspects of financial policy (DeAngelo et al. (2015); DeAngelo et al. (2022)). Such confidence would be reasonable, for instance, if capital structure behaviour mainly reflected attempts to rebalance leverage to a target debt-equity mix, while firms only held cash as a precautionary hedge in case of unanticipated funding emergencies. However, previous research has shown that simply adhering to a target leverage ratio is not enough to explain capital structure behaviour, suggesting that the relationship between leverage and cash balances may be more complex than previously thought (Gamba, A., & Triantis, A. (2008); DeAngelo, H., DeAngelo, L., & Whited, T. (2011); Whited, T., & Hennessy, C. (2005)). These studies empirically record that the target-based explanation does not well explain differences in capital structure regarding leverage targets due to slow Speed of Adjustments. At the same time, the studies find that funding of investments and payouts is of first-order importance for debt issuance. Consequently, the empirical record provides motivation to analyze the interaction of leverage and cash balances as leverage and cash decisions are plausibly interdependent at least through the roles they both play in funding decisions.

The hypothetical cash-balance is calculated as an "as if"-cash-balance, where the calculation yields the cash-balance a firm would have had if it hadn't raised external funds during a specific period. A negative hypothetical ratio is not feasible and implies that the firm would have run out of cash if it had not raised external funds. Equivalently, a positive hypothetical cash-balance implies that the firm generates enough internal funds to proceed with the investment plan without further concerns. To test the significance in the estimated values, we have used a two-sided T-test and a Kruskal Wallis H-test. The T-test is used to check for significant difference between those firms that would have run out of cash and those firms that would not. The Kruskal Wallis H-test is applied to test whether estimated values for 10 decile groups based on time-series in both range and standard deviation is significantly different.

Based on the applied methods and tests, this thesis documents a set of new interactions on the dynamics of leverage and cash-balance ratios for companies in the Nordic states. We find that both cash and leverage tend to vary over extended time horizons, just as DeAngleo et al. (2015) documents for leverage, and as DeAngelo et al. (2022) documents for leverage and cash-balance ratios. In accordance with the findings in DeAngelo et al. (2015) and DeAngelo et al. (2022) we find that there is a clear tendency in how leverage and cash-balance ratios interact. Firms with low time-series variation in leverage ratios tend to have an associated high time-series variation in the cash-balance ratio, and vice versa, firms with high time-series variation in leverage tend to have low time-series variation in the cash-balance ratio. In other words, we find that both market and book leverage ratios are volatile when cash-balance ratios are stable. In addition, cash-balance ratios tend to be quite volatile when leverage ratios are stable. We find that net-debt ratios are almost always subject to substantially high volatility.

The research by DeAngelo et al. (2022) is conducted on US firms in the period from 1950 to 2017. However, as there are large cultural differences between US and Europe, it is interesting to analyze whether the same dynamics hold for the Nordic market. In addition, it is favorable to study another period as firms have developed a lot in the recent years. As an example, current listed firms tend to be more asset light. The analyses performed by DeAngelo et al. (2022) is probably based on more traditional industry. Moreover, there are significant differences in the reporting language in US compared to the Nordic countries. US firms use US GAAP, while the Nordic firms must apply IFRS. As a result, there may be differences in the measurement of leverage and cash balances between the two geographical areas.

The remaining part of this paper is structured as follows: Section 2 provides explanations of the data and underlying methodology. Section 3 documents vital results on time-series variation in leverage and cash-balance ratios. Section 4 provides results on how these financial items interact. Section 5 reports findings on the link between cash-balance squeezes and leverage increases through the construction of a hypothetical cash-balance ratio. In section 6 we summarize our main findings, as well as comparing our results to the findings presented by DeAngelo et al. (2022). Limitations and extensions of the paper are found in section 7. References and appendix are found at the end of the paper.

2 Data and methodology

In this paper we investigate whether the leverage and cash dynamics found in DeAngelo et al. (2022) also applies to the Nordic countries.

2.1 Raw data

To obtain required financial data on Nordic companies, we use the 2023 version of Compustat. The database is produced and delivered by S&P Global Market Intelligence, which is a leading provider of financial and industry data (S&P Global (2023)). The Compustat database provides daily updated and detailed financial information and market data on 33,900 non-U.S. and non-Canadian firms (Wharton Research Data Services (2023)).

Compustat contains various financial information of listed European companies from 1987 to 2023. The financial statement data is first collected by each country's official body in charge of collecting financial information before it is standardized to a global corporate standard by Compustat. Standardization of the data makes it possible to compare across countries as the reporting principles are executed similarly and consistently.

In addition to financial statement data, we utilized data on Consumer Price Index (CPI) in the Nordic countries within coverage of 2000 to 2021. CPI data are collected from *The World Bank*, whose data is gathered data from the International Monetary Fund (The Wolrd Bank (2023)). Data on country-specific CPIs are necessary to control for differences in the timing of arrival of proceeds within a given period when constructing the hypothetical cash-balance. Details of the construction process of the hypothetical cash-balance can be found in Section 2.4.

2.2 From raw data to selected samples

In this sub-section we will present the pathway from raw data to our selected sample. The raw data encompasses all available data, while the selected sample refers to the data we treat in our analysis. To perform our intended analysis, we are dependent on detailed historical financial data and corresponding stock data for Nordic companies.

Our analyses include publicly listed firms in Norway, Denmark, Sweden, Finland, and Iceland. The limitation is made in order to secure consistency in reporting rules and laws, thus securing more robust data. In addition, the Nordic states are relatively homogenous in terms of economic development and culture. The Compustat database contains 2,547 publicly listed firms in the Nordics within the coverage of 2000-2021. The data include both survivors and non-survivors that appeared on Compustat at any time in the sample period.

The downloaded data from Compustat included severe outliers, which entailed abnormal results. As a result, we trimmed all central ratios at the upper and lower 2.5% percentiles to mitigate the effect of these outliers and eradicate errors in the data (Zender et al., 2008). The trimming is done by using winsorizing at 2.5% level in STATA.

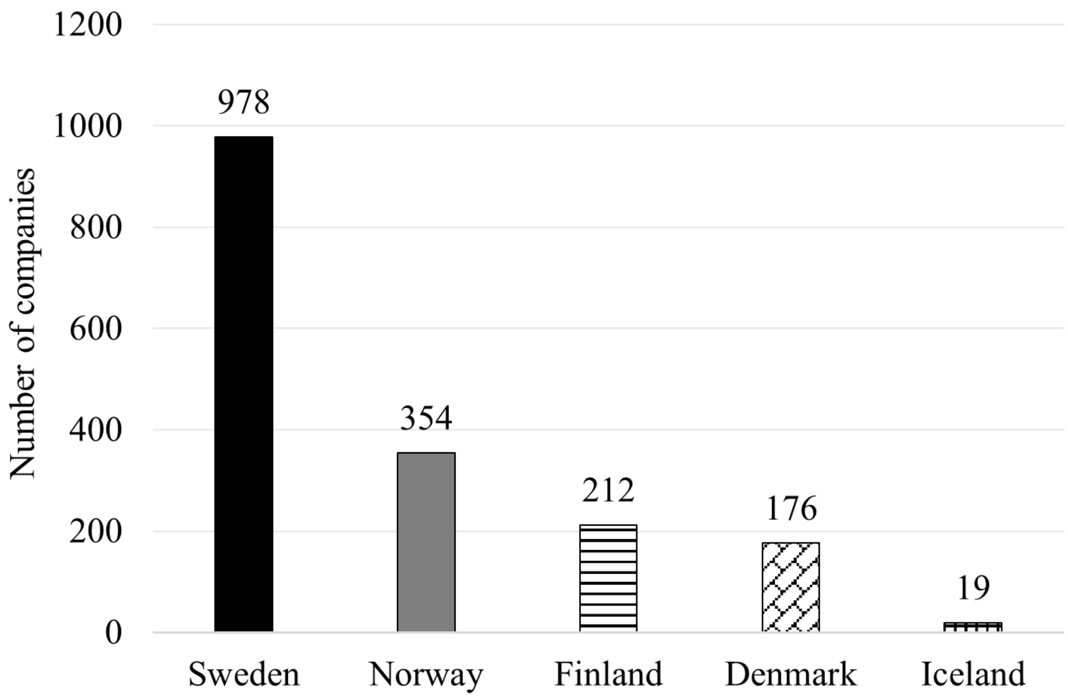
Further two regularities must hold for a firm-year observation to be included in the sample. Firstly, the firm cannot be classified as a financial or utility firm. Thus, we remove all firms with a North American Industry Classification System (NAICS) code starting with 52, 21 and 22. Financial firms are not relevant as their business involves inventories of marketable securities that are included in the cash-balance level, as well as their need to meet statutory capital requirements. Utilities are excluded as their cash balances can be subject to regulatory supervision. This leaves us with a sample consisting of 2,117 listed firms.

The second regularity controls for non-missing data on book value of debt, assets, and cash and Marketable securities for at least two consecutive years. We remove firms with missing market value data at end year as this is essential for the analyses. There are 1,739 firms that satisfy both conditions (hereafter, collectively referred to as the *full sample*). The number of firms provides us with a solid foundation for generalization to the population (Wooldridge (2020)). For some analyses, we focus on a subsample of 599 firms with at least 10 consecutive years of non-missing leverage and cash-balance data. We refer to this sample as the *10-year sample*. The latter subsample is important as firms with just a few years of observations can understate the long-horizon time-series variation in firm-level leverage and cash ratios (DeAngelo et al., 2022).

Based on the restrictions imposed, our full sample contains 978 (56% of full sample) firms in Sweden, 354 (20%) firms in Norway, 212 (12%) firms in Finland, 176 (10%) firms in Denmark, and 19 (1%) firms in Iceland. The relative distribution in the full sample is highly representative for the 10-year sample. Figure 2.1 displys the geographical distribution of the full sample.

Figure 2.1: Geographical distribution of firms in the full sample

The figure exhibits the geographical distribution of firms in the full sample. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.



The historical financial data used in this paper, is based on consolidated financial statements. The principle of consolidated financial statement follows IFRS 10 and is required when an entity (the parent) controls one or more other entities (subsidiaries) (The IFRS Foundation (2023)). The accounting principle ensures that a consolidated financial statement presents the financial statement of a parent and all its subsidiaries as a single economic entity. The use of unconsolidated financial statements is unfavorable as internal transactions would not be eliminated, which means that financial figures do not represent the actual value creation.

This paper is based on a coverage period of 22-years, thus representing a narrower time frame in comparison to similar literature (DeAngelo et al (2015); DeAngelo et al. (2022)). The advantage of a shorter time frame is that we better avoid time-series challenges related to accounting principles changes. The requirement that all European companies follow International Financial Reporting Standards (IFRS) standards within 2005 additionally secured higher quality and more consistent accounting (Deloitte AS (2023)). Consequently, it is easier to compare book values over time and across national borders.

2.3 Definitions and formuals behind central ratios

In this sub-section we present selected financial items and formulas behind central ratios in this paper. For all companies, Compustat provide data on *Total assets (AT)*, *Cash and marketable securities (CHE)*, *Non-current debt liabilities (LCT)*, and *Long-term debt liabilities (DLTT)*. An important notice is that the current debt liabilities and long-term debt liabilities only include interest-bearing debt. This includes for example short-term and long-term liabilities to credit institutions, bond loans, subordinated debt, and convertible debt. The remaining part of debt liabilities includes items such as accounts payable and tax liabilities (Grimsby, G., Eide, L. S., Wiftsad, K. (2017)). To capture the effect of liabilities used for financing purposes, we only consider interest-bearing debt. Equivalently, we exclude all other liabilities in the following analyses. The choice is in line with the methodology used in DeAngelo et al. (2022). As a result, we refer to total debt as the sum of current debt liabilities and long-term debt liabilities (LCT + DLTT).

The market value of equity is calculated as the product of number of *Common shares outstanding (CSHOI)* and *Closing price (PRCCD)* at fiscal year-end. To complement the analyzes, additional variables have been added, such as *North American industry classification code (NAICS)*, *Dividends common (DVC)*, and *Capital expenditure (CAPX)*. The additional variables are necessary for both the main and supporting research questions.

The various balance-metrics are used to calculate central ratios used in this analysis: leverage to total liabilities and market value of equity (ML), book leverage to total assets (BL), cash-balance to total assets (Cash/TA), and net-debt to total assets (Net debt/TA) (DeAngelo et al., 2022).

$$ML = \frac{Book\ value\ of\ total\ liabilities}{Book\ value\ of\ total\ liabilities + Market\ value\ of\ equity} \tag{2.1}$$

$$BL = \frac{Book\ value\ of\ total\ liabilities}{Total\ assets} \tag{2.2}$$

$$Cash/TA = \frac{Cash\ and\ marketable\ securities}{Total\ assets} \tag{2.3}$$

$$Net\ debt/TA = \frac{Book\ value\ of\ total\ liabilities\ \text{-}\ Cash\ and\ marketable\ securitites}{Total\ assets} \tag{2.4}$$

... where

$$Market\ value\ of\ equity = Price\ per\ share \times Number\ of\ shares \tag{2.5}$$

The ML ratio is the book value of leverage divided by the sum of book value of leverage and market value of equity. BL is given by the sum of book leverage divided by total assets. Cash/TA is calculated as the sum of cash and marketable securities divided by total assets. Net debt/TA is defined as net-debt divided by total assets, whereby net-debt equals total liabilities minus cash and marketable securities.

The market and book leverage ratios (ML and BL) share the same nominator, such the ratios become different due to their distinct denominators. The ML ratio is based on the current market value of a company's equity, which depends on the expected future cash flow distributed to shareholders. On the other hand, the BL ratio is based on the book value of assets, i.e., the historical value of a firm's assets. As a result, ML is a forward-looking measure of the extent to which debt is supported by prospective cash flows. Contrary, BL is a backward-looking measure that evaluates the amount of interest-bearing debt a company has already taken on to support its investments (DeAngelo et al., 2022). The net-debt ratio is a backward-looking measure that adjusts BL for the cash a firm can use to reduce its outstanding debt. Hence, the net-debt ratio is special as it contains features from both the book leverage ratio and cash-balance ratio.

The implication of the above-mentioned is that the four ratios are related. Corporate cash holdings (Cash/TA) have a direct impact on the ML ratio, as more cash on hands, holding everything else constant, equals a higher proportion of equity. Alternatively, more cash can symbolize better working capital management which lowers the investment in net working capital (Plenborg (2020)). The result is higher free cash flows in the future. Higher expected cash flows lead to higher firm valuations, and given no changes in debt level, the ML ratio becomes smaller as future expectations about cash rise. On the contrary, lower expectations of future cash flows will lower the market value, and the ML ratio decreases. Moreover, the cash holdings also have an indirect impact on the BL ratio through how increased cash holdings can be used to pay down debt. The latter are mirrored by the company's net-debt, which reports whether the company has most debt liabilities or cash on hand.

2.4 The hypothetical cash-balance

To analyze whether there is a link between time-series variation in leverage and cash squeezes, we construct a hypothetical cash-balance. A hypothetical cash-balance is calculated as the amount of cash a firm would have at the end of an event period if the firm did not raise external funds. An event period is either a period over which Cash/TA increases or decreases. A cash-squeeze period of Cash/TA is defined as moving from peak Cash/TA to later through. Peak Cash/TA is the highest value of the ratio over a firm's time in the sample. The through is given as the lowest Cash/TA ratio a firm attains within 10 years after peak. Focusing on levering-up episodes, we examine firms that move from all-time through levels of either ML, BL, or Net debt/TA to following peak levels of the ratio in question. The peak level is defined as the highest value of the ratio in question within 10 years after the through.

Based on the given event period, a hypothetical cash amount is calculated and represented as *NoExtCap Cash*. The definition of *NoExtCap Cash* is the same whether the ratio is increasing or decreasing. The hypothetical cash-balance is constructed as follows:

$$\textit{NoExtCap Cash} = \textit{CHE(T)} - \textit{Debt Proceeds (t to T)} - \textit{Equity Proceeds (t to T)} \quad (2.6)$$

The construction of the hypothetical cash-balance merely focuses on proceeds. This implies that net cash inflows must be equal to or greater than zero. A negative value is equivalent with no external financing during the period, i.e., negative net cash inflow. This assumption is mirrored in the following formulas as a maximum or minimum constraint. Period t is the year right before the event starts and T denotes the final year of the event window. Period h denotes a specific year during the event period. The hypothetical-cash-balance consists of the following components:

Total debt proceeds are given as the maximum increase in debt from the beginning of event period, t, to end of event period, T, or zero. To satisfy the negative net cash inflow constraint, debt proceeds cannot be less than zero.

$$\textit{Debt Proceeds (t to T)} = \textit{MAX}\ \{\textit{Debt(T)-Debt(t), 0}\} \tag{2.7}$$

In addition to debt proceeds, a firm can increase their cash on hand through equity proceeds. Equity proceeds can occur every year during the event period, and thus we need to find the total accumulated equity proceeds. Thereafter, the equity proceeds are CPI adjusted as the variable definition is to take account of differences in timing of arrival of proceeds within a given event. The consumer price index at different point of time is given as the variable *CPI(h)*. As the CPI differs for every year, total equity proceeds are calculated as the sum of CPI adjusted equity proceeds over the event period.

$$\textit{Equity Proceeds (t to T)} = \sum_{h=t}^{T} \textit{Equity proceeds(h)} \times \frac{CPI(T)}{CPI(h)} \tag{2.8}$$

There are two sources of equity proceeds: equity issuances and equity repurchase. Total equity proceeds at a given time during the event period, is the maximum value of the sum of equity issuance and repurchases or zero. Like debt proceeds, the equity proceeds in one period cannot be less than zero. Consequently, we must subtract increase in funds during the period.

$$\textit{Equity Proceeds(h)} = \textit{MAX}\ \{\textit{Equity issuance(h) - Equity Repurchase(h), 0}\} \tag{2.9}$$

Equity issuance at time h is given as sales of common and preferred stocks *(SSTK)* and change in book value of preferred stocks *(BVPS)*. The latter is given as the Compustat variable *(PSTK)*. First, we calculate the maximum of the change in book value of preferred stocks and zero. This adjustment accounts for changes in the underlying value of equity. Second, we take the maximum value of total sales of common and preferred stocks minus the change in book value of preferred shares, and zero. Thus, the formula provides us with the highest value of proceeds through sales of stocks and zero. Intuitively, it is not possible to sell at a negative price such that the value cannot be less than zero.

$$\textit{Equity Issuance(h)} = \textit{MAX}\ \{\textit{SSTK(h) - MAX[BVPS(h) - BVPS(h-1), 0], 0}\} \tag{2.10}$$

Equity repurchases is based on purchases of common and preferred stocks *(PRSTKC)*, as well as the change in book value of preferred stocks *(BVPS)*. The logic for change in book value of preferred stocks is similar as in the calculation of equity issuances. Total equity repurchases is the maximum value of cash used to buy common and preferred stocks as well as the increase in book value of preferred stocks, and zero. Intuitively, it is not possible to repurchase stocks at a negative cost.

$$\textit{Equity Repurchases(h)} = \textit{MAX}\ \{\textit{PRSTKC(h) - MIN[BVPS(h) - BVPS(h-1), 0], 0}\} \tag{2.11}$$

A constructed hypothetical cash-balance is used to analyze differences in leverage behavior of firms that would have run out of cash absent external funding and those who would not. The former group of firms cannot continue with their investments and payout-plan without raising external funds. The latter group of firms can continue with the intended plans without altering their investment and/or payout decisions. Thus, we can use the hypothetical cash-balance to analyze whether the need for funding is the main driver behind leverage and cash dynamics. Firms running out of cash absent external financing if defined as:

$$\textit{NoExtCap Cash} \leq 0 \tag{2.12}$$

Firms not running of cash absent external financing is defined as:

$$NoExtCap\ Cash \geq 0 \tag{2.13}$$

Secondly, the hypothetical cash-balance is used to calculate hypothetical cash-balance ratios. This is mathematically defined as:

$$NoExtCap\ Cash = \frac{NoExtCap\ Cash}{NoExtCap\ TA} \tag{2.14}$$

The denominator, *NoExtCap TA*, is defined as:

$$NoExtCap\ Cash = TA(T) - Debt\ Proceeds\ (t\ to\ T) - Equity\ Proceeds\ (t\ to\ T) \tag{2.15}$$

As the hypothetical cash-balance estimates the depth of cash squeezes, it is interesting to look at how the firm solve the issue of running out of cash. In other words, it is interesting look at how much capital the firm must raise to avoid running out of cash. To capture the extent of external financing over a firm's cash-squeeze or levering-up episode, we can add the following to our model:

$$\begin{gathered} External\ financing\ as\ a\ fraction\ of\ cash\ held\ at\ the\ end\ of\ the\ episode \\ = \frac{External\ financing}{Cash\ at\ peak\ or\ through} = \frac{Debt\ Proceeds\ (t\ to\ T) + equity\ Proceeds\ (t\ to\ T)}{CHE(T)} \end{gathered} \tag{2.16}$$

... and:

$$\textit{Proportion of external finanicng during the episode that comes from debt} = \delta$$
$$= \frac{\textit{Debt Proceeds (t to T)}}{\textit{MAX[Debt proceeds (t to T)} + \textit{Net Equity Proceeds (t to T), 0]}} \tag{2.17}$$

... where:

$$\textit{Net Equity Proceeds (t to T)} = \sum_{h=t}^{T} \textit{[Equity Issuances(h) - Equity Repurchases(h)]} \times \frac{\textit{CPI(T)}}{\textit{CPI(h)}} \tag{2.18}$$

The first formula considers the amount of external financing as a fraction of cash at the end of period. In other words, the total debt and equity proceeds as a fraction of cash-balance at end of event period. The latter formula estimates the total debt proceeds as a fraction of total external funds.

The calculations of debt and equity proceeds are based on the ones described above. As we want to find the cash-balance without external financing, we must subtract the total increase in funds through debt and equity. As equity proceeds consist of either selling or repurchasing common and preferred stocks, as well as the change in book value of preferred stocks, we calculate the accumulated net effect at each year during event period. Thereafter, the proceeds are CPI-adjusted to account for differences in time of arrival.

The hypothetical cash-balance can be used to test whether and to what extent the funding-related explanation of time-series variation in leverage and cash-balances holds. Thus, it can be useful to analyze capital expenditures and equity payouts at cash squeezes. These variables are categorized as the main users of funds in dynamic capital structure models, like the ones constructed by Gamba, A., & Triantis, A. (2008), DeAngelo, H., DeAngelo, L., & Whited, T. (2011), and Whited, T., & Hennessy, C. (2005). According to these models, capital expenditures and equity payouts are the key decision variables that can generate squeezes on internal funds. This might lead firms to seek external funding, and thereby alter their leverage ratios. Capital expenditures and equity payouts at a firm's cash-squeeze episode is given as follows:

$$\textit{Payouts over a firms's cash-squeeze epside} = \textit{Payouts(t to T)}$$
$$= \sum_{h=t}^{T} \textit{(Dividends} + \textit{MAX[Equity Repurchases(h) - Equity Issuances(h), 0])} \times \frac{\textit{CPI(T)}}{\textit{CPI(h)}} \tag{2.19}$$

Total equity payouts during the event period stems from two sources: regular dividend payouts or net repurchases of stocks. The latter is calculated as the maximum value of net equity proceeds and zero. If the difference between equity repurchases and issuances is negative, the firm has a positive net effect from trading stocks. Thus, the value is set to 0. If the net effect from trading equities is positive, the value is set to the net amount. Thereafter, the accumulated use of funds is calculated. Like the equity proceeds, payouts are CPI adjusted to account for differences in timing of arrival of proceeds within a given event. The CPI adjustment is identical the one described in top of the section. Dividends on common shares *(DVC)* are used as a measure of payouts.

The other main user of internal funds is capital expenditure. Capital expenditure is given by the Compustat variable *CAPX* and calculated as the use of funds due to investment at each year during event period.

$$\begin{gathered}\textit{Capital expenditures over a firm's cash-squeeze episode} \\ = \textit{Capital Expenditures}(t \text{ to } T) = \sum_{h=t}^{T} \textit{Capital Expenditures}(h)\end{gathered} \tag{2.20}$$

3 Vital facts on time-series variation in leverage and cash

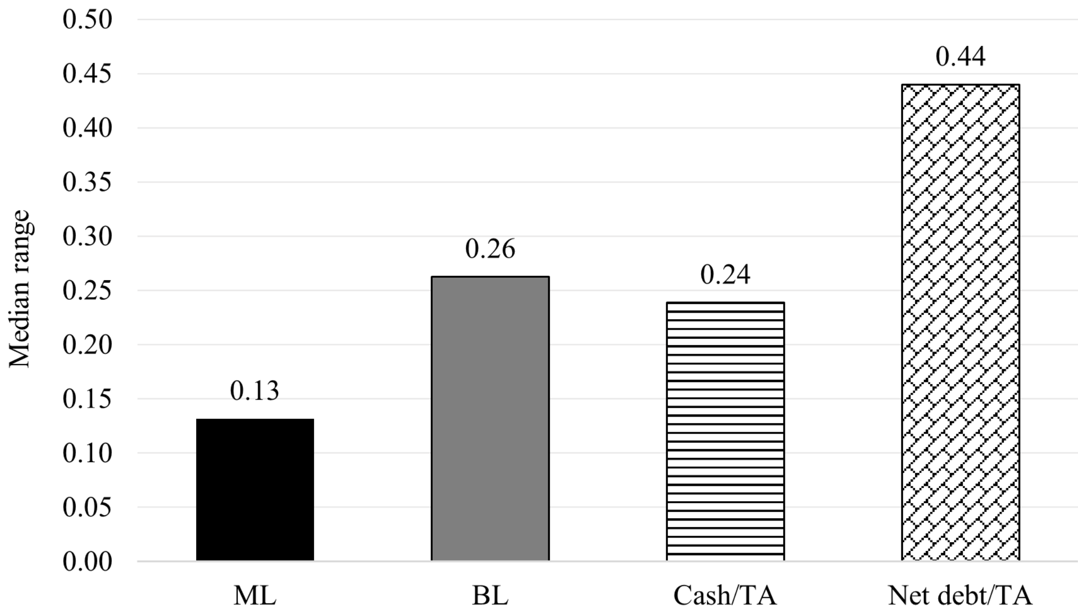
In this section we present vital facts on time-series variation in leverage and cash-balance ratios. The descriptive statistics reported in this section are fundamental for the later findings. In brief, we find that there are substantial cross-firm differences in the median time-series level of leverage and cash-balance ratios.

3.1 Two dominant explanations on time-series variation in leverage and cash

Opler et al. (1999) hypothesize that if a firm has leverage and cash-balance targets that share the determinants, then changes in those determinants will affect both targets. The implication is that leverage and cash-balance ratios should be volatile at the same time due to variation in their shared underlying target determinants. Figure 3.1 shows the median time-series range of leverage and cash-balance ratios for the full time in sample and favors the target-based explanation. A firm's range is defined as the difference between peak and bottom. The ML ratio has the smallest range of 0.13, while net debt ratio has the largest range of 0.44.

Figure 3.1: Time-series ranges over full time in sample

The figure exhibits the time-series median range of ML, BL, Cash/TA and Net debt/TA. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.



On the other hand, the funding-related explanation emphasizes volatility in leverage and cash because of variation in funding needs, which is affected by debt and equity issuance and cash-balance drawdowns. The explanation was first presented by Myers and Majluf's (1984) funding-based analysis of investment-related cash squeezes. Figure 3.2 provides evidence favouring this explanation. The figure reports the median time-series range of ML, BL, Cash/TA and Net debt/TA during three different types of stable episodes. Stable ML is defined as cases where ML stays in a bandwidth of +/- 0.05 (calculated as σ +/- 0.025) for at least 10 years. BL, Cash/TA and Net debt/TA is defined similarly. Among the 599 companies in the 10-year sample, we find that 191 companies have episodes with stable ML, 38 companies have a stable BL episode, 69 companies have a stable episode of Cash/TA and 0 companies have stable Net debt/TA episodes. The latter explains why Net debt/TA is excluded from the figure.

Figure 3.2: Time-series range during stable leverage or stable cash episodes

The figure exhibits the time-series median range of leverage and cash-balance ratios during stable episodes of ML, BL and Cash/TA. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

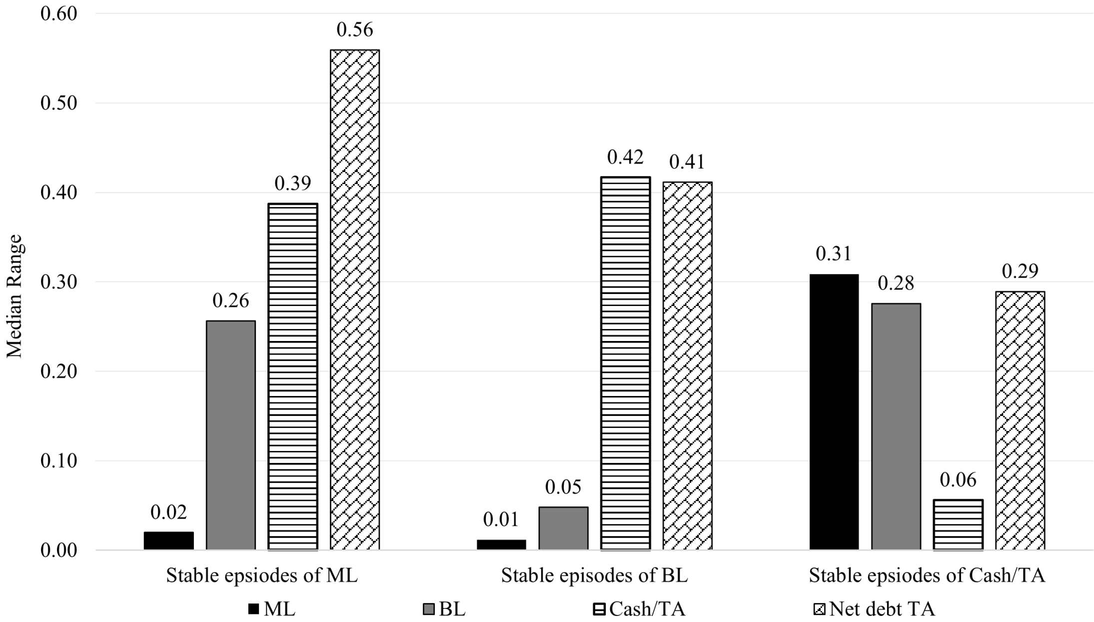


Figure 3.2 documents that Cash/TA varies widely when either ML or BL is stable. When Cash/TA is stable, both ML and BL tend to be volatile and with high standard deviations. Net debt/TA tends to be volatile regardless of definition of stable period. This is reasonable as Net debt/TA accounts for both book leverage and cash. The negative correlation between stability in either ML or BL and Cash/TA, reports an important finding from Figure 3.1. If companies have leverage and Cash/TA targets that share the same determinants, Figure 3.1 should display episodes of stability of one ratio together with episodes of stability in the other. However, Figure 3.1 shows the exact opposite and therefore contradicts the hypothesis constructed by Opler et al (1999).

Figure 3.3 exhibit time-series standard deviation of ML and Cash/TA. The firms are grouped into 10 decile groups based on each firm's specific time-series median Net debt/TA in the 10-year sample.

Figure 3.3: Time-series standard deviations of ML and Cash/TA sorted by firms' median level of Net debt/TA

The figure exhibits time-series median standard deviations of ML and Cash/TA sorted according to each firm's median level of Net debt/TA. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

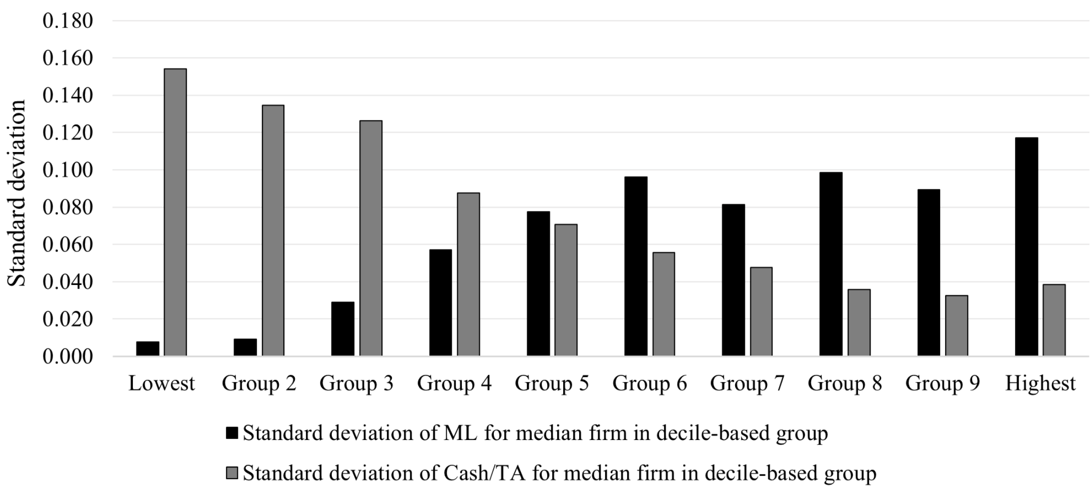


Figure 3.3 exhibits a clear trend in the interaction between leverage (ML) and the cash-balance ratio. Firms with low variation in ML are associated with a high variation in Cash/TA, and vice versa. The results are consistent with the predicted funding regime presented by Myers and Majluf (1984). It may be noted that Figures 3.2 and 3.3 show a level of interrelated trends, where stability in one is accompanied by instability in the other.

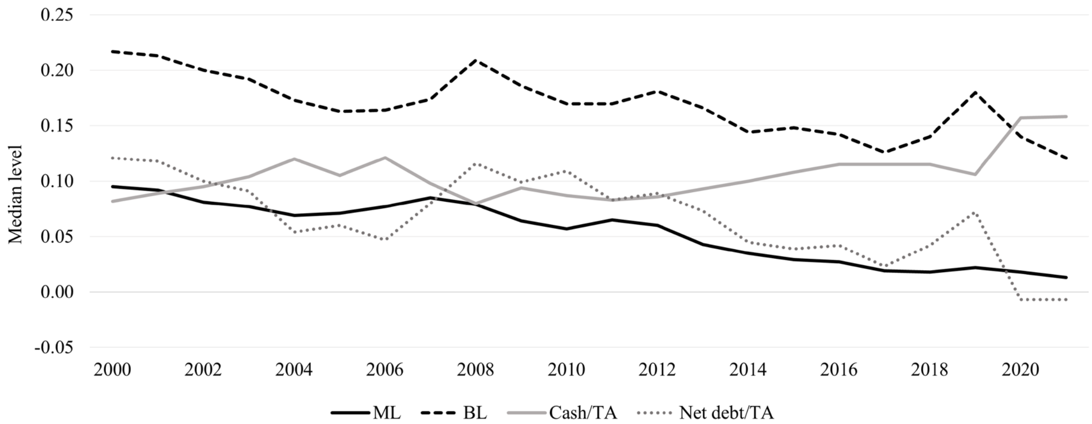
3.2 Fundamental statistics on time-series variation in leverage and cash

Figure 3.4 illustrates how the levels ML, BL, Cash/TA, and Net debt/TA are exposed to changes over time on a univariate basis. The net-debt ratio is subject to greater variation relative to the three other ratios. This is in line with the findings reported in Figure 3.2 and Figure 3.3. The figure illustrates the co-variation between cash, book leverage and net-debt, where an increase in cash-balance ratio is accompanied by a decrease in both book leverage and net-debt. The interpretation is that firms use some of the retained cash holdings to pay down debt, and thereby reduce their net-debt levels. Further, the figure documents spikes in book leverage levels before the financial crisis in 2008 and the Covid-19 crisis in 2020. The latter event is also illustrated through the Cash/TA, which illustrates how firm tends to hold more cash when facing high risk (Opler et al. (1999); Bates, Kahle & Stulz (2009)). Lastly, it is interesting to observe how the ML ratio has altered throughout the years, not following the other three ratios. The latter observation can possibly be explained by how stock valuations have increased over time. The weighted average stock increase from 2000 to 2021 is 356 % [2](Trading Economics (2023)).

[2]The weighted average stock increase is calculated as country specific stock increase from 2000 to 2021 multiplied by the fraction the given country constitute in the full sample Trading Economics (2023)

Figure 3.4: Development of median levels of leverage and cash

The figure exhibits the development of time-series median levels of ML, BL, Cash/TA and Net debt/TA. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.



There are also wide cross-firm differences in the time-series median levels of ML, BL, Cash/TA and Net debt/TA. Figure 3.5 demonstrates how leverage and cash policies vary between firms and there is no one-size-fits-all. Thus, we are likely to discover substantial differences between groups facing a cash-squeeze or not, which is analyzed thoroughly in Section 5.

Figure 3.5: Time-series median levels of leverage and cash in the 10-year sample

The figure exhibits the time-series median levels of leverage and cash-balance ratios. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

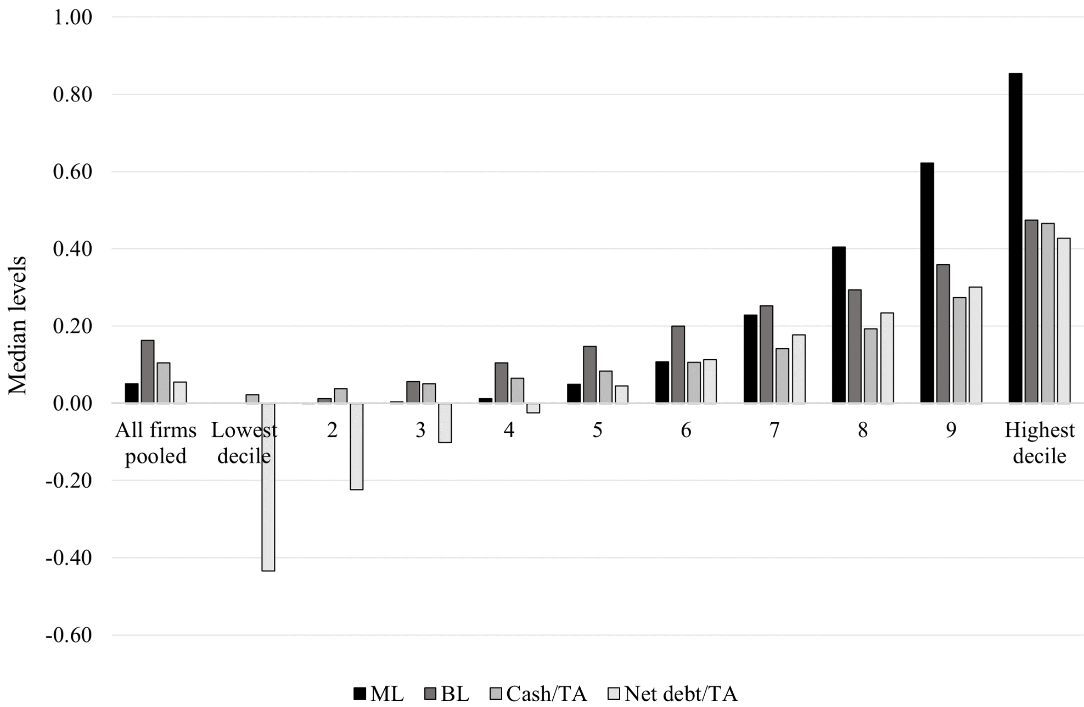


Figure 3.5 highlights the breadth of cross-firm variation in leverage and cash-balance ratios. The first bar-section displays the time-series median level across all firms in the sample. Considering all firms pooled together, we find median values of: ML of 0.050, BL of 0.162, Cash/TA of 0.104 and Net debt/TA of 0.054. Firms in deciles 1, 2, 3 and 4 have a negative time-series median net debt ratio, implying that these firms have higher

cash-balances than interest-bearing debt outstanding. However, a negative time-series median value of Net debt/TA does not necessarily imply that a firm has a permanent negative net-debt ratio as a financial policy target. The negative value could simply reflect transitory cash holdings that are large for extended periods of time (DeAngelo et al., 2022).

Although Figures 3.4 and 3.5 report vital information for our later results, we will not focus on explaining the cross-firm variations in the typical levels of ML, BL, Cash/TA and Net debt/TA. Our focus is to understand the interactions and dynamics of the mentioned ratios for a given firm.

3.3 Time-series variation in leverage and cash over different periods

Tables 3.1, 3.2 and 3.3 report time-series standard deviation and time-series range of ML, BL, Cash/TA and Net debt/TA for the median firm in the full sample.

Table 3.1 reports the standard deviation and time-series range for different time-series intervals for each of the four ratios in the 10-year sample. The first four columns report standard deviation and range based on samples consisting of 2, 5, 10 and 20 years of data. This implies that the column labeled “2” reports the median firm’s standard deviation and time-series range for the chosen leverage and cash-balance ratio using the first 2 annual years of observation for each firm. Similarly, the column labeled “5”, “10” and “20” reports the selected measures for respectively the first 5, 10 and 20 years for each firm. The column labeled "All" is based on the full sample, meaning it uses all available data on ML, BL, Cash/TA and Net debt/TA over the 22-year sample. However, as the periods only differ by 2 years, the values for the full sample are almost identical to the values based on 20 years of data. Both columns labeled “20” and “All” indicate that over long horizons, substantial time-series variation in leverage and cash-balance ratios is the norm for nonfinancial firms in the Nordic states. Our findings on time-series variation in leverage and cash balances confirm the documented trends in DeAngelo et al. (2015) and DeAngelo et al. (2022).

Table 3.1: Standard deviations and ranges: short versus long measurement horizons

The table exhibits standard deviations and ranges for short versus long measurement horizons. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Median value conditional on specified number of years of data:				
	2	5	10	20	All
Time-series standard deviation (σ)					
1. ML	0.006	0.012	0.022	0.045	0.045
2. BL	0.030	0.050	0.062	0.081	0.081
3. Cash/TA	0.050	0.061	0.063	0.074	0.074
4. Net debt/TA	0.079	0.109	0.116	0.135	0.135
Time-series ranges					
5. ML	0.011	0.029	0.059	0.132	0.132
6. BL	0.055	0.126	0.176	0.262	0.262
7. Cash/TA	0.089	0.146	0.176	0.239	0.239
8. Net debt/TA	0.136	0.260	0.325	0.439	0.440

Overall, Table 3.1 reveals that standard deviation and range increase over time for all four ratios. The implication is that one should not just use a few years of data to draw inferences about time-series variation over extended horizons in leverage and cash-balance ratios (DeAngelo et al. (2022)). There are two underlying reasons for this. Firstly, our dataset represents a stochastic process, such the volatility of the outcome variables – ML, BL, Cash/TA and Net debt/TA – increases as shock arrives and accumulates (A2). Extended time horizons increase the likelihood of encountering more shocks, leading to greater variation. Secondly, Compustat includes firms with limited data spanning only a few years, among others, due to factors such as mergers and financial distress. Of a total of 1739 firms, 518 are delisted, whereof 18 firms are delisted due to financial distress or liquidation. As a result, more troubled firms influence a minor fraction of the full sample. To mitigate potential inference problem stemming from delisting, most of our analyses focus on the 599 firms that have 10 consecutive years with non-missing data. However, in relation to our supporting research question, we also execute analyses focusing specifically on the 18 firms delisted due to financial distress.

3.4 Cross-firm differences in time-series variation in leverage and cash

Table 3.2 categorizes companies in the 10-year sample into 10 decile-based groups, sorted according to their time-series standard deviation of ML, BL, Cash/TA, and Net debt/TA. For example, the first row analyzes the sample based on the standard deviation (σ) of the ML ratio. The column labeled "lowest" reports the median for the 10% of firms with smallest standard deviation of the different ratios. The group labeled "2" presents data for the second decile group, i.e., the 10% of the sample with the next lowest standard deviation, and so on. The group labeled "highest" is the 10% of firms with highest standard deviation in the sample.

Table 3.2: Cross-firm distributions of the standard deviations of leverage and cash

The table exhibits cross-firm distributions of standard deviation of leverage and cash-balance ratios. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Sample sorted into ten groups according to each firm's σ of ML, BL, Cash/TA, or Net debt/TA										Ratio of
	Lowest σ group	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Highest σ group	Highest to lowest
Standard deviation (σ) for median firm											
1. ML	0.001	0.006	0.016	0.029	0.050	0.076	0.105	0.143	0.196	0.283	283
2. BL	0.019	0.049	0.063	0.073	0.082	0.096	0.109	0.129	0.151	0.195	10.3
3. Cash/TA	0.017	0.028	0.037	0.049	0.065	0.081	0.104	0.132	0.172	0.222	13.1
4. Net debt/TA	0.064	0.078	0.092	0.111	0.126	0.148	0.172	0.204	0.241	0.316	4.9

Further, Table 3.2 reveals large cross-firm variations in the volatility of ML, BL, Cash/TA and Net debt/TA. The σ(ML) for the highest decile group is 0.283, while the lowest group only have a standard deviation of 0.001. This causes a *highest-to-lowest-ratio* of 283, which implies that there is an extensive range between the minimum and maximum ML ratio among Nordic firms. The value appears extreme because several firms have zero interest-bearing debt. Consequently, the variation in the smallest decile group is minimal. The finding can be linked to Table 4.3 where the median firm has zero debt when ML remains stable for 33% of its lifetime.

The far-right column in 3.2 exhibits that BL, Cash/TA, and Net debt/TA have substantial differences between the lowest and highest decile group. With a ratio of 4.7, the net-debt ratio has the lowest *highest-to-lowest-ratio* of the four ratios. However, the volatility of the net-debt ratio is highest in all 10 decile groups, followed by BL, Cash/TA and ML. The takeaway is that a volatile net-debt ratio tends to be the norm for Nordic firms.

Table 3.3 presents the time-series median level of ML, BL, Cash/TA and Net debt/TA for all 10 decile groups. Firms with low time-series volatility of ML, BL and Cash/TA tend to have low median levels of the corresponding ratio, and vice versa. The opposite is true for Net debt/TA, where we see that low time-series standard deviation is accompanied by a high level of net-debt ratio, and that a high time-series standard deviation tends to have a low (and even negative) net-debt ratio.

Table 3.3: Median time-series levels of leverage and cash sorted by standard deviations

The table exhibits median time-series levels of leverage and cash-balance ratios sorted by standard deviation of the specified ratio. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Sample sorted into ten groups according to each firm's σ of ML, BL, Cash/TA, or Net debt/TA										Ratio of
	Lowest σ group	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Highest σ group	Highest to lowest
Time-series median level of specified ratio for median firm in group											
1. ML	0.000	0.001	0.010	0.030	0.076	0.126	0.268	0.379	0.384	0.389	0.074
2. BL	0.000	0.127	0.152	0.229	0.222	0.210	0.165	0.234	0.182	0.225	0.171
3. Cash/TA	0.035	0.051	0.060	0.075	0.104	0.129	0.131	0.185	0.211	0.273	0.097
4. Net debt/TA	0.230	0.212	0.172	0.115	0.087	0.031	-0.007	-0.013	-0.082	-0.068	0.080

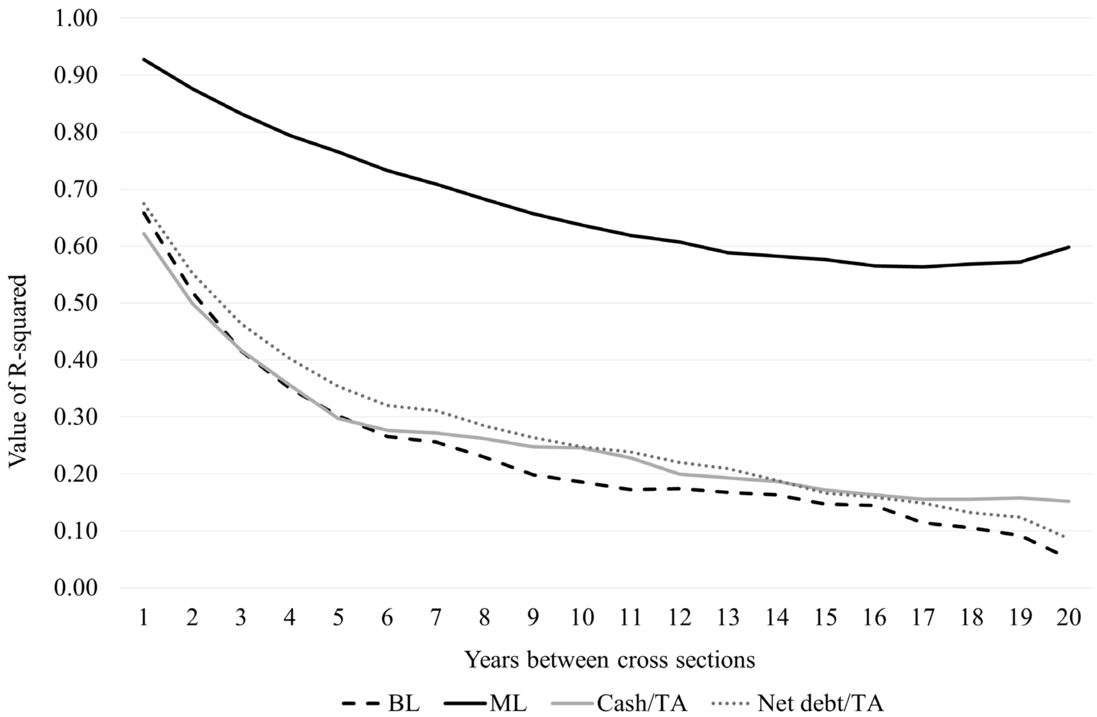
The connections between Table 3.2 and Table 3.3 are important findings for understanding the interactions between leverage and cash-balance ratios. The results are further elaborated on in Sections 4 and 5.

3.5 Time-series variation in leverage and cash over extended horizons

The extent of variation over time in the cross-sectional distributions of ML, BL, Cash/TA, and Net debt/TA is further illustrated in Figure 3.6. The methodology behind Figure 3.6 is based on DeAngelo et al. (2015, Figure 3) and DeAngelo et al. (2022, Figure 4). Figure 3.6 shows the degree of instability in the cross-sectional distribution of leverage and cash-balance ratios. The figure plots the average R-squared for a regression where the independent variable is the lagged variable of the dependent variable. The construction of the regressions is described in more detail in the Appendix (A2).

Figure 3.6: Time-series variation in leverage and cash over extended horizons

The figure exhibits the explanatory power of ML, BL, Cash/TA and Net debt/TA over extended horizons. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.



The overall trend is a modest change in the cross-section over the first few years, followed by a major "scrambling" over extended horizons. The scrambling is neither reverted nor stabilized, and the difference in explanatory power grows each year until there is almost no similarity in cross-sectional snapshots at various times. Hence, high values today are accompanied by high values of the same ratio over the next few years. However, the ability to use today's ratio to predict future values erodes after the first few years. The explanatory power of today's value drops notably during the first 10 years, before the erosion continues at a slower pace for the remaining 10 years until T = 20. As an example, the R-squared of BL, Cash/TA, and Net debt/TA is approximately 0.65 when T = 1 but decreases to approximately 0.25 when T = 10.

Interestingly, the ML-ratio has an R-squared of 0.93 when T = 1, and a R-squared of 0.60 when T = 20. The implication is that the ML ratio has a strong explanatory power cross-sections. The finding is interesting regarding prediction, as 3.6 documents that ML values can be used to predict future ML values to a greater extent than BL, Cash/TA, and Net debt/TA. The ML ratio has a stronger tendency to stabilize, and we observe that it reverts at T = 19. However, there are no good explanations for the reversion, such it should be considered as a random observation.

In sum, there are two important regularities from Figure 3.6. Firstly, the scrambling of the four ratios are univariate results, meaning that the results are based on one explanatory variable. Thus, the results do not consider co-movements over time in the leverage and cash-balance ratios. Secondly, the scrambling documented in Figure 3.6 indicates that a firm's Cash/TA, Net debt/TA, and BL ratio are poor predictors of the ratio in question over longer time horizons. The interpretation is that the standard deviation increases over time, which diminishes the explanatory power of the regressions. These two irregularities point out that high volatility in Cash/TA (and the other ratios) makes it hard to use current cash-balance ratios to predict future the cash-balance cross section over extended periods.

4 The interaction between leverage and cash dynamics

This section presents our findings on the interaction between leverage and cash-balance ratios. The dominating pattern is that sable episodes of ML and BL tend to be accompanied by volatile cash balances, and vice versa. The link to cash-balance squeezes will be discussed in section 5.

4.1 The relationship between leverage and cash

Table 4.1 presents an overview of the relationships between the median levels and volatilities of leverage and cash-balance ratios among firms in the full sample. The firms are sorted into 10 decile groups according to their time-series median net-debt ratio. This is useful as the net-debt ratio incorporates both leverage and cash.

The median firm in the lowest decile group has a net-debt ratio of -0.435, implying that these firms have higher cash holdings than interest-bearing debt. The median firm in the highest decile group has a net-debt ratio of 0.427. The first four decile groups have a negative level of Net debt/TA, indicating that approximately 40% of the firms have higher cash holdings than interest bearing debt liabilities. Row 7 exhibits that group 1 to 7, i.e., approximately 70% of the firms, have had negative net-debt at least once. Row 8 displays that all groups, except the lowest 10%, have had positive values of net-debt at least once during their lifetime. The takeaway is that negative net-debt ratios are common, but usually temporary occurrence in financial policy. Moreover, Table 4.1 reveals that zero debt policies are typically temporary.

Row 4 in Table 4.1 reveals large time-series variation in the net-debt ratio for all ten groups. However, the variation tends to be highest for firms with low net-debt ratio, generally decreasing with an increasing level of Net debt/TA.

Further, Table 4.1 uncovers how firms with low levels of Net debt/TA tend to be accompanied by relatively low values of ML and high values of Cash/TA. This seems reasonable considering that a negative net-debt ratio implies that a firm has more cash than debt, typically being correlated with a high Cash/TA. Further, low values of ML are reasonable as large cash holdings increase the value of equity and thereby decreases ML. Rows 4 and 6 in Table 4.1 exhibit the connection between Net debt/TA and the volatility of ML and Cash/TA. Low levels of Net debt/TA are coupled to high volatility in Net debt/TA and Cash/TA and low volatility in ML. Vice versa, high levels of Net debt/TA tend to be accompanied by low volatility in Net debt/TA and Cash/TA, but high volatility in ML.

However, rows 9 and 10 reveal that most firms carry conservative amounts of interest-bearing debt at some point in time, and positive amounts at other points in time. Even firms with a median value of zero have had positive amounts of debt at some point. In other words, most firms have some time-series variation in leverage. Assessing rows 11 and 12, we see that firms tend to have high levels of cash balances when their ML ratio is low, and vice versa. This finding is in line with the results from Figure 3.2 and Figure 3.3.

The main takeaway from Table 4.1 is that ML typically is volatile for firms with scare cash holdings. Vice versa, ML tends to be stable for firms with more substantial cash holdings. The findings seem plausible as squeezing of cash balances force firms to increase leverage to cover their funding needs.

Table 4.1: Time-series variation in leverage and cash sorted by level of Net debt/TA

The table exhibits the time-series variation in leverage and cash-balance ratios sorted into decile-based groups based on each firm's time-series median level of the net-debt ratio. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Firms sorted into decile-based groups according to time-series median level of Net debt/TA										
Value for median firm	Lowest 10 %	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Highest 10 %	All firms pooled
1. Time-series median Net debt/TA	-0.435	-0.224	-0.102	-0.025	0.044	0.113	0.176	0.233	0.301	0.427	0.080
2. Time-series median ML	0.000	0.001	0.007	0.044	0.091	0.188	0.260	0.277	0.330	0.594	0.074
3. Time-series median Cash/TA	0.459	0.257	0.162	0.127	0.080	0.069	0.053	0.048	0.043	0.049	0.097
4. Standard deviation of Net debt/TA	0.194	0.188	0.180	0.149	0.131	0.121	0.115	0.109	0.100	0.113	0.137
5. Standard deviation of ML	0.001	0.010	0.030	0.057	0.077	0.096	0.081	0.098	0.090	0.117	0.065
6. Standard deviation of Cash/TA	0.154	0.135	0.126	0.087	0.070	0.055	0.044	0.035	0.032	0.038	0.097
7. Time-series minimum Net debt/TA	-0.715	-0.520	-0.444	-0.277	-0.158	-0.126	-0.026	0.004	0.096	0.177	-0.189
8. Time-series maximum Net debt/TA	-0.099	0.067	0.171	0.232	0.267	0.312	0.340	0.393	0.460	0.573	0.326
9. Time-series minimum ML	0.000	0.000	0.000	0.000	0.002	0.022	0.069	0.079	0.085	0.090	0.002
10. Time-series maximum ML	0.025	0.038	0.103	0.254	0.321	0.470	0.570	0.577	0.580	0.800	0.300
11. Time-series minimum Cash/TA	0.180	0.077	0.035	0.026	0.023	0.019	0.013	0.016	0.010	0.010	0.023
12. Time-series maximum Cash/TA	0.735	0.532	0.462	0.360	0.268	0.231	0.179	0.169	0.126	0.140	0.292

4.2 Selected time-series levels and variations in leverage and cash

Table 4.2 Panel A sorts the sample based on each firm's time-series median σ(ML), while Panel B and C sort the sample based on respectively σ(BL) and σ(Cash/TA). The panels only display the median values for the lowest 10% and highest 10% of firms in the sample. This directs attention to the variation within the different ratios, further highlighting the range between the top 10% and bottom 10% of firms.

Panel A and B (row 1 to 8) in Table 4.2 show that firms with low levels of leverage (ML or BL) tend to have low leverage volatility (σ(ML) or σ(BL)) and high and volatile cash-balance ratios (Cash/TA). Contrary, firms with high levels of leverage (ML or BL) tend to have high leverage volatility, but low levels and volatility of the accompanied cash-balance ratio. The observation indicates that high variation in leverage can be linked to low values of cash balances, and thus potentially a cash-squeeze.

Panel C (row 10 to 14) in Table 4.2 sort firms by time-series median cash-balance ratios (Cash/TA). Firms with low levels of Cash/TA tend to have high levels and high volatility of leverage (ML and BL), and vice versa. Panel C also exhibits that low levels of Cash/TA are associated with low volatility of Cash/TA, and that high levels of Cash/TA typically are accompanied by high volatility of Cash/TA. The takeaway from Panel C is that firms with high Cash/TA typically have higher volatility in their cash-balance ratio than their leverage ratio (ML and BL).

Table 4.2: Interactions between time-series levels and volatilities in leverage and cash

The table exhibits time-series levels and volatilities for the lowest 10% and highest 10% of firms based on the ratio in question. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Median time-series level sort		Standard deviation sort	
Values for the median firm in the specified (lowest vs. highest) sample sorting	Lowest 10% (1)	Highest 10% (2)	Lowest 10% (3)	Highest 10% (4)
A. ML sorting				
1. σ(ML)	0.005	0.090	0.001	0.283
2. σ(Cash/TA)	0.147	0.033	0.132	0.091
3. Time-series median ML	0.000	0.853	0.000	0.389
4. Time-series median Cash/TA	0.308	0.053	0.242	0.093
B. BL sorting				
5. σ(BL)	0.045	0.107	0.019	0.194
6. σ(Cash/TA)	0.147	0.040	0.117	0.146
7. Time-series median BL	0.000	0.475	0.000	0.224
8. Time-series median Cash/TA	0.308	0.058	0.274	0.093
C. Cash/TA sorting				
9. σ(Cash/TA)	0.024	0.163	0.017	0.222
10. σ(ML)	0.087	0.008	0.085	0.025
11. σ(BL)	0.084	0.048	0.082	0.113
12. Time-series median Cash/TA	0.022	0.163	0.035	0.0272
13. Time-series median ML	0.252	0.000	0.405	0.003
14. Time-series median BL	0.333	0.000	0.298	0.041

In brief, Table 4.2 reveals that firms that are likely to run out of cash tend to take on debt and keep a considerable proportion of the issuance proceeds as cash balances. The actions result in higher leverage and cash-balance ratios, contributing to increased variation in both metrics. Additionally, the accumulation of issuance proceeds in the cash balances may explain why there is no apparent consistent relationship between leverage volatility and Cash/TA volatility when examining the columns of Table 4.2.

4.3 Assessing the stability of leverage and cash

Table 4.3 examines periods of stable leverage and cash balances. The summary provided is based on the analysis of the longest stable period for each firm, considering only one relevant episode per firm. Panel A examines stable episodes, while panel B examines episodes in which Cash/TA or ML are constantly low (i.e., never above 0.050) or constantly high (i.e., never fall below 0.300).

The first row in panel A reveals that 191 firms have stable episodes of market leverage, 38 have stable episodes of book leverage, and 69 firms have stable episodes of the cash-balance ratio. Net debt/TA is excluded from the table because none of the firms in the sample have stable episodes of Net debt/TA. The finding is in line with Figure 3.3 and indicates that at least one of the elements in the net-debt ratio (i.e., BL or Cash/TA) changes enough to violate the 0.050 bandwidth condition for Net debt/TA.

Row 3 in Table 4.3 shows that for the firms with stable ML episodes, the median number of years with data is 15 years. Similarly, for firms with stable BL and Cash/TA, the median number of years with data is respectively 15 and 19 years. Hence, the presented standard deviation, range and time-series median level is based on respectively 15, 14 and 19 consecutive years of data.

Panel B column 1 in Table 4.3 shows that when ML is stable, BL typically have low volatility, while Cash/TA and Net debt/TA tend to be volatile. Whitin a stable episode of ML, the median firm have σ(ML) of 0.007 and σ(Cash/TA) of 0.118. Hence, the Cash/TA ratio is approximately 16 times more volatile than the ML ratio. The same is more or less true for the range, as the range(Cash/TA) are calculated to be approximately 19 times larger than the range(ML). The same analysis on stable BL (Column 2) episodes finds that the Cash/TA ratio is approximately 9 times more volatile than the BL ratio, and exactly the same relation is found between range(Cash/TA) and range(BL). The latter is in accordance with the analysis conducted on the American market (DeAngelo et al. (2022)).

The third column in Panel B Table 4.3 highlights that stable episodes of Cash/TA tend to occur when firms have low levels of the cash-balance ratio, and moreover both high and volatile leverage ratios (ML and BL). These findings indicate that cash-balance squeezes tend to result in increased borrowing, causing higher volatility in both leverage ratios.

Table 4.3 also indicates that stable leverage episodes tend to occur during two types of episodes. First, when ML and BL are equal and/or close to zero, which is in line with DeAngelo et al. (2015) and DeAngelo et al. (2022). Second, when Cash/TA are both high and volatile. The latter is also consistent with the reported findings in DeAngelo et al. (2022). Hence, there is a strong tendency for firms in stable ML and/or BL regimes to have no interest-bearing debt outstanding, causing negative net-debt ratios. In other words, firms with excess cash tend to have minimal (or no) interest-bearing debt, with following low volatility in leverage ratios. The findings suggest there is a connection between time series variation in leverage and cash squeezes.

Panel C in Table 4.3 provides additional answers to our main research question. Panel C row 1 shows the percentage of firms in the sample with a negative net-debt ratio under the different episodes of stability. In stable ML regimes, 62% of the firms in the sample have negative net debt. Under stable BL regimes 93% of the firms have a negative net-debt ratio, and 0% of the firms have a negative net-debt ratio under stable cash-balance regimes. Further, the analysis uncovers that 33% of firms have zero interest-bearing debt during a stable ML episode. When BL is stable, 60% of the firms have zero interest-bearing debt. There are zero firms with zero interest-bearing debt under stable cash-balance regimes. Hence, many firms in stable ML and BL regimes have zero interest-bearing debt and a relative abundance of cash. Contrary, there are no firms subject to stable cash balances and no interest-bearing debt. This is plausible considering our earlier findings about the correlation between low volatility and levels of the cash-balance ratio.

Only 5% of the firms in the full sample have zero debt for all 22 years. Consequently, one should rather talk about financing regimes in which firms have temporarily zero interest-bearing debt, and not about firms always avoiding debt (DeAngelo et al. (2022)). The fact is that avoiding debt is an ultra-rare phenomenon. This is also emphasized by DeAngelo et al. (2015). Further, assessing episodes where Cash/TA > 0.300, we see that there is both a higher fraction of firms with negative net-debt and a non-trivial fraction of firms with zero debt. This strengthens our earlier findings, underlining that firms with high volatility in Cash/TA tend to have low levels of BL, i.e., low debt.

Table 4.3: Stable leverage and cash episodes

The table exhibits stable leverage and cash-balance episodes in the 10-year sample. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA. Panel D displays the subsample of 18 firms that were delisted due to financial distress.

	Episodes with ratio remaining in 0.050 bandwidth			Episodes with consistently low or consistently high ratios			
				Cash/TA during episode		ML during episode	
	Market leverage	Book leverage	Cash-balance ratio	<0.050	≥ 0.300	<0.050	≥0.300
A. Number of firms	191	38	69	175	115	176	181
Percent of sample	31.8%	6.3%	11.5%	29.2%	19.1%	46.1%	30.2%
Median number of years in episode	15	14	19	19	16	20	16
B. Median firm's value (during episode) of							
σ(ML)	0.007	0.003	0.0914	0.086	0.020	0.014	0.135
σ(BL)	0.076	0.014	0.081	0.090	0.083	0.093	0.088
σ(Cash/TA)	0.118	0.117	0.018	0.041	0.144	0.114	0.041
σ(Net debt/TA)	0.162	0.117	0.084	0.115	0.192	0.172	0.107
Range(ML)	0.020	0.011	0.108	0.298	0.065	0.049	0.433
Range(BL)	0.256	0.047	0.276	0.304	0.249	0.297	0.301
Range(Cash/TA)	0.387	0.417	0.056	0.147	0.446	0.377	0.149
Range(Net debt/TA)	0.559	0.411	0.289	0.403	0.612	0.588	0.386
Time-series median ML	0.001	0.000	0.352	0,230	0.001	0.002	0.614
Time-series median BL	0.054	0.000	0.301	0.252	0.038	0.065	0.271
Time-series median Cash/TA	0.170	0.358	0.034	0.046	0.306	0.163	0.058
Time-series median Net debt/TA	-0.091	-0.335	0.264	0.202	-0.223	-0.078	0.212
C. Median firm's % of years in episode with							
Negative net debt	62%	93%	0%	0%	58%	50%	0%
Zero debt	33%	60%	0%	0%	26%	10%	0%
D. Number of liquidated or bankrupted firms	1	1	0	0	1	1	6
Percent of sample	0.2%	0.2%	0.0%	0.0%	0.2%	0.2%	1.0%

As mentioned in Section 3, delisting of firms will affect the long-term time-series variation (DeAngelo et al (2022)). Panel D in Table 4.4 reports the number of delisted firms due to bankruptcies and liquidations. In our full sample there are 4 firms that go bankrupt and 14 firms that get liquidated because of financial distress. In the following we refer to these firms as “delisted firms”. Firms get delisted through the whole sample period and the delisted firms belong to different industries and nationalities. Based on the reported results in Table 4.4, we can report three interesting regularities about the delisted firms. Firstly, the number of delisted firms is highest when ML is sufficiently high (ML $>$ 0.300). This can be explained by either higher levels of leverage or lower valuations. Secondly, the number of delisted firms decrease as ML decreases. Thirdly, only one firm get delisted when Cash/TA is equally high as ML (Cash/TA $>$ 0.300). Hence, it is inferred that delisted firms tend to use a greater extent of interest-bearing debt to cover funding needs. The plausible explanation is that firms with high cash holdings generate sufficient cash flows through operational activities to cover current expenses, making the firms less in need of interest-bearing debt.

The key takeaway from Table 4.4 is that delisted firms are subject to greater time-series variation compared to firms listed for at least 10 years. More detailed group characteristics of delisted firms are shown in Table 4.4, which groups the sample into 10 decile groups based on both time-series levels and standard deviations. In general, the standard deviation of Cash/TA is higher among the delisted firms versus the listed firms. However, the table reveals large cross-firm differences among the delisted firms. In sum, financial distressed firms have significantly greater time-series variation in cash and leverage ratios compared to listed firms. This provides an answer to our first supporting research question. Moreover, it highlights the potential of our main research question to supply insights that may be useful in future for evaluating the cash management within firms.

Table 4.4: Interactions of time-series levels and volatilities in leverage and cash for delisted firms

The table exhibits median time-series levels and volatilities for the lowest 10% and highest 10% of delisted firms based on the ratio in question. The sample consists of 18 firms that were delisted due to financial distress in the period from 2000 to 2021. This subsample is derived from the full sample. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Median time-series level sort		Standard deviation sort	
Values for the median firm in the specified (lowest vs. highest) sample sorting	Lowest 10% (1)	Highest 10% (2)	Lowest 10% (3)	Highest 10% (4)
A. ML sorting				
1. σ(ML)	0.007	0.074	0.007	0.074
2. σ(Cash/TA)	0.204	0.029	0.204	0.118
3. Time-series median ML	0.000	0.883	0.005	0.235
4. Time-series median Cash/TA	0.196	0.060	0.196	0.061
B. BL sorting				
5. σ(BL)	0.019	0.159	0.019	0.159
6. σ(Cash/TA)	0.204	0.118	0.204	0.118
7. Time-series median BL	0.019	0.155	0.007	0.155
8. Time-series median Cash/TA	0.196	0.060	0.196	0.060
C. Cash/TA sorting				
9. σ(Cash/TA)	0.024	0.204	0.118	0.204
10. σ(ML)	0.074	0.007	0.085	0.025
11. σ(BL)	0.159	0.007	0.159	0.019
12. Time-series median Cash/TA	0.060	0.196	0.024	0.188
13. Time-series median ML	0.404	0.000	0.477	0.002
14. Time-series median BL	0.287	0.000	0.292	0.021

5 The link between time-series variation in leverage and hypothetical cash-balance squeezes

In this section we answer our main research question. Overall, we find a significant link between high time-series variation in leverage and hypothetical cash-balance squeezes. We also provide evidence that the time-series variation in leverage can be linked to firms' listing status. Capital expenditures are found to be the primary driver of the observed time-series variation.

5.1 Firms increase leverage when squeezing cash balances

Tables 5.1 analyzes cash-balance ratios and leverage ratios for firms in a cash-squeeze episode of Cash/TA for both full sample (Table 5.1). For brevity, we focus on the full sample as the results are similar for both samples. The findings on the 10-year sample are tabulated in Table the Appendix (A3).

The second column in Table 5.1 considers the subset of firms that would have run out of cash had they not raised external funding during the cash-squeeze episode. Column 3 addresses the firms that had a positive cash-balance at through without raising external funds. Row 3 displays the constructed hypothetical cash-balance at end of event period. An important note is that the hypothetical cash-balance assumes that everything else (i.e., earnings, investment, payouts, etc.), besides external funding during the episode, remains constant. A negative hypothetical cash-balance is not feasible in real life as firms cannot operate with negative cash balances.

The hypothetical cash-balance does not account for whether or to what extent firms adjusted their investments or payouts to avoid cash shortage. Therefore, we cannot conclude that a firm with a positive hypothetical cash-balance was completely immune to the pressure of running out of cash. The firm may have modified its investment and/or payout decisions during the period to prevent a cash shortage, which necessitated raising external funds. This is a natural response as investment and payout decisions are influenced by internal factors and must adhere to the firm's resource constraints. As a result, the analysis focuses on the actual investment and payout plan chosen and implemented during the specified period. This means that we examine how leverage ratios change based on whether the actual investment and/or payout decision required external funds.

Table 5.1 exhibits the movements of ML in a cash-squeeze period of Cash/TA by studying three subgroups: 1) all firms pooled, 2) positive or negative hypothetical cash-balance, and 3) debt as fraction of external funds. The median firm in the pooled full sample has a peak Cash/TA of 0.261 and a through value of 0.059 (panel A, rows 1 and 2). This large decrease in cash balances indicates a substantial cash squeeze. However, Cash/TA tends to underestimate the actual size of the cash-squeeze that firms typically face. The underestimation arises because firms facing cash-squeezes have incentives to raise funds and hold some of the funds as a precautionary hedge. This phenomenon was first documented by Bates, Kahle, & Stulz (2009), and later by Denis & McKeon (2021). The latter duo analyzes the importance of understanding the long-term temporal increase in average cash ratios first documented by the former researchers.

Table 5.1: Cash squeezes and contemporaneous leverage increases in the full sample

The table exhibits cash squeezes and contemporaneous leverage increases. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. The firm must have at least one year of data on Compustat after peak Cash/TA. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

		Would run out of cash without external funds?			Debt proceeds as a % of total external funds raised (δ)			
Median value (except Rows 8 and 9)	All firms pooled	Yes	No	T-statistic	$\delta = 100\%$ all debt	$0\%<\delta\leq 50\%$ issue mostly debt	$0\%<\delta\leq 50\%$ issue mostly equity	$\delta = 0\%$ all equity
Full sample								
1. Cash/TA at peak	0.261	0.240	0.307	-9.57***	0.197	0.233	0.396	0.224
2. Cash/TA at later through	0.059	0.053	0.094	-9.07***	0.057	0.056	0.090	0.049
3. Cash/TA at through w/o external financing	-0.319	-0.661	0.118	-4.80***	-0.163	-0.698	-0.957	0.048
4. External financing as a % of cash at through	369%	721%	2%	3.82***	291%	808%	511%	1%
5. ML at peak Cash/TA	0.018	0.035	0.001	3.09***	0.064	0.035	0.001	0.003
6. ML at later through	0.047	0.095	0.002	7.10***	0.156	0.101	0.002	0.003
7. Number of years from peak to through	3	3	3		2	3	2	4
8. Number of firms	1495	709	307		196	340	418	373
9. Percent of sample	100%	70%	30%		15%	26%	31%	28%

Row 3 in Table 5.1 exhibits the hypothetical cash-balance for seven sub-groups. The hypothetical cash-balance ratio for the median firm in the full sample is -0.319 (row 3, column 1), indicating a substantial cash squeeze. Hence, the median firm in the sample would not have been able to carry out chosen investment and payout decisions without raising external funds. The depth of the cash-squeeze can be seen as the amount of external capital raised from peak to later through. The median firm raised external capital equivalent to 369% of the cash held at through (row 4, column 1). The reported results document severe funding needs to carry out intended plans during event period.

Furthermore, rows 5 and 6 in Table 5.1 reveal that firms tend to increase ML when facing the risk of running out of cash. The remaining group of firms only have a minor increase in ML. The former group of firms increase ML from 0.035 to 0.095, while the latter group of firms only increase ML from 0.001 to 0.002. This difference in ML behavior is statistically significant at 1% level with a P-value below 0.010. The difference is also significant at 1% level when addressing peak Cash/TA, through Cash/TA, and hypothetical cash-balance. This indicates a significant different behavior between the firms that would have experienced a cash-squeeze if they had not raised external funds during the event period and not.

The proportion of external financing is denoted by δ, whereby δ=100% indicates that all such financing came from debt and δ=0% implies that all external financing came from equity. In the full sample, 41% of firms issue at least 50% debt, while most firms issue at least some debt. However, 28% of the firms only issue equity. The latter finding is important and surprising as it clearly violates both pecking order theory and standard trade-off theory in which the use of debt generates a benefit in terms of tax shield. Thus, in perfect capital markets with taxation, we should expect firms to use debt instead of equity. However, our analyses show that these theories are not always supported by empirical findings.

The four sub-groups in column 5 to 8 are subject to major differences in both leverage and cash-balance behavior. Firms with δ=100% experience a median ML increase from 0.064 to 0.156. Firms that issue more than 50% debt experience a median ML increase from 0.035 to 0.101. The group of firms that issue less debt than equity have a significantly smaller increase in ML, with a minor increase from 0.001 to 0.002. The findings are similar for the 10-year sample. Firms that only issue equity experience a decrease in ML from peak to later through. The explanation is that firms with a near-zero leverage ratio will decrease the amount of debt relative to equity, and thus adjust their marginal debt-equity ratio slightly below the initial debt amount.

Overall, the findings tabulated in Table 5.1 exhibits that time-series variation in leverage and cash balances can be linked to hypothetical cash squeezes. Firms facing a cash-squeeze increase ML by a significantly greater amount than firms not facing a cash-squeeze.

5.2 Firms face cash squeezes when levering-up

In this subsection we reverse the prior approach and study a situation where firms in the full sample lever up. For brevity, we focus on the full sample as the results are similar for both samples. Table 5.2 reports the results of the full sample from analyzing cash squeezes when firms lever up. The overall findings are that most firms would have run out of cash without raising external funds. The corresponding ML and Net debt/TA increased by a significantly larger amount for those firms running out of cash. Firms with a substantial cash-squeeze increase leverage by a significant amount, inducing greater time-series variation in leverage. The finding provides further answer on our main research question.

Sorting on ML and Net debt/TA, most firms experience a cash-squeeze. Further, to account for the cash-squeeze, firms increase cash balances drastically by raising respectively 510% and 703% of cash levels at peak during the event (from through to later peak). As a response, ML or Net debt/TA increases significantly. The median ML at through is 0.016 and further 0.169 at later peak. The median Net debt/TA moves from -0.086 at through to 0.240 at peak. The substantial change in ML and Net debt/TA implies an increase in leverage. Hence, firms that experience a hypothetical cash-squeeze in levering-up periods have greater time-series variation in leverage compared to deleveraging periods.

Table 5.2: Cash squeezes when firms lever up

The table exhibits cash-balance squeezes when firms lever up. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. The firm must have at least one year of data on Compustat after through ML or Net debt/TA. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	ML				Net debt/TA			
		Would run out of cash?				Would run out of cash?		
Median value (except Rows 8 and 9)	All firms pooled	Yes	No	T-statistic	All firms pooled	Yes	No	T-statistic
A. Full sample								
1. Cash/TA at leverage through	0.112	0.106	0.159	-8.84***	0.219	0.203	0.379	-9.07***
2. Cash/TA at leverage peak	0.082	0.073	0.162	-8.37***	0.072	0.064	0.126	-10.99***
3. Cash/TA at leverage peak w/o external financing	-0.442	-0.637	0.104	-1.70*	-0.491	-0.825	0.179	-2.74***
4. External financing as a % of cash at peak	392%	510%	20%	2.37***	455%	703%	5%	1.47*
5. ML or Net debt/TA at its through	0.000	0.016	0.001	3.63***	-0.282	-0.086	-0.534	9.20***
6. ML or Net debt/TA at its peak	0.115	0.169	0.028	3.41***	0.153	0.240	-0.027	8.82***
7. Number of years from peak to through	3	4	2		3	4	3	
8. Number of firms	1495	758	222		1495	689	238	
9. Percent of sample	100%	77%	23%		100%	74%	26%	

The time-series variation in leverage and cash-balance ratios can partly be explained by analyzing delisted firms, as these firms often are exposed to severe cash squeezes. The findings, consistent with the reported results in Section 4 and presented in Table 5.3, reveal a significant disparity in leverage and cash-balance behaviour between delisted and non-delisted firms. The changes in leverage and cash-balance ratios illustrate the fluctuations observed over time. A T-test confirms that delisted firms experience a significantly higher increase in leverage compared to non-delisted firms, indicating their tendency to take on more interest-bearing debt. Consequently, the accompanied higher leverage ratio can account for why these firms face delisting due to financial distress. These findings align with the bankruptcy models proposed by Beaver (1966) and Ohlson (1980). Hence, incorporating time-series variation in leverage as an additional explanatory variable may enhance existing models.

Table 5.3: Cash squeezes and levering-up periods for delisted firms

The table exhibits cash-squeeze and levering-up episodes for delisted firms. The sample consists of 18 firms that were delisted due to financial distress in the period from 2000 to 2021. This subsample is derived from the full sample. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

Median value	Delisted firms	Non-delisted firms	T-statistic
From peak to later through Cash/TA			
1. Cash/TA at peak	0.437	0.261	-4.649***
2. Cash/TA at later through	0.028	0.059	0.644
3. Cash/TA at through w/o external financing	-0.608	-0.319	-0.213
4. External financing as a % of cash at through	484%	369%	-0.054
5. ML at peak Cash/TA	0.018	0.018	-0.59
6. ML at later through	0.065	0.047	4.655***
From through to later peak ML			
1. Cash/TA at through	0.070	0.112	1.127
2. Cash/TA at later peak	0.041	0.082	3.569***
3. Cash/TA at through w/o external financing	-1.312	-0.442	-0.004
4. External financing as a % of cash at through	362%	392%	-0.1867
5. ML at through	0.020	0.000	-2.217**
6. ML at later peak	0.232	0.115	-1.91**
From through to later peak BL			
1. Cash/TA at through	0.116	0.116	-0.435
2. Cash/TA at later peak	0.043	0.079	0.048
3. Cash/TA at through w/o external financing	-1.463	-0.480	-0.187
4. External financing as a % of cash at through	427 %	414%	-0.262
5. BL at through	0.000	0.017	4.60***
6. BL at later peak	0.262	0.279	-9.29***

Figures 5.1, 5.2 and 5.3 highlight the differences in cash squeezes between levering-up and cash-squeeze episodes. Figure 5.1 displays the depth of cash squeezes and illustrates that the median firm in a levering-up episode raises at least 400% of its end cash-balance. The median firm in a cash-squeeze episode raises only 150% to 250% of its end cash-balance. The findings imply that a levering-up firm requires more funds to avoid running out of cash. Both levering-up and cash-squeeze episodes provide answer to our main research question, as it documents that cash squeezes are solved through leverage increases. The key takeaway is that more severe cash-squeeze is accompanied with greater increase in leverage.

Figure 5.1: External funding as a percent of cash balances at end of period

The figure exhibits the median firm's external funding as a percent of cash balances at end of period. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

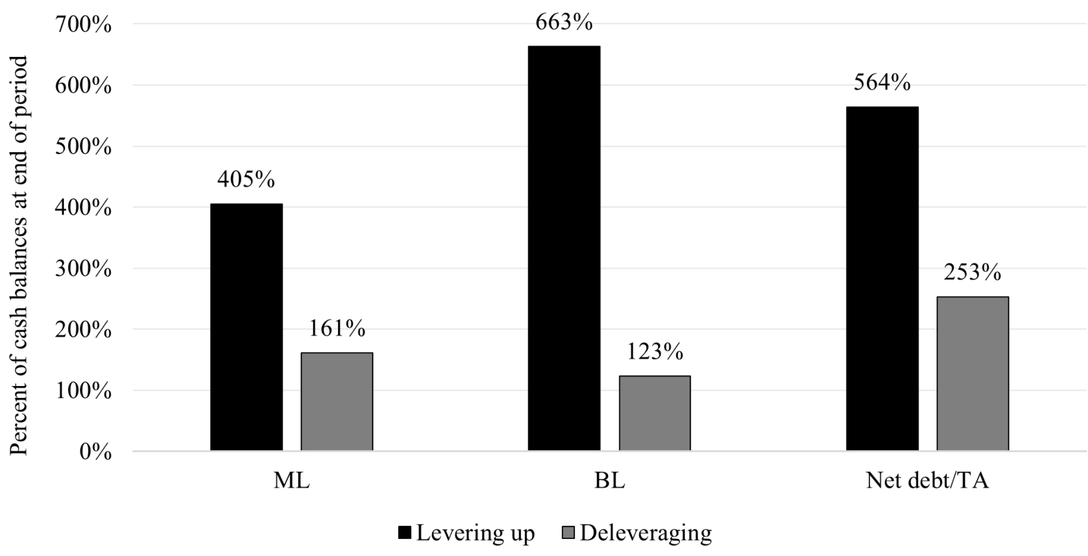


Figure 5.2 considers the median firm's hypothetical cash-balance ratio absent external funding. The median levering-up firm would have had a greatly negative hypothetical cash-balance ratio without raising external funds. The median deleveraging firm experiences a smaller hypothetical cash-balance ratio. Sorting firm based on their deleveraging in ML and Net debt/TA results in a slightly negative cash-balance ratio, whereas sorting based on deleveraging in BL leads to a slightly positive cash-balance ratio.

Figure 5.2: Hypothetical Cash/TA absent external funding

The figure exhibits the median firm's hypothetical Cash/TA absent external funding. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

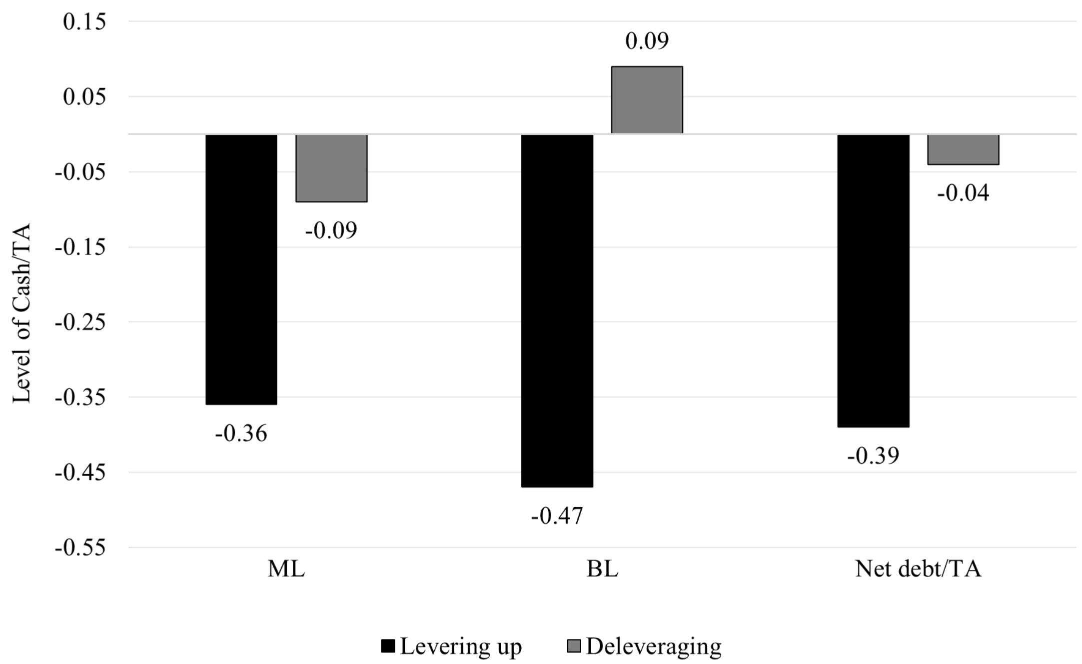
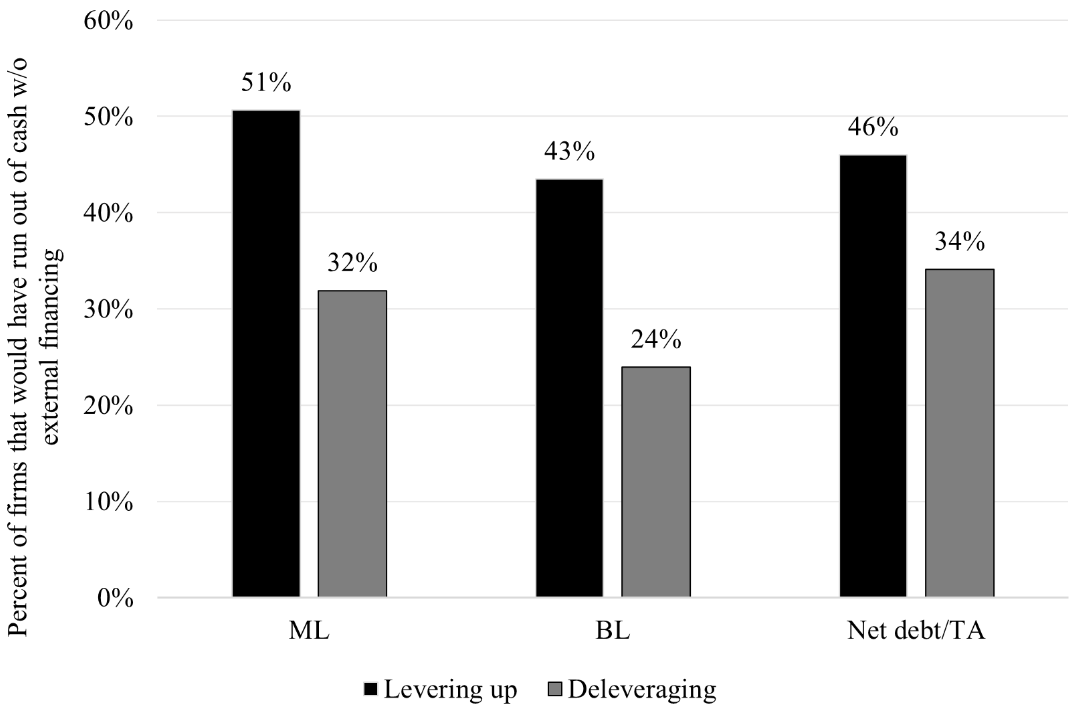


Figure 5.3 exhibits the fraction of firms that would have run out of cash without raising external funds, comparing levering-up firms and deleveraging firms. The fraction of levering-up firms facing a cash-squeeze is nearly double the fraction of deleveraging firms encountering such financial pressures.

Figure 5.3: Percent of firms that would have run out of cash without external financing

The figure exhibits the percentage of firms that would have run out of cash without external financing. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.



The main takeaway from analyzing the asymmetric incidence of cash squeezes for levering -up and deleveraging episodes, can be linked to the relevance of funding needs. Figures 5.1, 5.2 and 5.3 provide support for theories in which funding needs are key drivers of time-series variation in leverage. This is especially highlighted through Figures 5.1 and 5.2, as these figures display the depth of cash squeezes in episodes where the need for funding is substantial.

5.3 Explaining cash squeezes through capital expenditures and equity payouts

Capital expenditures and equity payouts are the two main users of funds according to Hennessy & Whited (2005), Gamba & Triantis (2008), DeAngelo, DeAngelo & Whited (2011). The two variables can generate a squeeze on internal funds which leads firms to seek external funds and adjust leverage ratios. Thus, it is interesting to examine whether capital expenditure and equity payouts can be used as primary explanation for the depth of a cash squeeze.

Tables 5.4 and 5.5 documents the scale of capital expenditures and equity payouts for firms that face a cash-squeeze, as well as levering-up firms, for respectively the full sample and 10-year sample. Both samples are tabulated because we obtain different results for the two samples. Panel A and B measure capital expenditures and equity payouts as a fraction of total assets at the end of episode in question. Panel C measures accumulated equity payouts as a fraction of the sum of capital expenditures and equity payouts during the given period.

Table 5.4: Capital expenditures and equity payouts during cash squeezes and levering-up episodes in the full sample

The table exhibits capital expenditures and equity payouts during two distinct episodes. The sample consists of 1,739 firms with at least least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. The firm must have at least one year of data on Compustat after peak Cash/TA. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Would have run out of cash?		
Value of median firm (full sample)	Yes	No	T-statistics
A. Capital expenditures as a % of TA			
Cash-balance squeeze episodes	5%	2%	2.62**
Cash squeezes: all-equity external funding	<1%	1%	2.27**
Levering up: ML	8%	4%	0.28
Levering up: BL	10%	9%	1.03
Levering up: Net debt/TA	9%	3%	2.64***
B. Payouts as a % of TA			
Cash-balance squeeze episodes	0%	0%	0.65
Cash squeezes: all-equity external funding	0%	0%	0.91
Levering up: ML	0%	0%	-0.63
Levering up: BL	0%	0%	0.38
Levering up: Net debt/TA	0%	0%	-0.46
C. Payouts as a % of (Capital expenditures + Payouts)			
Cash-balance squeeze episodes	0%	0%	0.92
Cash squeezes: all-equity external funding	0%	0%	-1.38
Levering up: ML	0%	0%	0.79
Levering up: BL	5%	0%	1.98**
Levering up: Net debt/TA	2%	0%	1.65*

Table 5.5: Capital expenditures and equity payouts during cash squeeze and levering-up episodes in the 10-year sample

The table exhibits capital expenditures and equity payouts during two distinct periods. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. The firm must have at least one year of data on Compustat after peak Cash/TA. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Would have run out of cash?		
Value of median firm (10-year sample)	Yes	No	T-statistics
A. Capital expenditures as a % of TA			
Cash-balance squeeze episodes	9%	6%	1.15
Cash squeezes: all-equity external funding	1%	2%	1.39
Levering up: ML	6%	1%	-0.79
Levering up: BL	23%	13%	0.22
Levering up: Net debt/TA	18%	6%	0.31
B. Payouts as a % of TA			
Cash-balance squeeze episodes	0%	0%	-0.76
Cash squeezes: all-equity external funding	0%	0%	0.63
Levering up: ML	0%	0%	-0.19
Levering up: BL	4%	0%	1.16
Levering up: Net debt/TA	<1%	0%	1.43
C. Payouts as a % of (Capital expenditures + Payouts)			
Cash-balance squeeze episodes	2%	0%	0.74
Cash squeezes: all-equity external funding	0%	0%	-0.53
Levering up: ML	6%	18%	1.68**
Levering up: BL	1%	0%	0.72
Levering up: Net debt/TA	6%	0%	1.01

The median firm that runs out of cash tends to have relatively large capital expenditures compared to the median firm that does not face a cash-squeeze. Focusing on the full sample, the capital expenditure proportions for the median firm is particularly significant (Table 5.4, panel A). However, equity payouts represent a negligible portion of total assets for the median firm in both samples, regardless of their cash status. Panel C reveals that equity payouts constitute an insignificant fraction of total fund utilization for the median firm in the full sample. The results are somewhat more ambiguous for firms in the 10-year sample (Table 5.5, panel 3), as equity payouts account for a higher proportion of total payouts (combined capital expenditures and equity payouts). The disparity between the full sample and the 10-year sample can be linked to traditional life-cycle theory, which predicts that younger firms tend to have smaller payouts compared to more mature firms.

The analysis of the full sample in Table 5.4 indicates that firms with a negative hypothetical cash-balance have significantly larger capital expenditures compared to firms with a positive hypothetical cash-balance. This pattern is further supported when examining firms in the 10-year sample. In both analyses, equity payouts are found to be negligible for the median firm. However, when considering equity payouts as a fraction of capital expenditures, a small portion of both samples exhibits substantial values. Based on these findings, we conclude that capital expenditures play a crucial role in describing the depth of cash squeezes, while equity payouts play limited role for listed firms in the Nordic countries.

5.4 Linking time-series variation with hypothetical cash-balance squeezes

The link between time-series variation in leverage and cash squeezes is reported in Table 5.6 and Table 5.7. Time-series range and standard deviation are employed as measures of time-series variation, while the hypothetical cash-balance indicates the depth of a cash-squeeze absent external funding. Both tables present the estimated cash-balance for the median firm, grouped into ten deciles based on various metrics. Table 5.6 sorts the full sample into ten groups based on each firm's time-series range of ML, BL, Cash/TA, and Net debt/TA from lowest 10% to highest 10%. Table 5.7 sorts the sample into 10 decile groups based on each firm's time-series standard deviation of ML, BL, Cash/TA, and Net debt/TA.

The findings consistently demonstrate that firms with greater time-series range experience larger hypothetical cash squeezes across all categories, including ML, BL, Cash/TA, and Net debt/TA. The Kruskal Wallis test confirms significant differences in hypothetical cash balances among the ten decile-based groups. In sum, we conclude that time-series variation affects the cash-squeeze a firm face. Higher time-series range corresponds to a greater cash-squeeze. The findings strengthen the answer on our main research question.

Table 5.7 presents the link between time-series standard deviation and cash squeezes. Firms are sorted into 10 decile-based group based on the ratio in question. Across all categories, including ML, BL, Cash/TA, and Net debt/TA, the general trend indicates larger hypothetical cash squeezes for firms with higher time-series standard deviation. The Kruskal Wallis test further confirms significant differences in hypothetical cash balances, indicating a notable variation in cash squeezes based on time-series standard deviation.

Table 5.6: Linking leverage ranges with hypothetical cash balances

The table exhibits hypothetical cash balances for the full sample sorted into 10 decile groups based on median range of the ratio in question. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Firms sorted into decile-based groups according to their median range										
Value for median firm	Lowest 10 %	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Highest 10 %	Kruskal Wallis test Statistics
ML range sorting											
1. Time-series median range	0.002	0.018	0.044	0.078	0.107	0.152	0.211	0.269	0.347	0.444	
2. Time-series median hypothetical cash balances	-0.077	-0.086	-0.0565	-0.116	-0.151	-0.337	-0.335	-0.407	-0.416	-0.382	0.0001***
BL range sorting											
3. Time-series median range	0.076	0.165	0.211	0.248	0.275	0.318	0.362	0.413	0.472	0.595	
4. Time-series median hypothetical cash balances	-0.127	-0.258	-0.253	-0.231	-0.369	-0.301	-0.817	-0.658	-0.587	-0.514	0.0081***
Cash/TA range sorting											
5. Time-series median range	0.051	0.099	0.134	0.174	0.226	0.283	0.356	0.439	0.551	0.691	
6. Time-series median hypothetical cash balances	-0.066	-0.047	-0.072	-0.116	-0.339	-0.081	-0.260	-0.352	-0.031	0.045	0.0001***
Net debt/TA range sorting											
7. Time-series median range	0.214	0.272	0.326	0.382	0.446	0.503	0.575	0.683	0.811	1.000	
8. Time-series median hypothetical cash balances	-0.108	-0.275	-0.221	-0.468	-0.705	-0.549	-0.529	-0.104	-0.514	0.228	0.0001***

Table 5.7: Linking standard deviation in leverage with hypothetical cash balances

The table exhibits hypothetical cash balances for the 10-year sample sorted into 10 decile groups based on standard deviation of the ratio in question. The sample consists of 1,739 firms with at least two consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

	Firms sorted into decile-based groups according to their median standard deviation										
Value for median firm	Lowest 10 %	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Highest 10 %	Kruskal Wallis test Statistics
ML(σ) sorting											
1. Time-series median (σ)	0.000	0.006	0.013	0.022	0.032	0.046	0.063	0.083	0.109	0.154	
2. Time-series median hypothetical cash balances	-0.127	-0.090	-0.513	-0.225	-0.153	-0.365	-0.383	-0.347	-0.242	-0.493	0.0001***
BL (σ) sorting											
3. Time-series median (σ)	0.021	0.049	0.063	0.073	0.082	0.096	0.108	0.129	0.151	0.195	
4. Time-series median hypothetical cash balances	-0.127	-0.240	-0.257	-0.391	-0.271	-0.340	-0.530	-0.692	-0.862	-0.795	0.0036***
Cash/TA (σ) sorting											
5. Time-series median (σ)	0.017	0.029	0.034	0.049	0.065	0.082	0.104	0.132	0.171	0.221	
6. Time-series median hypothetical cash balances	-0.086	-0.090	-0.097	-0.070	-0.220	-0.096	-0.093	-0.121	-0.008	0.219	0.0006***
Net debt/TA (σ) sorting											
7. Time-series median (σ)	0.064	0.079	0.092	0.111	0.125	0.147	0.169	0.204	0.241	0.315	
8. Time-series median hypothetical cash balances	-0.212	-0.118	-0.533	-0.377	-0.391	-0.510	-0.533	-0.567	-0.176	0.009	0.0053***

To conclude, our analysis posits that the hypothetical cash-balance can effectively explain time-series variation in leverage. The findings demonstrate that firms with higher time-series standard deviation are linked to more substantial cash squeezes. This highlights the significance of time-series variation in understanding the dynamics of cash squeezes faced by firms.

6 Conclusion and implication of main findings

In this section, we summarize our main findings, and comparing our results with the findings presented by DeAngelo et al. (2022).

6.1 Conclusion

This paper investigates whether cash squeezes in Nordic firms can be linked to time-series variation in leverage ratios. We uncover that high time-series variation in leverage and cash-balance ratios is the norm for firms facing hypothetical cash squeezes in the period January 2000 to December 2021. Capital expenditures represent the main utilization of funds for these firms. Consequently, being the primary driver of time-series variation in leverage ratios.

Overall, we document that most firms solve cash squeezes by taking on interest-bearing debt. The need for cash contributes to time-series variation in leverage as, the median firms build up and down cash-holdings to adapt to the external environment. Our analyses uncover that changes in cash holdings are a consequence of variation in funding needs. This implies that our results support the funding-related explanation presented by Myers & Majluf (1984).

We find that the time-series variation in both leverage and cash-balance ratios vary significantly across firms. Both market and book leverage ratios are quite volatile when cash-balance ratios are stable. Vice versa, cash balances tend to be quite volatile when the leverage ratios (ML and BL) are stable. The net-debt ratio is almost always subject to high volatility. The latter regularity also applies for firms with negative net-debt ratios. Through understanding the interactions of leverage and cash-balance dynamics, we conclude that time-series variation in leverage are linked to hypothetical cash-balance squeezes for publicly listed firms in the Nordics in the period 2000 to 2021.

Time-series variation in leverage and cash-balance ratios is significantly higher for firms being delisted due to financial distress. Interestingly, delisted firms experience a significantly higher increase in leverage compared to non-delisted firms. The implication is that delisted firms tend to take on more interest-bearing debt. These findings align with the bankruptcy models proposed by Beaver (1966) and Ohlson (1980). Hence, incorporating time-series variation in leverage as an additional explanatory variable may enhance existing bankruptcy models.

We provide additional evidence that capital expenditures can be used as primary explanatory variable for the depth of a cash-squeeze. Capital expenditures are significantly larger for firms with a negative hypothetical cash-balance compared to firms with a positive hypothetical cash-balance. Equity payouts, as a fraction of both total assets and capital expenditures, are nontrivial for the median firm in the sample. The implication is that capital expenditures can be seen as the primary user of funds, and thus as the main contributor to external funding needs for firms in the Nordic countries. The findings favor the funding-related explanation presented by Myers & Majluf (1984).

In sum, we document a strong empirical link between leverage increases and cash squeezes. This paper provides evidence why researchers and companies should start to consider leverage and cash balances as co-dependent, rather than univariate elements, of financial policy. Our research is placed in the intersection between the two large research fields of capital structures and cash balances, providing valuable insights to the small research field of leverage and cash dynamics.

6.2 How our results compare to DeAngelo, Gonçalves & Stulz (2022)

In line with DeAngelo et al. (2022), we find that high time-series variation in leverage can be linked to hypothetical cash squeezes. The crucial differences between our results lie in the initial sample, market values, accounting principles, and assessment of delisted firms.

DeAngelo et al. (2022) study a full sample of 17,245 non-financial and publicly listed US firms that have at least two consecutive years of non-missing leverage and cash-balance data within the coverage period of 1950 to 2017. To draw long-time inferences DeAngelo et al. (2022) focus on a subsample consisting of 3,099 firms with at least 20 consecutive years of non-missing data. To comparison our full sample is based on 1,739 non-financial publicly listed firms in the Nordic. These firms have at least two years of non-missing leverage and cash-balance data within the coverage period of 2000 to 2021. To draw long-time inferences, we focus on a subsample consisting of 599 firms with at least 10 consecutive years of non-missing data. Hence, there are substantial differences between the size of the US and Nordic sample.

The crucial differences between our findings lie in the initial sample of firms and the chosen time frame. Both factors probably cause some differences stemming from how reporting rules have developed through the years. Moreover, differences in the accounting principles between the US and Nordic countries might be a factor. The differences in accounting culture affect the handling of different financial items, which affects the overall classification.

The differences between the ML values reported in this paper and the article by DeAngelo et al. (2022) probably stem from three main factors. First, and as aforementioned, the historical benchmark indexes for stock exchanges in the Nordic states show considerable increase in market values from beginning of year 2000 to end of 2021 (Trading Economics, 2023). Consequently, the market values used in this paper is considerable larger than the ones used by DeAngelo et al. (2022). As there is no substantial difference in the amount of interest-bearing debt, a higher market valuation will yield a lower ratio of market leverage. Second, that valuation techniques have developed to better fit the listed companies, and thereby affecting market values. Third, the general technological development has entailed more asset-light companies compared to firms from mid-end of the 1900s. As a result, we are influenced by different company characteristics compared to DeAngelo et al. (2022).

Our additional analyses of delisted firms distinguish this study from the research conducted by DeAngelo et al. (2022). The research trio acknowledges that the time-series variation is affected by firms delisted. However, some of these firms are delisted due to financial distress, but the trio does not delve further into the assessment of these firms. In contrast, we emphasize that firms delisted due to financial distress represent extreme outcomes of a cash-squeeze. Examining the interplay between leverage and cash-balance dynamics among delisted firms provides an added understanding of how the two financial items interact. Our results are, as far as we know, the first in the Nordics, providing unique insight into how time-series variation in leverage and cash balances can be linked to delisting of firms due to financial distress. In our view, leverage and cash balance dynamics should be of high interest for both theoreticians and practitioners.

7 Limitations and extensions

In this section we will put emphasis on the validity and reliability of this thesis. Thereafter, we provide a short discussion on future research.

7.1 Limitations

This research is based on data from Compustat, which is globally accepted as an accurate and reliable data source. However, it should be mentioned that Compustat is a secondary data source, and we have only conducted spot checks on some of the companies in the sample to check for the accuracy of the data material. Based on the acceptance of Compustat and our random checks, we argue for overall good reliability of the underlying data material.

A weakness in this thesis is the relatively limited sample obtained. This is a result of both our imposed restrictions, such as 10-consectuive years with non-missing data, as well as the data availability on Compustat. However, we argue it is reasonable considering the size of the Nordic population.

Our results are based on financial information of publicly listed companies in Norway, Sweden, Denmark, Finland, and Iceland. The listing status indicates that the collected data should be reliable, and moreover adequate for comparisons due to IFRS. However, the lack of common global reporting rules can make it challenging to generalize our key takeaways to markets outside Europe.

Our analysis is based on a period of 22 years, stretching from the year 2000 to 2021. This implies that our results incorporate effects from both the financial crisis in 2008 and the covid-19 pandemic. Nevertheless, we would argue that eliminating these effects would be the same as neglecting the real world. We believe the special conditions that succeeded these events provide valuable material for the analysis conducted in this paper.

7.2 Extensions

To gain further insight into the interactions between leverage and cash-balance ratios, it would be valuable to examine whether the observed time-series variation in these ratios is influenced by specific industry characteristics. It is widely acknowledged that leverage and cash-balance ratios exhibit systematic variations across industries (Chudson (1945); DeAngelo et al. (2015); Berk & DeMarzo (2020)). Furthermore, DeAngelo et al. (2015) have demonstrated significant industry-specific time-series variations in median leverage ratios.

The characteristics of time-series variation in leverage and cash balances are also associated with industry dynamics. Given the varying capital requirements across industries, with some being more capital-intensive than others, it is reasonable to expect differences in cash squeezes among firms within different industries. As cash squeezes reflect the need for external funds, our main findings in this paper suggests that industries with greater cash squeezes would exhibit larger time-series variations in leverage compared to less capital-intensive industries. Thus, exploring this aspect would provide an intriguing avenue for further research.

Another interesting field for further research, would be to examine whether the same trends apply to privately held firms in the Nordic countries. A paper by Mortal, Nanda, & Reisel (2019) documented differences in cash holdings for private and public firms in the US due to the costs of debt and the costs of holding precautionary cash. The paper highlights that private firms face higher cost of debt, but at the same time holds greater cash amounts due to the precautionary motive. This implies that we should find higher levels of cash in private firms than public firms, and thereby less time-series variation in cash holdings. Possible challenges are the lack of reliable values and accurate financial data, enabling for valid and reliable comparison.

References

Acharya, V., Almeida, H., & Campello, M. (2007). Is cash negative debt? a hedging perspective on corporate financial policies.

Almeida, H., Campello, M., & Weisbach, M. (2004). The cash flow sensitivity of cash.

Almeido, H., & Campello, M. (2010). Financing frictions and the substitution between internal and external funds.

Bates, T. W., Kahle, K. M., & Stulz, R. M (2009). Why do u.s. firms hold so much more cash than they used to?

Beaver, W. H. (1966). Financial ratios as predictors of failure.

DeAngelo, H., & Roll, R. (2015). How stable are corporate capital structures?

DeAngelo, H., DeAngelo, L., & Stulz, R. (2010). Seasoned equity offerings, market timing, and the corporate lifecycle.

DeAngelo, H., DeAngelo, L., & Whited, T. (2011). Capital structure dynamics and transitory debt.

DeAngelo, H., Gonçalves, A. S., & Stulz, A. S. (2018). Corporate deleveraging and financial flexibility.

DeAngelo, H., Gonçalves, A. S., & Stulz, A. S. (2022). Leverage and cash dynamics.

Deloitte AS (2023). Hva er ifrs? Retreived 10th of April, from: https://www2.deloitte.com/no/no/innsikt/okonomi-og-finans/ifrs/hva-er-ifrs.html.

Denis, D., & McKeon, S. B. (2012). Debt financing and financial flexibility evidence from proactive leverage increases.

Dittmar, A., & Duchin, R. (2010). The dynamics of cash.

Frank, M. Z., & Goyal, V. K. (2009). Capital structure decisions: Which factors are reliably important?

Gamba, A., & Triantis, A. (2008). The value of financial flexibility.

Grimsby, G., Eide, L. S., Wiftsad, K. (2017). Hvem finansierer norge?

Huang, R., & Ritter, J. R. (2009). Testing theories of capital structure and estimating the speed of adjustment.

Lemmon, M., Roberts, M., & Zender, J. (2008). Back to the beginning: persistence and the cross-section of corporate capital structures.

Myers, S., & Majluf, N. (1984). Corporate financing and investment decisions when firms have information that investors do not have.

Ohlson, J. A. (1980). Financial ratios and the probabilistic prediction of bankruptcy.

Opler et al. (1999). The determinants and implications of corporate cash holdings.

Plenborg, T. & Kinserdal, F. (2020). *Financial Statement Analysis*, volume 2. Fagbokforlaget.

Rajan, R. & Zingales, L. (1995). What do we know about capital structure? some evidence from international data.

S&P Global (2023). Marketplace s&p global. Retreived 21th of April, from: https://www.marketplace.spglobal.com/en/datasets/compustat-financials-(8).

The IFRS Foundation (2023). Ifrs 10 consolidated financial statements. Retreived 11th of March, from: https://www.ifrs.org/issued-standards/list-of-standards/ifrs-ten-consolidated-financial-statements/.

The Wolrd Bank (2023). Consumer price index. Retreived 13th of March, from: https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?end=2021fbclid=IwAR15-i2wksqWs9KfE3MFcG63vZZ8IR18DhEI5x5cvVnqWjd_635RwyuX-1Ylocations=NO-DK-SE-FI-ISstart=2000.

Titman, S., & Wessels, R. (1988). The determinants of capital structure choice.

Trading Economics (2023). Sweden stock market index. Retreived 27th of May, from: https://tradingeconomics.com/sweden/stock-market.

Wharton Research Data Services (2023). About compustat. Retreived 27th of March, from: https://wrds-www.wharton.upenn.edu/pages/get-data/compustat-capital-iq-standard-poors/compustat/.

Whited, T., & Hennessy, C. (2005). Debt dynamics.

Wooldridge, J. (2020). *Introductory Econometrics*. Cengage Learning Inc.

Appendix

A1 Testing for significance

A1.1 Kruskal Wallis H-test

To check for significant differences between the 10 decile-based groups, we conduct a Kruskal Wallis test. The test is sometimes referred to "one-way AVNOVA on ranks" and is a rank-based nonparametric method used to test whether there are statistically significant differences between two or more groups of an independent variable (Lærd Statistics , 2023). The null hypothesis is that the rank sum is equal, and the alternative hypothesis is that the rank sum is not equal. The test statistics is calculated as follows:

$$K = \frac{12}{N(N+1)} \times \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \tag{.1}$$

... where R_i is the sum of ranks for group i.

The test uses the chi-squared distribution to determine the significant level. The critical chi-squared value is 5.991 which equals a significance level of 5%. If the critical chi-squared value is above 5.991, then the null hypothesis is rejected and there are differences between the subgroups.

A1.2 T-test

To check whether two groups are significant different from each other, we conducted a two-sided T-test. This is a statistical approach to used test for significant difference between two samples (Wooldridge, 2020). The null hypothesis is that the two sample means are not different, while the alternative hypothesis is that the two sample means are different. Since the number in each sample in this paper is different, as well as the variance being unequal, one must use an unequal variance T-test. The test statistic for this test is given by:

$$T = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{\sigma^2}{n_1}} + \sqrt{\frac{\sigma^2}{n_2}}} \tag{.2}$$

The critical T-value for a two-sided T-test is 2.060, which equals a significance level of 5%. If the T-value is above 2.060, we reject the null hypothesis about zero difference, and keep the alternative hypothesis about significant difference at 5% level.

A2 Description of an AR(1) process with a unit root

Our dataset represents a stochastic process, such the volatility of the outcome variables – ML, BL, Cash/TA and Net debt/TA – increases as shock arrives and accumulates. If the standard deviation of the dependent variable is given in an AR(1) process with a unit root, the regression is given as:

$$x_t = a + b \times x_{t-1} \tag{.3}$$

... with a standard deviation equal to:

$$\sigma(x)_t = \sigma \times \sqrt{(t-n)} \tag{.4}$$

The standard deviation will increase with the longer time horizon before approaching a finite limit. Hence, a stochastic process is the opposite of a mean reversion process. The implication is that when the estimated standard deviation is based on only two observations, i.e., two years, it will gauge so-called conditional volatility, as the observation depends on only one shock. The explained case is an AR(1) process. As we only have one shock, the explanatory variable will be dependent on that one shock. With more periods we get an AR(n) process which will include several shocks. As a result, the outcome variable no longer depends on only one shock, causing so-called unconditional volatility.

The constructed regressions in Figure 3.6 are AR(n) processes with a unit root. We have executed a simple regression where the inputs differ by T years, stretching from T = 1 to T = 20. In all regressions, the right-hand side of the regression includes a constant and the lagged variable. The left-hand side of the regression represents the same value as the independent variable only T years forward in time. A firm is included in a given pair if, and only if, it has available data on Compustat for both years.

The general construction of the regressions can be illustrated by the following example: if vi have an AR(1) process, where the independent variable lags T = 1 years behind, the reported R-squared in Figure 5 is the average R-squared for all regressions pairing 2000 with 2001, 2001 with 2002, and so forth. The final pair is 2020 with 2021. If we have an AR(2)-process, we report the average R-squared for all pairs lagging 2 years, i.e. pairing year 2000 with 2002, 2001 with 2003, and lastly 2019 with 2021. The maximum years behind is 20 years, i.e., an AR(20)-process.

A3 Cash squeezes and contemporaneous leverage increases in the 10-year sample

The table exhibits cash squeezes and contemporanous leverage increases. The sample consists of 599 firms with at least 10 consecutive years of non-missing data on Compustat of total book assets, the market value of common stocks, and cash holdings and marketable securities. The firm must have at least one year of data on Compustat after peak Cash/TA. ML is the book value of debt divided by the sum of market value of equity (common stocks) and book value of debt. BL is the book value of debt divided by the book value of total assets. Cash/TA is total cash plus marketable securities divided by book value of total assets. Net debt/TA is BL minus Cash/TA.

		Would run out of cash without external funds?			Debt proceeds as a % of total external funds raised (δ)			
Median value (except Rows 8 and 9)	All firms pooled	Yes	No	T-statistic	$\delta = 100\%$ all debt	$0\%<\delta\leq50\%$ issue mostly debt	$0\%<\delta\leq50\%$ issue some debt	δ=0% all equity
10-year sample								
1. Cash/TA at peak	0.208	0.203	0.228	-2.99***	0.159	0.264	0.159	0.213
2. Cash/TA at later through	0.046	0.030	0.091	-1-89**	0.101	0.053	0.049	0.029
3. Cash/TA at through w/o external financing	-0.038	-0.204	0.046	-1.66	0.007	-0.410	-0.322	0.01
4. External financing as a % of cash at through	201%	338%	0%	1.41	96%	777%	390%	1%
5. ML at peak Cash/TA	0.031	0.060	0.001	1.51	0.242	0.0423	0.003	0.005
6. ML at later through	0.063	0.111	0.001	3.38***	0.250	0.194	0.012	0.003
7. Number of years from peak to through	4	5	3		1	5	5	3
8. Number of firms	599	19	19		90	137	93	94
9. Percent of sample	100%	50%	50%		22%	33%	22%	23%