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Three Perspectives on the Cash Flow Sensitivity of Cash

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Three Perspectives on the Cash Flow Sensitivity of Cash

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Content

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Abstract

In this thesis, I analyze the effect of cash flows on changes in cash holdings. I compare the cash flow sensitivity of cash in financially constrained and unconstrained firms, and find that financially constrained firms have a positive and significant cash flow sensitivity of cash. I also investigate cash holdings before, during, and after the 2008 financial crisis. The results show that firms display an increased sensitivity of cash holdings to cash flow changes during the financial crisis. Finally, I study the difference in cash holdings and their sensitivity to cash flow changes in private and public firms and find that private firms have a greater cash flow sensitivity of cash than public firms do. Overall, my findings support the hypothesis that financially constrained firms have a positive cash flow sensitivity to cash.

Financial Constraints Impose Greater Cash Retention

In this thesis, I analyze the effect of cash flows on changes in cash holdings – the cash flow sensitivity of cash. I do so by fitting two regression models of cash holdings developed by Almeida et al. (2004) on three samples of financially constrained and financially unconstrained firms. I find that: First, financially constrained firms have a positive cash flow sensitivity of cash. Secondly, private firms save significantly more cash out of their cash flows. Thirdly, when firms expect financing frictions, they retain more cash. Overall, my results indicate that financial constraints impose greater cash retention. My thesis contributes to the existing literature by expanding the usage of the two cash holdings models and by providing insights into a rarely studied group of companies – private firms.

My research question is "Do financial constraints impose greater cash retention?" The question is interesting because studies show that firms hold a significant fraction of their total assets as cash, in spite of efficient-markets theories implying that firms should not need to, since funding is always available for profitable projects. In 2007, private, Norwegian, industrial firms, held 20% of their assets as cash while financially constrained firms had an average cash ratio over 30% (Ehling, 2010). Researchers have also found that private firms are at a disadvantage with respect to external financing and loan costs in particular. Funding of private firms is a central topic for the Norwegian economy in the as we are looking for "the new oil", because innovation and jobs are mainly created in private firms.

The first hypothesis is that firms considered financially constrained have a positive and significant cash flow sensitivity of cash while unconstrained firms do not. To test the hypothesis, I use a baseline and an augmented model, developed by Almeida et al. (2004). I test the models on subsamples of financially constrained and financially unconstrained firms, defined by three criteria: payout ratio, size, and the KZ-index. My results are, in part, consistent with the findings of Almeida et al. (2004). I find that firms considered financially constrained have a positive and significant cash flow sensitivity of cash. However, the results with respect to unconstrained firms are inconclusive.

The second hypothesis is that private firms should have a greater cash flow sensitivity of cash than public firms do. The rationale is that private firms have less access to external financing compared to public firms and should therefore behave like financially constrained firms and retain more cash from their cash flows. Since the private firms generally have very different characteristics than the public firms, I create a subsample of private firms that match the public firms with respect to industry and size. I then compare the public firms to the matched private firms and to the full sample of private firms, using the baseline and augmented models from Almeida et al. (2004). The results show that both the private and the matched private firms have a positive and significant cash flow sensitivity of cash, while it is not significant for public firms. Thus, the findings support the hypothesis.

My third hypothesis is that firms should demonstrate a greater cash flow sensitivity of cash when expecting financial frictions. Again, I test the hypothesis using the baseline and augmented models from Almeida et al. (2004), this time with a dummy variable capturing the effect of the 2008 financial crisis. I find that both private and public firms increase their propensity to save cash out of cash flows in the 2007-2008 period. I.e., I find support for my hypothesis.

My thesis contributes to the literature in three ways. First, I provide a re-contextualization of the models of Almeida et al. (2004) by applying their framework to updated data on Norwegian, public firms. Secondly, I combine their baseline and augmented models with the research design from Gao et al. (2013) and find that the models reveal interesting differences in cash to cash flow sensitivities of private and public firms. Thirdly, I find results confirming their theory of increased cash retention as a response to macroeconomic shocks by testing their model on the 2008 financial crisis.

The remainder of my paper is organized as follows. A literature review is presented in Section 2. In Section 3, I describe the sample and data. My hypotheses and methodology is explained in Section 4, and the results are presented in Section 5. Finally, I conclude in Section 6.

2. Literature Review

Why Do Firms Hold Cash?

To examine the effect of cash flows on changes in cash holdings, it is necessary to know why firms hold cash. In the existing literature, several motives for holding cash are described:

1. *The transactions-motive.* The transactions-motive is the motive to hold a sufficient amount of cash to manage the day-to-day operations of the firm (Baumol, 1952; Keynes, 1936; Miller & Orr, 1966), e.g. being able to pay bills on time.
2. The *precautionary-motive.* Holding cash in the case of a contingency payment is an example of the precautionary-motive (Bates, Kahle, & Stulz, 2009; Keynes, 1936). Harford, Klasa, and Maxwell point out that firms use cash to hedge against refinancing risk (2014).
3. The *speculative-motive*. Speculating-motives for holding cash include holding cash to be able to take advantage of an unforeseen investment opportunity (Keynes, 1936).
4. *The tax-motive.* Firms who face repatriation taxes on foreign earnings, have an incentive to retain the earnings as cash abroad unless they have attractive investment opportunities (Fritz Foley, Hartzell, Titman, & Twite, 2007).
5. *The agency motive.* The agency motive for holding cash stems from a conflict of interest between shareholders and managers. The theory postulates that managers have an incentive to overinvest, e.g. to hire more employees than necessary or take on less profitable expansion projects, in order to increase their managerial status (Jensen, 1986). Thus, studies show that cash holdings are higher in countries where shareholder protection is low (Dittmar, Mahrt-Smith, & Servaes, 2003)

How Much Cash Should Firms Hold?

Having established why firms hold cash, the question is "How much cash should they hold?" Existing literature presents three main theories related to corporate capital structure and cash holdings: the trade-off theory, the pecking order theory and the free cash flow theory (Tahir, Alifiah, Arshad, & Saleem, 2016).

1. The trade-off theory suggests that a firm's optimal level of cash holdings is defined by the marginal cost and the marginal benefit of holding liquid assets (Myers, 1984). The benefits relates to transactional- and precautionary-motives, while the costs stem from having to forgo a profitable investment in order to save cash (Keynes, 1936).
2. The pecking order theory proposes that firms prefer internal to external financing and debt to equity (Myers, 1984). Fazzari et al. (1988) mention several reasons for the lower cost of internal financing, e.g., transaction costs, financial distress costs and asymmetric information between management and new creditors or investors.
3. The free-cash-flow theory builds on agency theory arguments and infers that firms should avoid keeping excess cash when there is a conflict of interest between shareholders and management, as this will cause managers to overinvest (Jensen, 1986).

In his classical work, Keynes (1936) points out that there is no need to hold cash if it can be easily acquired at the time of necessity. Thus, the importance of a liquid balance sheet depends on a firm's access to capital markets, and financial frictions should lead to liquidity management being a key issue for corporate policy.

Keynes' theory is supported by the findings of Billett and Garfinkel (2004), who show that increased financial flexibility correlates with smaller fractions of cash and marketable securities on the balance sheet. Their results cohere with those of Almeida et al. (2004), who find that financially constrained firms have a disposition towards increasing their holdings of liquid assets as a response to positive cash flow shocks. This disposition is referred to as having a positive cash flow sensitivity of cash. However, there has also been found evidence of the contrary, i.e., that cash flows and cash retention is negatively related (Riddick & Whited, 2009).

Determinants of Financing Frictions

The payout ratio and similar measures are often used to determine which companies are considered financially constrained (Almeida et al., 2004; Campello, Graham, & Harvey, 2010; Fazzari et al., 1988). Dividend stickiness, i.e. firms' reluctance to decrease dividends due to a negative signal effect (Brav, Graham, Harvey, & Michaely, 2005; Guttman, Kadan, & Kandel, 2010; Lintner, 1956), makes company payouts a good indicator of the expected prospects of the firm.

Firm size is another criteria used to define financially constrained firms (Almeida et al., 2004; Campello et al., 2010; Gilchrist & Himmelberg, 1995; Hadlock & Pierce, 2010; Mulligan, 1997). Although large firms often depend on substantial, long-term loans, they are often able to allocate capital internally in cases where smaller firms would have to seek external financing (Beck, Demirgüç-Kunt, & Maksimovic, 2005). One may therefore expect smaller firms to experience more financing frictions (Almeida et al., 2004).

Almeida et al. (2004) employ the KZ-index to distinguish between financially constrained and unconstrained firms. The index is developed from Kaplan and Zingales' (1997) research and Almeida et al. (2004) use the results of Lamont, Polk and Saaá-Requejo (2001) to compute the index values. The index consists of a pool of five variables: cash holdings, cash flow, Q, dividends and leverage. The probability for a firm to be ranked as financially constrained according to the KZ-index is greater for firms that are highly levered, have higher values for Q, and which do not pay dividends. The probability is lower for firms that have high dividend payments, high retained earnings net of dividends, high cash flows and cash holdings, and that are not highly levered. However, Almeida et al. (2004) find that the firms considered financially constrained according to the KZ-index behave in line with expectations for unconstrained firms and vice versa. Other researchers criticize the KZ-index and recommend caution in interpreting the results of this measure (Hadlock & Pierce, 2010).

Cash Holdings in Financially Constrained Firms

According to the theory developed by Almeida et al. (2004), cash flows should have a positive and significant impact on changes in cash holdings in financially constrained firms. This relation is the main concern of their analysis. The researchers also control for size, due to economies of scale effects. Finally, they include Q, the ratio of market value of assets to book value of assets, as a proxy for future investment opportunities. They hypothesize that constrained firms should have a positive Q estimate, while the coefficient should be unsigned for unconstrained firms.

In their augmented model, Almeida et al. (2004) also include capital expenditures (capex), acquisitions, changes in noncash net working capital, and changes in short-term debt. Firms can use cash to pay for investments and acquisitions, thus the coefficients for capex and acquisitions are expected to be negative. Changes in net working capital is included because working capital may substitute cash (Opler, Pinkowitz, Stulz, & Williamson, 1999) or cash can be used to increase working capital (Fazzari & Petersen, 1993). Similarly, the firm can substitute short-term debt for cash or use it to increase cash reserves (Almeida et al., 2004).

Cash holdings in private and public firms

There are two conflicting explanations for the discrepancy in cash holdings between public and private firms. The first explanation is that firms with a greater cost of external capital, for instance due to information asymmetry between the company and its creditors, hold more cash (Fazzari et al., 1988; Myers, 1984). Saunders and Steffen (2011) find evidence of private firms having a disadvantage with respect to loan costs. Thus, private firms should hold more cash than public firms should, because private firms have less access to external financing. The second explanation is that firms with greater agency conflicts between shareholders and management hold more cash (Gleason, Greiner, & Kannan, 2017; Jensen, 1986). In their research from 2013, Gao et al. find that the agency costs of public firms are greater than the reduction in external financing costs, which leads to larger cash holdings in public firms.

Demand for cash and the financial crisis

Previous research has shown that the impact of financial constraints are not consistent over time (Lamont et al., 2001) and several scholars have found evidence of financial constraints being more severe during recessions (Gertler & Gilchrist, 1994; Gertler & Hubbard, 1988; Kashyap, Lamont, & Stein, 1994). Fazzari et al. (1988) emphasizes the importance of macroeconomic factors, as they find that changes in companies' cash flows and liquidity correlates with fluctuations in the economy as a whole over the life of the company. Further, Almeida et al. (2004) find that financially constrained firms increase cash retention in response to macroeconomic shocks, while unconstrained firms do not.

Campello, Graham, and Harvey (2010) investigate the effect of the 2008 financial crisis on cash holdings in financially constrained and unconstrained firms. Their results show that financially constrained U.S. firms substantially reduce their cash deposits in the year after the crisis, while the cash levels of the unconstrained firms remained stable. A similar pattern was found for European firms (Campello et al., 2010).

Moving forward

Most previous studies on the topic of cash flow sensitivity of cash have been conducted using data on public, U.S. firms. Meanwhile, Norway differs from the U.S. in important areas. At the company level, Norwegian firms hold less cash and have a greater ratio of foreign sales to total sales than U.S. firms do. At the country level, apart from the obvious size difference, the two countries score differently on variables such as industry diversification and political stability (Fernandes & Gonenc, 2016). These differences motivates a study on the cash flow sensitivity of cash of Norwegian firms.

Furthermore, few studies have been done on private firms due to lack of quality data. Berzins and Bøhren (2009) suggest that inferences from research conducted on public firms may actually be invalid for private firms because differences in regulatory climate may impact firm behavior in aspects such as investments, financing and profitability. Thus, research on private firms is not only interesting, but necessary if we want to understand the behavior of private firms.

3. Sample and Data

Data

The first analysis is conducted using panel data from Datastream consisting of accounting variables and market value for all companies traded at the Oslo Stock Exchange in the period from 1992 to 2016. The data was retrieved the 20th of April 2017. The original dataset contains 11 316 firm-years. I exclude the 6 746 firm-years that have missing recordings of cash holdings because these observations will be irrelevant for the analyses. Further, I adhere to standard research practice and exclude financial and utilities firms from my sample as these companies often display distinctive characteristics with respect to cash holdings and capital structure (see for example (Gao et al., 2013; Harford et al., 2014; Opler et al., 1999). Following Almeida et al. (2004) , I remove firm-years with asset growth or sales growth of more than 100% as these rates of change are not likely to sustain over time. Finally, I eliminate firm-years where the market value of assets is less than 1 000 000 NOK as this is the minimum amount of equity necessary to take a company public in Norway.

This procedure leaves me with a sample of 3 840 firm-years. To avoid the effect of rare events such as very large mergers and severe firm shocks as well as extreme outliers caused by recording or measurement mistakes, I winsorize all continuous variables at the 1% and 99% levels (Gao et al., 2013; Hovakimian & Titman, 2006; Quader & Abdullah, 2016).

The analyses comparing private and public companies and are conducted using data from the Centre for Corporate Governance Research (CCGR) at BI Norwegian Business School. The dataset includes all Norwegian private and public firms in the period from 2000 to 2015. There are 3 011 983 firm-years in total, of which 3 005 951 are observations of private firms and 6 032 are observations of public firms. Cleaning of the data is done following the same procedure as above, with some exceptions:

1. Since market value data is unavailable for most private firms; there is no lower limit of market value. Instead, only firms with positive total assets are included.

2. The data cleaning procedure above fails to remove some extreme outliers. To correct for these outliers, I winsorize the variables at the 2.5% and 97.5% levels. The same levels are used in a similar study by Gao et al. (2013).

After cleaning, the sample consists of 2 511 805 firm-years for private firms and 4 458 firm-years for public firms.

Definition of Variables

All continuous variables from both Datastream and CCGR are CPI adjusted to the 2016 level. The 2016 Norwegian CPI is retrieved from Statistics Norway (SSB). For references to ID numbers of the variables in Datastream and CCGR respectively, see APPENDIX A. The analyzed variables are described as follows.

Endogenous variable

To measure corporate cash holdings, I follow Almeida et al. (2004) and Gao et al. (2013) and define the endogenous variable *CashHoldings* as the ratio of cash and marketable securities to total assets. Since I am interested in the change in cash holdings, I use the first difference of the variable, i.e., *ΔCashHoldings*. The definition is the same in both the Datastream and CCGR dataset.

Exogenous variables

My exogenous variables are *CashFlow*, *Q*, *Size*, *Expenditures*, *Acquisitions*, *ΔNWC*, and *ΔShortDebt*. The definitions are mostly consistent with those of Almeida et al. (2004). There are cases where specification of the variables in the CCGR sample differ from the variables in the Datastream sample. In those cases, both specifications are described in the following list:

- *CashFlow* is the primary exogenous variable of interest. In my analysis, it is defined as the ratio of earnings before extraordinary items and dividends to total assets.
- *Q* (Tobin's q) is measured as market value to book value of assets.
    - Since market value data is unavailable for the CCGR sample, *Q* is replaced by *InvOpp*, when CCGR data is used. *InvOpp* is defined as capital expenditures (capex) scaled by property, plant and

equipment (Adam & Goyal, 2008), where capex is measured as the change in net property, plant, and equipment.

- *Size* is the natural log of total assets.
- *Expenditures* is capital expenditures scaled by total assets
    - *Expenditures* is measured as the change in net property, plant, and equipment scaled by total assets in the CCGR sample.
- *Acquisitions* is acquisitions scaled by total assets.
    - *Acquisitions* is unavailable in CCGR, thus, the variable is omitted.
- *ΔNWC* is defined as the first difference of the ratio of noncash net working capital to total assets.
- *ΔShortDebt* is the first difference of the ratio of short-term debt to total assets.

Variables used for sample split

To examine the difference between financially constrained and unconstrained firms with respect to the cash flow sensitivity of cash, I need to be able to distinguish between the two groups of firms. For this purpose, I use three schemes from Almeida et al. (2004): (1) *payout ratio*, (2) *firm size*, and (3) the *KZ-index.*

- Scheme 1 – *payout ratio*: I compute the *payout ratio* as the ratio of dividends to operating income and define, each year, the companies in the bottom three deciles as financially constrained, and the companies in the top three deciles as unconstrained.
- Scheme 2 – f*irm size*: *Firm size* is simply measured as total assets. All companies are ranked by firm size annually. The companies in the bottom three deciles are considered financially constrained, while the companies in the top three deciles are considered unconstrained.
- Scheme 3 - "*KZ-index*": The *KZ-index* stems from research by Kaplan and Zingales (1997). In line with Almeida et al. (2004), I will employ the results from Lamont, Polk, and Saaà-Requejo (2001) to compute the index:

$$KZindex = -1.002 * CashFlow + 0.283 * Q + 3.139 * Leverage$$
$$-39.368 * Dividends - 1.315 * CashHoldings.$$

> For each of the sample years, all companies are ranked according to the KZ-index. The companies in the top three deciles are considered financially constrained, while the companies in the bottom three deciles are considered unconstrained.

The three schemes capture different aspects related to cash holdings. The *payout ratio* is expected to be higher for firms with good business prospects. This expectation is based on the negative-signal effect of decreasing dividend payouts. The negative-signal effect leads firms to be careful not to set the level of payouts too high. Therefore, a high payout ratio signals that a company expects to do well in the future. Since funding should be easily available at the time of necessity to firms with good prospects, firms with high payout ratios are expected to retain less cash.

Firm size is included to capture economies-of-scale effects. Large firms can benefit from the opportunity to allocate funds internally and they have easier access to external financing than small firms do. Thus, large firms should have less need for cash.

Finally, the *KZ-index* provides a holistic perspective by including several variables affecting firm behavior. Measured by the *KZ-index*, a firm is more likely to be defined as financially constrained if cash flows, dividends and cash holdings are low and if the firm is highly levered or has a high Q (market-to-book ratio). However, Almeida et al. (2004) find reversed results for this measure. I.e., firms considered financially constrained display insignificant cash flow sensitivity of cash, while the opposite is true for financially unconstrained firms. Thus, it is not clear what to expect from this classification scheme, yet it is included for completeness.

To study the effect of a macroeconomic shock on the cash flow sensitivity of cash, I take advantage of the opportunity to analyze cash holdings in the periods before, during, and after the 2008 financial crisis. I expect firms to display an increased cash flow sensitivity of cash in response to news about the financial crisis. To determine the time of the "announcement", I look at the amount of newspaper articles containing the word “finanskrise” (financial crisis) in Norwegian paper based and web based newspapers in the ATEKST database in the period from January 1 2006 to December 31 2009. The search reveals a clear spike in articles from the fall of 2007. Since I need at least two years of data to measure the change in cash holdings, I define the period from 2007 to 2008 as the time of announcement and name this period “during”. The period prior to 2007 is named “before”, and the period after 2008 is named “after”. In accordance with prior literature, I expect there to be a heightened cash flow sensitivity of cash in the “during” period (Almeida et al., 2004; Fazzari et al., 1988).

Summary Statistics

To provide an overview of the two samples and the variables, I present the summary statistics for the Datastream and CCGR samples in Table 1 and Table 2, respectively.

Table I

Summary Statistics of the Datastream Sample

Table 1 displays summary statistics for the full sample from Datastream. All continuous variables are winsorized at the 1% and 99% levels.

Panel A: Summary statistics of *CashHoldings*				
	Mean	Median	Std. dev.	N. obs.
CashHoldings	0,168	0,102	0,187	3 840
Panel B: Summary statistics of dependent and independent variables				
	Mean	Median	Std. Dev.	N. Obs.
Dependent variable				
ΔCashHoldings	-0,004	-0,001	0,096	3 049
Independent variables				
CashFlow	0,012	0,045	0,172	366
Q	1,012	0,566	1,377	3 357
Size	14,380	14,425	2,022	3 840
Expenditures	0,077	0,045	0,095	3 671
Acquisitions	0,008	0,000	0,029	2 683
ΔNWC	-0,021	-0,021	0,195	3 512
ΔShortdebt	0,077	0,045	0,115	3 639
Panel C: Summary statistics of variables used for sample split				
	Mean	Median	Std. dev.	N. obs.
Payout ratio	-0,257	0,010	5,324	422
*Firm size**	13 907 356	1 839 390	68 766 336	3 840
*KZ-index**	12 014 270	3 782 837	31 205 523	340

* The variable is measured in units of 1 000.

In the Datastream sample the mean and median levels of *CashHoldings*, i.e., the levels of cash scaled by total assets, are close to the findings in other analyses (Gao et al., 2013; Opler et al., 1999) and very close to the level of cash holdings in Sweden of 16.1%, as reported in Quader and Abdullah (2016). The change in *CashHoldings* is -0.4% on average, while the median value is -0.1%. These values differ from the findings of Gao et al. (2013) who find positive mean and median changes only. However, negative values of *ΔCashHoldings* are found for Germany, France, and Japan in Riddick and Whited (2009). The summary statistics for the *CashFlow* variable is comparable to similar studies (Gao et al., 2013). Note that the number of observations is small for this variable compared to the number of observations for the other variables. Investigating the sample, I find that the reason is that the number of firms with reported dividends is quite low. This feature may distort my results since I do not know whether missing observations on dividends mean that dividends are in fact zero. The same explanation applies to the payout ratio and KZ-index.

Table II

Summary Statistics of the CCGR Sample

Table 2 displays summary statistics for the CCGR sample. All continuous variables are winsorized at the 2.5% and 97.5% levels.

Panel A: Summary statistics of *CashHoldings*

	Mean	Median	Std. dev.	N. obs.
CashHoldings	0,277	0,153	0,303	2 437 649

Panel B: Summary statistics of dependent and independent variables

	Mean	Median	Std. dev.	N. obs.
Dependent variable				
ΔCashHoldings	0,006	0,000	0,174	1 858 704
Independent variables				
CashFlow	-0,025	0,022	0,300	2 437 649
InvOpp	0,177	0,008	0,382	1 293 762
Size	14,616	14,647	1,879	2 437 649
Expenditures	0,021	0,000	0,076	1 858 704
ΔNWC	-0,014	0,000	0,300	1 858 704
ΔShortdebt	0,015	0,000	0,263	1 858 704

The summary statistics for the CCGR sample presented in Table 2, display that the *CashHoldings* are much larger in this sample than in the Datastream sample. This difference is probably due to the fact that the CCGR sample consists mainly of private firms and that these have distinctive characteristics. The change in *CashHoldings* is positive, which is in line with previous research. The mean

CashFlow is negative and much smaller than the positive median of 2.2%. It is also worth noting that the standard deviation is generally larger in the CCGR sample, probably due to a wider range of firm sizes.

4. Hypotheses and Methodology

Hypothesis development

Previous research describes the precautionary- and speculative-motives as two of the main reasons for firms to hold cash. The purpose is to have sufficient liquid assets to pay unanticipated costs and/or to be able to fund an unforeseen, yet profitable project. However, if a firm has unlimited access to external funding at the time of necessity, there is no need for the firm to hold cash. Thus, theory predicts that firms facing financial constraints should have a greater propensity to save cash out of cash flows than unconstrained firms do. I formulate my first hypothesis as follows:

H1: *Financially constrained firms have a positive and significant cash flow sensitivity of cash, while financially unconstrained firms do not.*

Further, private firms are expected to behave similarly to financially constrained firms with respect to cash retention because they have less access to external funding compared to public firms. I therefore hypothesize the following:

H2: *Private firms have a positive and significant cash flow sensitivity of cash that is greater than that of public firms.*

Finally, it has been shown that macroeconomic events, such as a recession or a change in federal interest rates, affects the availability of external funding to firms. The uncertainty related to such events should lead firms to save more cash for precautionary purposes. To examine this theory, I test the following hypothesis:

H3: *Firms have a greater cash flow sensitivity of cash during a financial crisis.*

Models of Cash Holdings

Following Almeida et al. (2004), I use their baseline and augmented models of cash holdings to investigate the cash flow sensitivity of cash in financially constrained firms. I estimate the models in Stata, using panel data regressions and controlling for firm fixed effects. I also control for heteroscedasticity using the Huber/White estimator.

The baseline model

The baseline model is a simple model, measuring the change in the independent variable, *CashHoldings*, as a function of three independent variables: *CashFlow*, *Q*, and *Size*. The model is designed to reflect the business decision of whether or not the firm should store cash "today" to facilitate future investments "tomorrow".

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} + \epsilon_{i,t}$$

Equation 1: Baseline model

ΔCashHoldings represents the change in liquid assets available to managers. It is the relation between *ΔCashHoldings* and *CashFlow*, that constitutes the emphasis of Almeida et al.'s (2004) theory. Therefore, the *CashFlow* variable is the main variable of interest. It measures the amount of cash available to save for future investments while its coefficient, α_1, represents the magnitude of the cash flow sensitivity of cash. The sensitivity is expected to be positive and significant for financially constrained firms, while unconstrained firms are expected to show no systematic cash to cash flow relation. Thus, a positive α_1 for constrained firms and an unsigned α_1 for unconstrained firms, would support the first hypothesis.

As the theory proposes that the change in cash holdings should be affected by future investment opportunities, *Q* is included as a proxy variable. *Q* is the market-to-book ratio of total assets and has been found to provide the highest information content relative to other measures of investment opportunities (Adam & Goyal, 2008). The *Q* coefficient, α_2, is expected to be unsigned for financially unconstrained firms as they can easily obtain external funding for their investments at the time of necessity. Financially constrained firms, however, may not have prospects of external funding and will need to save cash to be able to take advantage of future investment opportunities. Consequently, in the presence of financial constraints, α_2 should be positive.

Finally, *Size* is the natural log of total assets. It is included in the model mainly to control for effects of economies-of-scale. The theory implies that large companies are equipped to funnel cash across the organization to its best use. Almeida et al. (2004) do not state expectations with regards to the sign of α_3 or the significance of *Size*, as it is not the focus of their study. However, it seems reasonable to expect a negative sign if firms are large.

The augmented model

Although a parsimonious model may be desirable, it is important to consider potential omitted variable bias. Therefore, I also employ Almeida et al.'s (2004) augmented model. The augmented model accounts for alternative uses as well as other sources of funds. Thus, in addition to the independent variables of the baseline model, the following variables are added: *Expenditures*, *Acquisitions*, *ΔNWC*, and *ΔShortDebt*. All of the new variables are scaled by total assets.

$$\begin{aligned}\Delta CashHoldings_{i,t} = \alpha_0 + \ & \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} \\ & + \alpha_4 Expenditures_{i,t} + \ \alpha_5 Acquisitions \\ & + \alpha_6 \Delta NWC_{i,t} + \ \alpha_7 \Delta ShortDebt_{i,t}\end{aligned}$$

Equation 2: Augmented model

Expenditures and *Acquisitions* are included to account for the use of cash holdings to pay for capital expenditures and acquisitions, respectively. E.g., an increase in expenditures should cause a decrease of cash holdings if firms fund their expenditures with cash. Therefore, α_4 and α_5 are expected to have negative signs.

The augmented model includes the change in noncash net working capital, *ΔNWC*, because research has shown that working capital can be a substitute for cash (Opler et al., 1999). Conversely, firms may also use cash to increase working capital (Fazzari & Petersen, 1993). A similar rationale applies to the inclusion of the change in short-term debt, *ΔShortDebt*. I.e., firms can substitute short-term debt for cash or use short-term debt to increase cash reserves (Almeida et al., 2004).

According to Almeida et al. (2004), one can expect the magnitude of the *CashFlow* coefficient to be greater in the augmented model compared to the baseline model, because the added variables make the model approach an accounting identity. However, the model does not constitute a perfect identity, thus the *CashFlow* coefficient should still be close to zero if a firm is considered financially unconstrained.

Model modification for CCGR samples

One of the challenges of private-firms research is the lack of market value data. Since both the baseline and augmented models rely on *Q*, the market-to-book ratio; they cannot be used for comparison of cash to cash flow sensitivity in private and public firms without modification. Thus I have replaced it with *InvOpp* – the CAPEX/PPE ratio, which hopefully will capture some of the effects of future investment opportunities. The rationale is that firms who commit to maintenance of their assets, expect that their prospects are good. Thus, the baseline model will be estimated as follows:

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 InvOpp_{i,t} + \alpha_3 Size_{i,t} + \epsilon_{i,t}$$

Equation 3: Modified baseline model

Due to lack of data, the *Acquisitions* variable is omitted from the augmented regression model when using CCGR samples. The modified model is therefore estimated as follows:

$$\begin{aligned}\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 InvOpp_{i,t} + \alpha_3 Size_{i,t} \\ + \alpha_4 Expenditures_{i,t} + \alpha_5 \Delta NWC_{i,t} \\ \alpha_6 \Delta ShortDebt_{i,t}\end{aligned}$$

Equation 4: Modified augmented model

Modelling qualitative differences

To model differences in private and public firms, in matched private and public firms, and in firms in or not in a crisis period; I estimate the modified baseline and augmented models using dummy variables. I substitute "dummy" for the relevant variable in each case. All interaction terms are included in both models:

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 InvOpp_{i,t} + \alpha_3 Size_{i,t} \\ + \alpha_4 dummy + \alpha_5 CashFlow * dummy \\ + \alpha_6 InvOpp * dummy + \alpha_7 Size * dummy + \epsilon_{i,t}$$

Equation 5: Modified baseline dummy model

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 InvOpp_{i,t} + \alpha_3 Size_{i,t} \\ + \alpha_4 Expenditures_{i,t} + \alpha_5 \Delta NWC_{i,t} + \alpha_6 \Delta ShortDebt_{i,t} + \alpha_7 dummy \\ + \alpha_8 CashFlow * dummy + \alpha_9 InvOpp * dummy + \alpha_{10} Size * dummy \\ + \alpha_{11} Expenditures_{i,t} * dummy + \alpha_{12} \Delta NWC_{i,t} * dummy \\ + \alpha_{13} \Delta ShortDebt_{i,t} * dummy + \epsilon_{i,t}$$

Equation 6: Modified augmented dummy model

I use the following two dummy variables:

1. *public*, which equals one if a firm is public and zero otherwise,
2. *crisis*, which equals one if the year is 2007 or 2008 and zero otherwise.

5. Results

I have studied the sensitivity of cash to cash holdings testing the following three hypotheses:

H1: *Financially constrained firms have a positive and significant cash flow sensitivity of cash, while financially unconstrained firms do not.*

H2: *Private firms have a positive and significant cash flow sensitivity of cash that is greater than that of public firms.*

H3: *Firms have a greater cash flow sensitivity of cash during a financial crisis.*

Hypothesis 1

My first hypothesis is:

H1: *Financially constrained firms have a positive and significant cash flow sensitivity of cash, while financially unconstrained firms do not.*

I test this hypothesis by first dividing the public firms from the Datastream sample into subsamples of financially constrained and unconstrained firms according to three financial constraint criteria. Secondly, I summarize the *CashHoldings* variable for each subsample to display the difference between constrained and unconstrained firms. Thirdly, I fit the baseline model and the augmented model for each subsample.

Firm classification

I use three financial constraints criteria to distinguish between financially constrained and financially unconstrained firms: payout ratio, firm size, and the KZ-index. Table 3 presents the results of classifying firms as either constrained or unconstrained according to those criteria. It also displays the results of cross classifying the firms. For instance, there are 172 firm-years considered to be financially constrained according to the payout ratio criterion. Out of these, 37 firm-years are also constrained under the firm size criterion while 41 are considered unconstrained.

Table III
Cross-classification of Financial Constraint Criteria

Table 3 presents the number of firm-years categorized as financially constrained or unconstrained according to the three financial constraint criteria: payout ratio, firm size and KZ-index. Cross-classifications of the constraint types are also displayed. For visual purposes, the letter (A) represents financially constrained firms, while the letter (B) represents unconstrained firms.

Financial Constraints Criteria	Payout ratio		Firm Size		KZ index	
	(A)	(B)	(A)	(B)	(A)	(B)
1. Payout ratio						
Constrained firms (A)	172					
Unconstrained firms (B)		134				
2. Firm size						
Constrained firms (A)	37	1	1149			
Unconstrained firms (B)	41	78		1149		
3. KZ-index						
Constrained firms (A)	25	42	0	95	108	
Unconstrained firms (B)	58	36	28	23		108

The number of firm-years ranked by the firm size criterion is substantially larger than the number of firm-years ranked by the other two criteria. This difference is caused by the fact that dividends are paid in only 12.7% of the cases, which directly affects the number of firm-years available for ranking by the payout ratio and KZ-index criteria.

There appears to be a positive relation between the subsamples generated by the firm size and payout ratio criteria. For example, out of the 1 149 constrained firm-years according to firm size, only one is considered unconstrained, while 37 are considered constrained under the payout ratio criterion. However, as can be seen from the table, the association is not consistent.

The firms-years ranked by the KZ-index seem to behave quite differently from those ranked by the other two criteria. For example, out of the 109 KZ-constrained firm-years, 96 were considered unconstrained and none were considered constrained under the firm size criterion. This tendency is consistent with the findings of Almeida et al. (2004).

Cash holdings in financially constrained vs unconstrained firms

To determine whether the firms considered financially constrained differ from those considered unconstrained with respect to cash holdings, I summarize the key statistics of *CashHoldings* for each subsample. I also test for mean and median equality using t-tests and Wilcoxon's ranksum tests, respectively. The results are presented in Table 4. The firms considered constrained under the payout ratio and firm size criteria have significantly larger mean cash holdings than the unconstrained firms. However, median cash holdings are not significantly different for constrained and unconstrained firms under the payout ratio criterion. Under both of the first two criteria, the standard deviation is greater for the constrained firms. This feature indicates that the constrained firms may constitute a more heterogenic group with respect to cash holdings. The results are reversed for the KZ-index, where the constrained firms hold significantly less cash than the unconstrained firms and the standard deviation is smaller for the constrained firms. This finding is consistent with the findings of Almeida et al. (2004)

Table IV
Summary Statistics of Cash Holdings

Table 4 displays summary statistics for *CashHoldings* for each group of financially constrained and unconstrained firms. The letter (A) is assigned to constrained firms and the letter (B) to unconstrained firms. The p-values from the t-test and Wilcoxon's ranksum tests are presented for each group. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Financial Constraints Criteria	Mean	Median	Std. dev.	N. obs.
1. Payout ratio				
Constrained firms (A)	0,168	0,083	0,210	172
Unconstrained firms (B)	0,124	0,098	0,134	134
p-value (A - B ≠ 0)	(0,037)**	(0,367)		
2. Firm Size				
Constrained firms (A)	0,279	0,202	0,245	1149
Unconstrained firms (B)	0,099	0,078	0,086	1149
p-value (A - B ≠ 0)	(0,000)***	(0,000)***		
3. Kaplan-Zingales index				
Constrained firms (A)	0,108	0,104	0,074	108
Unconstrained firms (B)	0,182	0,108	0,194	108
p-value (A - B ≠ 0)	(0,000)***	(0,002)***		

Fitting of the baseline regression model

To find out if financially constrained firms do indeed have a positive cash flow sensitivity of cash, while unconstrained firms do not, I fit the baseline model of the cash flow sensitivity of cash for each of the subsamples of constrained and unconstrained firms. The results are presented in Table 5. If changes in cash holdings in financially constrained firms are sensitive to cash flows, the *CashFlow* coefficient should be positive and significant for those subsamples. For the unconstrained firms, the *CashFlow* coefficient should not be significantly different from zero, as the prediction is that the change in cash holdings for these firms are unrelated to cash flow shocks. The *Q* coefficient represents future investment opportunities and it is expected to be positive for constrained firms and close to zero for the unconstrained firms. The rationale is that the constrained firms need to save cash to be able to fund future investments, while unconstrained firms will get the necessary funding when they need it.

Table V
The Baseline Regression Model

Table 5 displays the estimation results of the baseline regression model. The letter (A) is assigned to constrained firms and the letter (B) to unconstrained firms for visual purposes. The regressions are executed using fixed effects and the White-Huber estimator. P-values are presented in parentheses. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Dependent	Financial Constraints Criteria					
Variable	1. Payout ratio		2. Firm Size		3. KZ-index	
Δ CashHoldings	(A)	(B)	(A)	(B)	(A)	(B)
CashFlow	0,158	0,284	0,186	0,253	0,135	0,233
	(0,007)***	(0,102)	(0,047)**	(0,035)**	(0,273)	(0,017)**
Q	0,040	0,009	0,063	-0,001	-0,015	0,046
	(0,029)**	(0,536)	(0,001)***	(0,918)	(0,693)	(0,070)*
Size	-0,004	-0,025	0,062	-0,006	0,007	0,007
	(0,839)	(0,161)	(0,138)	(0,544)	(0,627)	(0,587)
Intercept	0,047	0,367	-0,861	0,083	-0,123	-0,142
	(0,866)	(0,197)	(0,127)	(0,608)	(0,632)	(0,463)
N. obs.	120	102	24	145	98	98
Adjusted R^2	0,12	0,16	0,68	0,06	0,00	0,19

As expected, the *CashFlow* and *Q* are positive and significant for financially constrained firms under the payout ratio criterion, while none of the independent variables are significant for the unconstrained subsample. *Size* is negative, but not significant at any of the usual significance levels.

Under the firm size criterion, *CashFlow* is significant at the 5% level for both constrained and unconstrained firms. The result is surprising, but further investigation of the data reveals that only a small fraction (10%) of the firms ranked by the firm size criterion pays dividends, leading to many missing data points in the *CashFlow* variable, which depends on dividends. By assuming that missing data on dividends in the years where other accounting data is reported means that the firm did not pay dividends, i.e. dividends = 0, the regression results reveal that neither the constrained nor the unconstrained firms have a positive cash flow sensitivity of cash under the firm size criterion. *Q*, however, is positive and significant at the 1% level for constrained firms. It is also close to zero and insignificant for the unconstrained firms. This result indicates that smaller firms increase their cash savings when there appears to be future investment opportunities, while large firms do not.

The firms considered financially constrained under the KZ-index criterion, seem to behave similar to the unconstrained firms under the payout ratio criterion. Correspondingly, the KZ-index unconstrained firms appears to behave like constrained firms under the payout ratio criterion. The discovery is not unexpected given the summary statistics, which are also reversed. This result is also consistent with Almeida et al.'s (2004) findings.

Fitting of the augmented regression model

To account for alternative uses and sources of cash in a firm and to avoid omitting any significant variables, I also test the augmented model on each of my subsamples. The model adds four new variables to the regression: *Expenditures*, *Acquisitions*, *ΔNWC*, and *ΔShortDebt*. The *Expenditures* and *Acquisitions* coefficients are expected to be negative for constrained firms and unsigned for unconstrained firms because the former will draw on their cash reserves to pay for these investments while unconstrained firms can obtain external funding. There are no a priori suggestions with respect to the sign of the *ΔNWC* and *ΔShortDebt* coefficients because these two variables represent both alternative sources of funds and alternative usages of funds. The expectations for the *CashFlow* and *Q* coefficients are the same as for the baseline model, i.e., they should both be positive and significant for constrained firms and insignificant for unconstrained firms. The results are displayed in Table 6.

Table VI

The Augmented Regression Model

Table 6 displays the estimation results of the augmented regression model. The letter (A) is assigned to constrained firms and the letter (B) to unconstrained firms for visual purposes. The regressions are executed using fixed effects and the White-Huber estimator. P-values are presented in parentheses. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Dependent Variable	Financial Constraints Criteria					
	1. Payout ratio		2. Firm Size		3. KZ-index	
Δ CashHoldings	(A)	(B)	(A)	(B)	(A)	(B)
CashFlow	0,153	0,323	0,183	0,396	0,299	0,294
	(0,065)*	(0,076)*	(0,001)***	(0,007)***	(0,109)	(0,020)**
Q	0,044	0,006	-0,192	-0,001	-0,005	0,047
	(0,000)***	(0,578)	(0,026)**	(0,903)	(0,897)	(0,093)*
Size	-0,019	-0,021	-0,141	-0,012	-0,002	0,009
	(0,248)	(0,315)	(0,002)***	(0,352)	(0,893)	(0,520)
Expenditures	-0,239	-0,342	1,260	-0,247	0,001	-1,112
	(0,321)	(0,123)	(0,026)**	(0,101)	(0,995)	(0,046)**
Acquisitions	-0,220	-0,413	-4,302	-0,744	-1,436	0,052
	(0,691)	(0,196)	(0,016)**	(0,016)**	(0,000)***	(0,942)
ΔNWC	-0,554	0,057	-0,172	-0,309	-0,240	-0,364
	(0,000)***	(0,766)	(0,000)***	(0,079)*	(0,173)	(0,009)***
ΔShortDebt	-0,556	0,013	-0,765	-0,232	-0,139	-0,179
	(0,000)***	(0,927)	(0,000)***	(0,111)	(0,399)	(0,387)
Intercept	0,275	0,327	2,064	0,195	0,033	-0,142
	(0,258)	(0,345)	(0,003)***	(0,359)	(0,910)	(0,504)
N. obs.	105	92	18	136	89	84
Adjusted R^2	0,34	0,22	0,92	0,16	0,17	0,21

As expected, the constrained firms under the payout ratio criterion still have a positive and significant cash flow sensitivity of cash as well as a positive and significant coefficient for *Q*. It is also interesting to observe that positive changes in noncash net working capital and in short-term debt are significant and that they lead to a reduction in cash holdings. This observation is in line with a priori expectations and it is consistent with the notion that net working capital and short-term debt represent alternative usages of funds. Unconstrained firms do also appear to have significant cash flow sensitivity of cash. However, neither of the other independent variables are significant.

Under the firm size criterion, it appears that cash holdings of both constrained and unconstrained firms are sensitive to cash flow changes also in the augmented model. In addition, the sample of constrained firms is very small and there appears to be a problem with overfitting the model resulting in a very large adjusted R^2. The small sample size is due to many missing values of dividends resulting in few observations of the *CashFlow* variable. The issue of overfitting was resolved when I modified the sample so that only firms with data on *CashFlow* were included from the beginning. However, various attempts to reform the sample do not change the result of both constrained and unconstrained firms having significant cash flow sensitivities of cash.

In line with previous findings, the unconstrained firms under the KZ-index behave similarly to the expectations for constrained firms. I.e., the unconstrained KZ-index firms display a positive and significant cash flow sensitivity of cash, while *Q* and *Expenditures* also have the signs and significance expected from constrained firms. The KZ-index constrained firms, on the other hand, do not have a significant cash flow sensitivity of cash. The reversed behavior of the KZ-index firms is consistent with the findings of Almeida et al. (2004)

Hypothesis 1 – Preliminary findings

The first hypothesis is twofold: First, financially constrained firms should have a positive and significant cash flow sensitivity of cash. Secondly, financially unconstrained firms should not have a significant cash flow sensitivity of cash. My results support the first part of the hypothesis since constrained firms in four out of six cases display a positive and significant cash flow sensitivity of cash. The findings from studying unconstrained firms, however, are more ambiguous. There is some support for unconstrained firms not having a positive cash to cash flow sensitivity, however, the results are inconclusive, and therefore, this part of the hypothesis cannot be confirmed with certainty.

Hypothesis 2

My second hypothesis is:

> H2: *Private firms have a positive and significant cash flow sensitivity of cash that is greater than that of public firms.*

To test this hypothesis, I first create three subsamples: public firms, private firms, and matched private firms, using data from CCGR. The sample of matched private firms consists of private firms in the same industry and of approximately the same size as the public firms. Secondly, I summarize all the variables by sample and compare the findings. Thirdly, I fit the baseline and augmented models for each subsample. Using a dummy variable capturing the effect of being a public firm, I also fit the two models to the full sample and to the combined sample of public and matched private firms.

Sample selection and the matching process

The full CCGR sample consists of all Norwegian private and public firms. I restrict private firms to limited liability companies only. Since the private and public firms differ substantially in size distribution, I create a subsample of matched private firms to better isolate the difference in cash flow sensitivity of cash stemming from being a private firm. As in Gao et al. (2013), I match each public firm to a private firm in same industry and of approximately the same size measured in total assets. To determine the industry, I use the 21 main categories of SSB's industry classification, which is based on the NACE rev. 2 standard. For details, see (Appendix B). Conforming to standard practice on the field, I exclude financial and utilities firms.

To create the matched sample, I first find all private firms in the same industry as the public firm each year. Then, I compute the ratio of total assets of each private firm to the total assets of the corresponding public firm. I keep only the matches for which the ratio is between 0.8 and 0.12. I.e., the matched firm is not allowed to deviate more than 20% from the public firm with respect to total assets. At this point, each private firm appears several times in a year if it has been matched with multiple public firms. I want each private firm to appear only once each year. Thus, I compute the absolute value of the difference (delta) in total assets between the private and public firms and rank each private firm by delta each year. I keep only the observation for which the delta value is the lowest for each firm-year. Now, each private firm-year is unique. However, there are still multiple matches for each public firm. For each public firm-year, I sort the matches by delta and keep only the match with the smallest value.

At this stage, I have the best-matching private firm for each public firm each year. However, the match changes from year to year. It would be unrealistic to have changing firms every year and I need some continuity of the firms to be able to compute differenced variables. I therefore keep the best matching private firm in the first year of data for each public firm until it exits the full data sample. If, one year, a matched private firm has exited the sample, I replace it with the best match for that year.

To display the results of the matching procedure, I have summarized the total assets variable for each subsample Table 7. The summary shows that the sample of all private firms differs significantly from the sample of public firms in both mean and median total assets. On average, the private firms' total assets are only 2% of the average total assets of the public firms. Although the sample of matched private firms does not perfectly replicate the public-firms sample, it is much closer in terms of mean, median, and standard deviation of total assets. In fact, the mean total assets are not significantly different from the mean total assets of the public firms.

Table VII
Total Assets in Matched Samples

Table 7 presents summary statistics for total assets in the private, matched private and public subsamples. The mean and median total assets of the private and matched private firms' are compared to the mean and median in the public firms using the t.test and Wilcoxon's ranksum tests. P-values are presented in parentheses. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Statistics	Private firms	Matched private firms	Public firms
Mean	30 030 283	1 292 273 122	1 494 873 301
T-test	(0,000)***	(0,209)	
Median	2 289 000	150 744 992	204 714 000
Wilcoxon-test	(0,000)***	(0,000)***	
Std. dev.	866 960 789	6 428 140 622	6 939 313 800
N. obs.	2 433 903	3 442	3 442

Matching firms with respect to industry is important because research shows that cash holdings vary systematically by industry (Gao et al., 2013). Thus, I want the matched sample to have the same distribution of firms with respect to industry. The fractional distribution of the full samples of private and public firms are displayed in Figure 1. It shows that the public firms sample is characterized by large fractions of firms in the C, H, J, and M industries. The private-firms sample, on the other hand, has the largest fractions of firms in the G, H, L, and M industries. (For an overview of the industry codes and names, see Appendix B.)

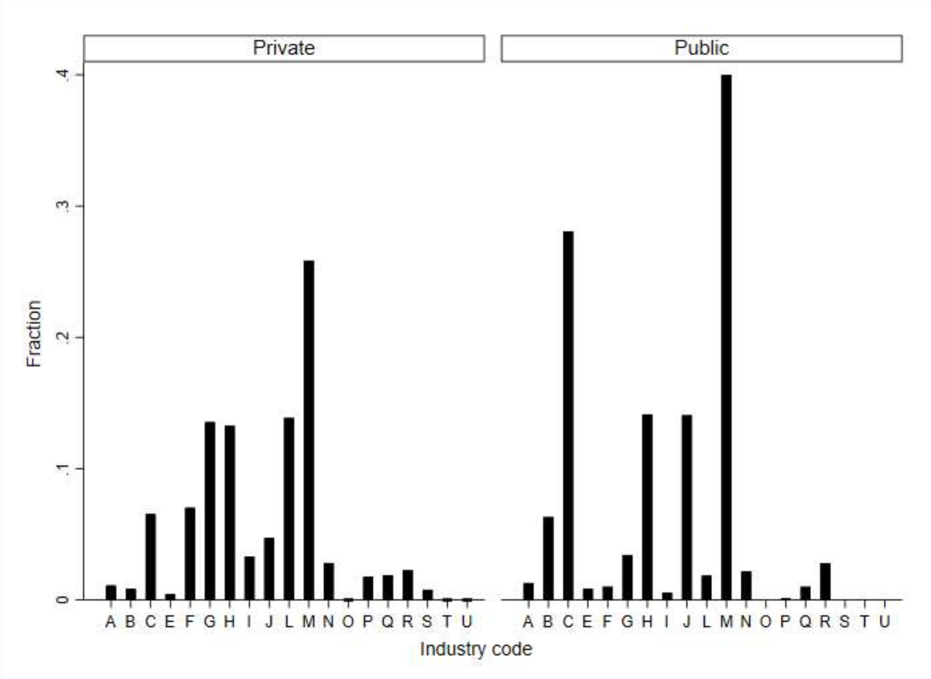

Figure 1: Fractional distribution of firms by industry code in the private firms and public firms samples

The results of the matching procedure with respect to industry are displayed in Figure 2. Since the matched private firms sometimes change their industry codes over the lifetime of the company, the distributions are not identical. However, the distribution of firms by industry in the matched private-firms sample is now much closer to the distribution in the public-firms sample.

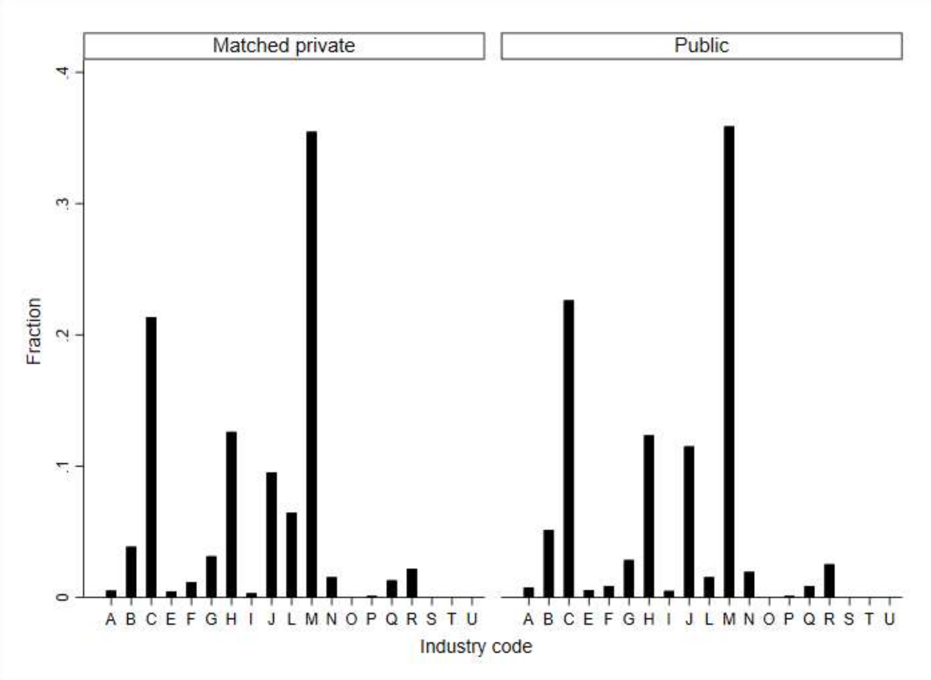

Figure 2: Fractional distribution of firms by industry code in the matched private firms and public firms samples

Overall, the matching process results in a sample of private firms that matches the sample of public firms reasonably well. However, I will move forward testing all three samples. I.e., the full sample of private firms, the matched private-firms sample, and the public firms sample.

Summary statistics of subsamples

To further examine the similarities and differences between the samples, I have summarized the level of cash holdings and all the variables of both the baseline and augmented models. Given the large difference in both size and industry distribution between private and public firms, these two samples are expected to differ substantially. The samples of matched private firms and public firms, are also expected to differ. However, due to the matching process, the differences should stem from inherent factors, characteristic of each group, such as cost of external financing, regulatory climate, information asymmetry, and agency costs, that are not related to size or industry deviation.

The summary is presented in Table 8. Some of the variables differ from the original models' variables. Due to lack of market value data, *Q*, i.e., the market to book ratio, is replaced by *InvOpp*, defined as the ratio of capital expenditures to fixed, tangible assets. The *Acquisition* variable is omitted and the specification of *Expenditures* is slightly altered.

Table VIII
Summary Statistics

Table 8 displays summary statistics for the variables in the CCGR sample for all private firms, all private firms matched to a public firm, and all public firms. For each variable, the p-values of the t-test and Wilcoxon-test are presented below. ***, **, and * denotes that the variable's mean (median) differ from the mean (median) of the sample of public firms at the 10%, 5%, and 1% levels, respectively. The variables are winsorized at the 2.5% and 97.5% levels.

	Private firms			Matched private firms			Public firms		
Variables	Mean	Median	Std. dev.	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Cash-Holdings	0,277	0,153	0,303	0,145	0,040	0,226	0,168	0,063	0,239
	(0,000)***	(0,000)***		(0,000)***	(0,000)***				
ΔCash-Holdings	0,006	0,000	0,174	0,003	0,000	0,129	-0,005	0,000	0,147
	(0,001)***	(0,000)***		(0,028)**	(0,005)***				
CashFlow	-0,025	0,022	0,300	0,018	0,032	0,200	-0,109	-0,002	0,345
	(0,000)***	(0,000)***		(0,000)***	(0,000)***				
InvOpp	0,177	0,008	0,382	0,175	0,073	0,394	0,368	0,265	0,525
	(0,000)***	(0,000)***		(0,000)***	(0,000)***				
Size	14,611	14,644	1,876	17,676	18,267	1,565	17,856	18,292	1,422
	(0,000)***	(0,000)***		(0,000)***	(0,000)***				
Expend-itures	0,021	0,000	0,076	0,021	0,002	0,079	0,018	0,001	0,067
	(0,013)**	(0,000)***		(0,061)*	(0,002)***				
ΔNWC	-0,014	0,000	0,300	-0,006	0,000	0,233	-0,018	-0,005	0,260
	(0,622)	(0,018)**		(0,057)*	(0,010)**				
ΔShort-Debt	0,015	0,000	0,263	0,010	0,000	0,205	0,023	0,004	0,252
	(0,249)	(0,002)***		(0,042)**	(0,007)***				

Consistent with the results of Gao et al. (2013), I find that private firms in general hold significantly more cash relative to total assets than public firms do. This result implies that the cost of external financing is greater for the average private firm than for the average public firm. For the sample of matched private firms, however, cash holdings are lower than cash holdings in public firms. The explanation may be that public firms suffer from greater information asymmetry between owners and managers, which results in greater agency costs in the form of excessive cash holdings. The full sample of private firms however, have a much larger cash ratio. Since the matched private firms are among the largest private firms, it is likely that these companies have lower costs of external financing than the numerous small, private firms do.

Overall, most of the variables differ significantly between the samples.

Fitting of the baseline regression model

To test my hypothesis of private firms having a positive and significant cash flow sensitivity of cash greater than that of public firms, I begin by fitting the baseline model to the three subsamples of private, matched private, and public firms. If private firms' changes in cash holdings are sensitive to cash flows, there should be a positive and significant coefficient for *CashFlow* in both the private firms and matched private firms samples. I expect a positive cash flow sensitivity of cash for the private and matched private firms as theory suggests that external financing is more costly for these firms. For public firms, I expect the *CashFlow* coefficient not to differ significantly from zero, as these firms should be able to obtain external funding at the time of necessity and not rely on cash savings. If the *InvOpp* variable succeeds in capturing future investment opportunities, I would expect a positive sign for all samples of private firms and a value close to zero for the public firms. However, this is a noisy proxy and the coefficient should therefore not be highlighted.

I also specify a model using a dummy variable, *public*, which equals one if a firm is public and zero otherwise. All interaction terms are included. The dummy variable model is then fitted for both the full sample of public and private firms and for the sample of public and matched private firms. Since I expect the cash flow sensitivity of cash in private firms to be higher than the sensitivity in public firms, the coefficient for the *public**CashFlow* interaction term should be negative and significant. The regression results are displayed in Table 9.

Table IX
The Baseline Regression Model

Table 10 displays the estimation results of the baseline regression model. The regressions are executed using fixed effects and the White-Huber estimator. All continuous variables are winsorized at the 2.5 and 97.5 levels. P-values are presented in parentheses. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Dependent Variable *Δ CashHoldings*	Private	Matched private	Public	Full sample	Matched private and public
CashFlow	0,075	0,053	-0,007	0,075	0,053
	(0,000)***	(0,047)**	(0,730)	(0,000)***	(0,042)**
InvOpp	-0,071	-0,051	-0,022	-0,071	-0,051
	(0,000)***	(0,000)***	(0,007)***	(0,000)***	(0,000)***
Size	0,006	0,016	0,004	0,005	0,017
	(0,000)***	(0,317)	(0,769)	(0,000)***	(0,294)
public				-0,138	0,243
				(0,423)	(0,544)
*public*CashFlow*				-0,051	-0,057
				(0,008)***	(0,086)*
*public*InvOpp*				0,043	0,025
				(0,000)***	(0,117)
*public*Size*				0,006	-0,013
				(0,501)	(0,549)
Intercept	0,000	0,000	0,000	-0,071	-0,301
	(0,000)***	(0,000)***	(0,000)***	(0,000)***	(0,000)***
N. obs.	1 291 725	2 291	2 037	1 293 762	4 122
Adjusted R^2	0,04	0,03	0,01	0,04	0,02

As seen in Table 9, cash flows have a positive and significant impact on cash holdings in the private and matched private-firms subsamples, while the impact is insignificant in public firms. This is in line with a priori expectations and supports the hypothesis of private firms having a positive cash flow sensitivity of cash. For the full sample and for the combined sample of matched private and public firms, the *CashFlow* coefficient is also positive and significant. However, I am mainly interested in the *public*CashFlow* interaction term. The *public*CashFlow* coefficient is negative for both the full and the matched samples at the 1% and 10% levels respectively. This result indicates that the changes in cash holdings in public firms are less sensitive to cash flow changes compared to cash holdings in private firms, in fact the *public*CashFlow* coefficient completely counteracts the effect of cash flows on cash holdings for public firms in the matched sample.

The *InvOpp* coefficients are negative and significant for all samples. This indicates that it may not capture future investment opportunities, but rather some other relevant property of the changes in cash holdings. Given the definition, i.e., capital expenditures to fixed total assets; it is likely that it captures use of funds rather than investment opportunities.

The low values for adjusted R^2 indicate that the model explains only a small fraction of the total changes in cash holdings. However, the relation between the independent and dependent variables is still valid. Overall, the results support the second hypothesis, i.e., that private firms have a positive and significant cash flow sensitivity of cash, while public firms do not.

Fitting of the augmented regression model

I test the differences in cash flow sensitivity of cash in private and public firms also by fitting the augmented model. The intention is to avoid omitted variable bias. I therefore include variables that represent alternative uses and sources of funds. Additionally, I fit a dummy variable version of the model, similar to the dummy variable version of the baseline model to confirm whether the cash flow sensitivity of cash is significantly different for private and public firms.

The expectation for the *CashFlow* coefficient is the same as previously. I.e., it is expected to be positive and significant for private and matched private firms only. According to Almeida et al. (2004), one can expect the magnitude of the *CashFlow* coefficient to be greater in the augmented model compared to the baseline model. The *Expenditures* coefficient should be negative if firms use their cash reserves to pay for them. The signs for *ΔNWC* and *ΔShortDebt* may be either positive or negative depending on whether firms substitute cash using working capital or short-term debt or whether they use cash to increase net working capital or repay debt. Given that public firms easily can obtain external funding when they need it, the coefficients for the added variables should be insignificant. Conversely, private firms are expected to have less access to external funding and should therefore have significant coefficients for each of the new variables.

Regarding the dummy version of the model, I am mainly interested in the *public*Cash* interaction term. I expect its coefficient to be negative, if private firms do indeed have a greater cash flow sensitivity of cash than public firms do. The results of fitting the augmented model is presented in Table 10.

Table X
The Augmented Regression Model

Table 10 displays the estimation results of the augmented regression model on the CCGR sample. The regressions are executed using fixed effects and the White-Huber estimator. All continuous variables are winsorized at the 2.5 and 97.5 levels. P-values are presented in parentheses. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Dependent Variable *Δ CashHoldings*	Private	Matched private	Public	Full sample	Matched private and public
CashFlow	0,131	0,093	-0,002	0,131	0,096
	(0,000)***	(0,001)***	(0,924)	(0,000)***	(0,000)***
InvOpp	-0,028	-0,020	-0,010	-0,028	-0,022
	(0,000)***	(0,116)	(0,275)	(0,000)***	(0,093)*
Size	0,010	0,029	0,006	0,010	0,030
	(0,000)***	(0,023)**	(0,547)	(0,000)***	(0,019)**
Expenditures	-0,504	-0,289	-0,194	-0,504	-0,286
	(0,000)***	(0,000)***	(0,009)***	(0,000)***	(0,000)***
ΔNWC	-0,642	-0,465	-0,299	-0,642	-0,464
	(0,000)***	(0,000)***	(0,000)***	(0,000)***	(0,000)***
ΔShortDebt	-0,555	-0,377	-0,256	-0,555	-0,376
	(0,000)***	(0,000)***	(0,000)***	(0,000)***	(0,000)***
public				-0,050	0,457
				(0,754)	(0,144)
*public*CashFlow*				-0,089	-0,097
				(0,000)***	(0,005)***
*public*InvOpp*				0,012	0,007
				(0,173)	(0,680)
*public*Size*				0,002	-0,024
				(0,861)	(0,160)
*public*Expenditures*				0,329	0,117
				(0,000)***	(0,254)
*public*ΔNWC*				0,341	0,149
				(0,000)***	(0,023)**
*public*ΔShortDebt*				0,304	0,105
				(0,000)***	(0,125)
Intercept	-0,128	-0,516	-0,115	-0,128	-0,551
	(0,000)***	(0,027)**	(0,541)	(0,000)***	(0,019)**
N. obs.	1 291 725	2 291	2 037	1 293 762	4 122
Adjusted R^2	0,46	0,31	0,11	0,46	0,20

The results presented in Table 10, show that the private and matched private firms have a positive *CashFlow* coefficient that is significant at the 1% level. As anticipated, the magnitude of the coefficient is greater compared to the coefficient in the baseline model. The *CashFlow* coefficient is close to zero for the public firms, also in line with a priori expectations. In the dummy variable regressions, I find that the *public*CashFlow* coefficient is negative and highly significant in both the full sample and in the combined sample of matched private firms and public firms. For the matched sample, the magnitude of the *public*CashFlow* coefficient completely neutralizes the effect of cash flows on cash holdings for public firms.

The *Expenditures*, *ΔNWC* and *ΔShortDebt* coefficients are all negative. The negative signs for *ΔNWC* and *ΔShortDebt* imply that the variables represent alternative uses rather than alternative sources of funds. All three variables are significant at the 1% level in all samples. They were expected to be significant only for the private firms. However, the magnitude of their impact is smaller in the public-firms sample. This difference is also confirmed in the full sample regression, since the *public*Expenditures*, *public*ΔNWC*, and *public*ΔShortDebt* interaction terms are all positive and significant. The positive signs mean that the negative impact of *Expenditures*, *ΔNWC,* and *ΔShortDebt* on *ΔCashHoldings* is reduced for public firms. However, for the combined sample of matched private firms and public firms, only the *public*ΔNWC* interaction term is significant. Thus, public firms' cash holdings are less sensitive to the negative effect of increased net working capital compared to the cash holdings of matched private firms, but the effects of capital expenditures and changes in short-term debt are not significantly different.

Finally, the augmented model appears to explain more of the changes in cash holdings than the baseline model does. The adjusted R^2 is higher for the samples of private and matched private firms compared to the sample of public firms. In addition, the adjusted R^2 is higher in the full sample of private and public firms than in the combined sample of matched private firms and public firms. This finding implies that the model explains more of the variation in cash holdings in private firms than in cash holdings in public firms. It also explains more of the variation in private firms' cash holdings than in the matched private firms' cash holdings. Overall, the results from fitting the augmented regression model support the third hypothesis of private firms having a positive and significant cash flow sensitivity of cash, while public firms do not.

Hypothesis 2 – Preliminary findings

I find convincing support for the third hypothesis. Fitting both the baseline and augmented models to my samples, I find that private firms have a positive and significant cash flow sensitivity of cash, while the public firms do not. One could argue that private firms, on average, are much smaller, and operate in other industries than public firms do and that this is the reason for the differences. However, I control for differences in size and industry distribution, using a subsample of matched private firms and find that my results still hold for the matched sample.

The results imply that external financing is more costly for private firms than for public firms. The cost of external financing may also be the reason why private firms on average hold much more cash relative to total assets than public firms do. The cash holdings of the matched private firms, however, are significantly lower than the cash holdings of the public firms. This finding suggests that public firms may suffer from agency costs.

Hypothesis 3

My third hypothesis is:

> H3: *Firms have a greater cash flow sensitivity of cash during a financial crisis.*

I test H3 by analyzing the effect of the 2008 financial crisis on the cash to cash flow sensitivities of both private and public firms. I use CCGR data and the baseline and augmented models. I first define the crisis period and then fit the baseline and augmented models to the samples of private and public firms.

Defining the crisis period

To examine the effect of the financial crisis on changes in cash holdings and in the cash flow sensitivity of cash, I need to define the crisis period. Since firms save cash for precautionary purposes, it is likely that they will save more cash when uncertainty about the availability of funds is greater. The first indications of a financial downturn came in 2007. A search in the ATEKST database of Norwegian newspapers reveals that there is a sharp increase in newspaper articles about the financial crisis in September 2007. The number of articles continues to increase throughout 2008. I therefore define years from 2007 to 2008 as the crisis period because one would expect firms to start saving cash out of cash flows as soon as they expect future financial difficulties.

Fitting the baseline and augmented models

To capture the effect of the financial crisis, I have included a dummy variable that equals one if the year is 2007 or 2008 and zero otherwise. All interaction terms are also included. In particular, I am interested in the interaction term between the *crisis* dummy and the *CashFlow* variable. If firms have a significantly greater cash flow sensitivity of cash during the financial crisis, the coefficient of this interaction term should be positive and significant. The results of fitting the regression models are presented in Table 11.

Table 11
The Financial Crisis

Table 11 displays the estimation results of the baseline and augmented regression models fitted for private and public firms, respectively. The regressions are executed using fixed effects and the White-Huber estimator. All continuous variables are winsorized at the 2.5 and 97.5 levels. P-values are presented in parentheses. Significance at the 10%, 5%, and 1% levels are indicated with *, **, and ***, respectively.

Dependent	Sample			
Variable	Public firms		Private firms	
Δ CashHoldings	Baseline	Augmented	Baseline	Augmented
CashFlow	-0,019	-0,014	0,071	0,130
	(0,332)	(0,498)	(0,000)***	(0,000)***
InvOpp	-0,023	-0,011	-0,072	-0,028
	(0,006)***	(0,209)	(0,000)***	(0,000)***
Size	0,008	0,011	0,006	0,010
	(0,589)	(0,295)	(0,000)***	(0,000)***
Expenditures		-0,182		-0,502
		(0,010)**		(0,000)***
ΔNWC		-0,302		-0,640
		(0,000)***		(0,000)***
ΔShortDebt		-0,246		-0,553
		(0,000)***		(0,000)***
crisis	0,131	0,239		-0,005
	(0,589)	(0,321)		(0,118)
*crisis*CashFlow*	0,128	0,112	0,029	0,008
	(0,008)***	(0,005)***	(0,000)***	(0,010)**
*crisis*InvOpp*	0,023	0,017	0,002	0,000
	(0,174)	(0,361)	(0,062)*	(0,773)
*crisis*Size*	0,008	-0,014	0,006	0,000
	(0,589)	(0,287)	(0,000)***	(0,051)*
*crisis*Expenditures*		-0,114		-0,016
		(0,592)		(0,005)***
*crisis*ΔNWC*		-0,006		-0,019
		(0,962)		(0,000)***
*crisis*ΔShortDebt*		-0,149		-0,014
		(0,243)		(0,004)***
Intercept		-0,200		-0,128
		(0,294)		(0,000)***
N. obs.	2 037	2 037	1 291 725	1 291 725
Adjusted R^2	0,01	0,12	0,04	0,46

As Table 11 displays, the public firms do not have a positive, significant cash flow sensitivity of cash. In fact, the sign of the *CashFlow* coefficient is negative for public firms. Although the coefficient it is not significant, the negative sign is in line with previous research from Riddick and Whited (2009) who state that firms have a negative cash flow sensitivity of cash because positive cash flow shocks lead to investments that draws on the cash reserves and vice versa. The *crisis*CashFlow* coefficient, however, is positive and significant, which means that although, public firms do not generally save cash as a response to positive cash flow shocks, they do so during the financial crisis.

As before, the private firms have a positive and significant cash flow sensitivity of cash. However, the *crisis*CashFlow* coefficient is significantly positive also for the private firms. This finding implies that the private firms save even more cash out of cash flows during the financial crisis. The financial crisis appears to also increase the effect of *Expenditures*, *ΔNWC,* and *ΔShortDebt* on cash holdings in private firms.

Hypothesis 3 – Preliminary findings

I find support for the hypothesis that firms retain more cash out of cash flows during the financial crisis. The result applies to both private and public firms. My findings are in line with previous research on the cash flow sensitivity of cash and macroeconomic shocks (Almeida et al., 2004), and suggest that firms expecting financial constraints will retain a larger portion of the cash flow as cash on the balance sheet.

6. Conclusion

My research question is “Do financial constraints impose greater cash retention?” I analyze the question from three perspectives. First, I examine whether public firms considered financially constrained according to three different financial constraints criteria have positive cash flow sensitivities. I find that in most cases, they do. However, the results for firms considered financially unconstrained, are inconclusive. Secondly, I hypothesize that private firms have less access to external funding and they should therefore act like financially constrained firms and retain cash out of their cash flows, while public firms should not. I find convincing support for this hypothesis. Even when I fit the models to a sample of private firms, similar to the public firms in size and industry, the private firms display a significant and positive cash flow sensitivity of cash. The public firms of this sample do not show such propensities. Thirdly, I test whether the cash flow sensitivity of cash is greater when uncertainty is high. I find that the cash to cash flow sensitivity of private firms increases significantly during the financial crisis. Interestingly, I find that public firms, which otherwise do not have significant cash flow sensitivities of cash, have a positive and significant sensitivity during this period. Thus, overall find support in favor of financial constraints imposing greater cash retention.

My study is important because private firms constitute a significant part of the economy, yet they are rarely studied since quality data is hard to find. Moreover, inferences from studies done on public firms may be invalid for private firms, due to differences in regulatory climate. In Norway, support and funding of private firms, is a hot topic as we are searching for “the new oil” in the aftermath of the oil crisis. Recent research shows that private firms generate two out of three new jobs. Thus, knowledge about financial constraints for these firms is important for government regulators in their efforts to facilitate growth and innovation.

For the entrepreneur, it is valuable to know that she may need to hold more cash than models created for public firms would imply, to compensate for restricted access to external financing. For the CEO of a public company, on the other hand, it is useful to understand that she may not have to hold large amounts of cash “just in case”, since funding is generally available at the time of necessity.

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APPENDIX A – Variable IDs

Datastream variables

Variable	ID
Depreciation	WC01148
Operating Income	WC01250
Net Income Before Extra Items/Preferred Dividends	WC01551
Cash	WC02003
Current Assets Total	WC02201
Total Assets	WC02999
Short Term Debt & Current Portion Of Long Term Debt	WC03051
Current Liabilities Total	WC03101
Total Debt	WC03255
Dividends	WC04052
Net Assets From Acquisitions	WC04355
Capital Expenditures (Additions To Fixed Assets)	WC04601
Market Capitalization	WC08001

CCGR Variables

Variable	ID
Total Current Liabilities	item_109
Depreciation	item_15
Operating Income	item_19
Income before extraordinary items	item_35
Dividends	item_41
Total fixed assets (tangible)	item_51
Total fixed assets	item_63
Investments in listed companies	item_71
Investments in listed bonds	item_72
Investment in other traded financial instruments	item_73
Total investments	item_75
Cash and Cash Equivalents	item_76
Total current assets	item_78
Revenue	item_9
Total provisions	item_91
Total other long-term liabilities	item_98
Industry codes	item_5010[illegible]
Enterprise type	item_6

APPENDIX B – Industry Code

Broad Structure of NACE Rev. 2/SSB industry categories

Section	Title
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organisations and bodies

APPENDIX C – Stata Script

```
*******************************************************************************
******                       SCRIPT DATA ANALYSES                        ******
*******************************************************************************

**  This Stata script documents all the analyses provided in the thesis. For
*   variable definitions, see the enclosed appendix. All tables are exported to
*   Excel for further formatting.



*******************************************************************************
******                         ANALYSES FOR H1                           ******
*******************************************************************************


*******************************************************************************
*************            Import, format and sort data             *************
*******************************************************************************

clear all
set more off, perm
use "Data\Datastream\Datastream full sample.dta"

* Define company ID (cid) as the panel variable
* and year (yr) as the time variable
xtset cid yr
sort cid yr

*******************************************************************************
*************                  Data cleaning                      *************
*******************************************************************************

* Drop financial and utilities firms
drop if industrycode == "D" //utilities firms
drop if industrycode == "K" //financial and insurance companies

* Drop firmyears where cash exceed total assets
drop if cash > totassets

* Generate the enogenous variable and drop observations for which it is missing
cap drop CashHoldings
gen CashHoldings = cash / totassets
drop if CashHoldings == .

* Drop firmyears where the market value is less than 1 000 000
drop if mcap < 1000     // market cap is reported in units of 1000 NOK


* Generate variables for asset growth and sales growth
cap drop assetgrowth salesgrowth
gen assetgrowth = (totassets - L.totassets)/L.totassets * 100
gen salesgrowth = (sales - L.sales)/L.sales * 100

* Drop firmyears where asset growth exceeds 100 %
drop if assetgrowth > 100 & assetgrowth != .

* Drop firmyears where sales growth exceeds 100 %
drop if salesgrowth > 100 & salesgrowth != .

*******************************************************************************
*************                Generate variables                   *************
*******************************************************************************

* Generate Model 1 (baseline model) variables

cap drop CashFlow Q Size
gen CashFlow = (netinc + depr * (1-0.28) - div)/totassets
replace CashFlow = (netinc + depr *(1-0.27) - div)/totassets if yr >= 2014
* The corporate tax rate changed from 28 % to 27 % in 2014
gen Q = mcap / totassets
gen Size = ln(totassets)

* Generate Model 2 (augmented model) variables

cap drop Expenditures Acquisitions NWC ShortDebt
```

```
gen Expenditures = capex/ totassets
gen Acquisitions = acqui/ totassets
gen NWC = (currassets - currliab - cash)/ totassets
gen ShortDebt = shortdebt/ totassets

* Winsorize all variables to remove extreme outliers
winsor2 CashHoldings CashFlow Q Size Expenditures Acquisitions NWC ShortDebt ///
, cuts(1 99)
local vars CashHoldings CashFlow Q Size Expenditures Acquisitions NWC ShortDebt
foreach var of local vars {
replace `var' = `var'_w
}
******************************************************************************
*************       Create financial constraint schemes          *************
******************************************************************************
// Scheme 1 - payout ratio

* Define the payout ratio variable
cap drop payoutratio
gen payoutratio = div / opinc

* Compute the 30th and 70th percentiles
sort yr
by yr: egen scheme1p30 = pctile(payoutratio), p(30)
by yr: egen scheme1p70 = pctile(payoutratio), p(70)

* Define constrained and unconstrained firms according to the payout ratio
cap drop scheme1constr scheme1unconstr
gen scheme1constr = 0
replace scheme1constr = 1 if payoutratio <= scheme1p30 & payoutratio !=.

gen scheme1unconstr = 0
replace scheme1unconstr = 1 if payoutratio >= scheme1p70 & payoutratio !=.


// Scheme 2 - firm size

* Compute the 30th and 70th percentiles of total assets
sort yr
by yr: egen scheme2p30 = pctile(totassets), p(30)
by yr: egen scheme2p70 = pctile(totassets), p(70)
cap drop scheme2constr scheme2unconstr

* Define constrained and unconstrained firms according to total assets
gen scheme2constr = 0
gen scheme2unconstr = 0
replace scheme2constr = 1 if totassets <= scheme2p30 & totassets !=.
replace scheme2unconstr = 1 if totassets >= scheme2p70 & totassets !=.


// Scheme 3 - KZ-index (scheme #5 in Almeida et al. 2004)

* Define the Leverage and Dividens variables
cap drop Leverage Dividends
gen Leverage = totdebt
gen Dividends = div

* Generate the KZ-index
gen KZindex = -1.002*CashFlow + 0.283*Q + 3.139*Leverage ///
            -39.368*Dividends - 1.315*CashHoldings

* Compute the 30th and 70th percentiles the KZ-index
sort yr
by yr: egen scheme3p30 = pctile(KZindex), p(30)
by yr: egen scheme3p70 = pctile(KZindex), p(70)

* Define constrained and unconstrained firms according to the KZ-index
cap drop scheme3constr scheme3unconstr
gen scheme3constr = 0
gen scheme3unconstr = 0
replace scheme3unconstr = 1 if KZindex <= scheme3p30 & KZindex !=.
replace scheme3constr = 1 if KZindex >= scheme3p70 & KZindex !=.
sort cid yr

** control
```

```
cap drop control*
local schemes scheme1 scheme2 scheme3
foreach scheme of local schemes {
    gen control_`scheme' = .
    replace control_`scheme' = 1 if `scheme'constr == 1 & `scheme'unconstr == 1
    count if control_`scheme' == 1
    replace `scheme'constr = . if control_`scheme' == 1
    replace `scheme'unconstr = . if control_`scheme' == 1
}


******************************************************************************
**************              Summary statistics                ****************
******************************************************************************
local filename "Data\Output files\Regressions.xlsx"

matrix summary = J(12,4,.)
matrix colnames summary =    "Mean" "Median" "Std. Dev." "N. Obs."
matrix rownames summary =    "CashHoldings" "D_CashHoldings" "CashFlow" "Q" ///
                             "Size" "Expenditures" "Acquisitions" "D_NWC" ///
                             "D_Shortdebt" "PayoutRatio" "FirmSize" "KZ-index"

local vars  CashHoldings d.CashHoldings CashFlow Q Size ///
            Expenditures Acquisitions NWC ShortDebt ///
            payoutratio totassets KZindex
local i = 1

foreach var of local vars {
    qui summ `var', d
        qui matrix summary[`i',1] = r(mean)
        qui matrix summary[`i',2] = r(p50)
        qui matrix summary[`i',3] = r(sd)
        qui matrix summary[`i',4] = r(N)
    local ++i
}

matrix list summary
putexcel set "`filename'", sheet (SumStats) modify
putexcel A1 = matrix(summary), names

******************************************************************************
**********      Cross classification of constraint types        **************
******************************************************************************

* Make Table 1: Cross Classification of Constraint types

matrix crossclass = J(6,6,.)
matrix colnames crossclass = "1A" "1B" "2A" "2B" "3A" "3B"
matrix rownames crossclass = 1A 1B 2A 2B 3A 3B

qui count if scheme1constr == 1
qui matrix crossclass[1,1] = r(N)
qui count if scheme1unconstr == 1
qui matrix crossclass[2,2] = r(N)

qui count if scheme1constr == 1     & scheme2constr == 1
qui matrix crossclass[3,1] = r(N)
count if scheme1constr == 1         & scheme2unconstr == 1
qui matrix crossclass[4,1] = r(N)
qui count if scheme1unconstr == 1   & scheme2constr == 1
qui matrix crossclass[3,2] = r(N)
qui count if scheme1unconstr == 1   & scheme2unconstr == 1
qui matrix crossclass[4,2] = r(N)

qui count if scheme1constr == 1     & scheme3constr == 1
qui matrix crossclass[5,1] = r(N)
qui count if scheme1constr == 1     & scheme3unconstr == 1
qui matrix crossclass[6,1] = r(N)
qui count if scheme1unconstr == 1   & scheme3constr == 1
qui matrix crossclass[5,2] = r(N)
qui count if scheme1unconstr == 1   & scheme3unconstr == 1
qui matrix crossclass[6,2] = r(N)

qui count if scheme2constr == 1
qui matrix crossclass[3,3] = r(N)
```

```
qui count if scheme2unconstr == 1
qui matrix crossclass[4,4] = r(N)

qui count if scheme2constr == 1     & scheme3constr == 1
qui matrix crossclass[5,3] = r(N)
qui count if scheme2constr == 1     & scheme3unconstr == 1
qui matrix crossclass[6,3] = r(N)
qui count if scheme2unconstr == 1   & scheme3constr == 1
qui matrix crossclass[5,4] = r(N)
qui count if scheme2unconstr == 1   & scheme3unconstr == 1
qui matrix crossclass[6,4] = r(N)

qui count if scheme3constr == 1
qui matrix crossclass[5,5] = r(N)
qui count if scheme3unconstr == 1
qui matrix crossclass[6,6] = r(N)

matrix list crossclass

putexcel set "`filename'", sheet (T1) modify
putexcel A1 = matrix(crossclass), names

********************************************************************************
** Summary Stats of CashHoldings under three financial constraints criteria   **
********************************************************************************

* Generate group variables for each financial constraint scheme
cap drop scheme1 scheme2 scheme3
local schemes scheme1 scheme2 scheme3
foreach scheme of local schemes {
    gen `scheme' = ""
    replace `scheme' = "constrained" if `scheme'constr == 1
    replace `scheme' = "unconstrained" if `scheme'unconstr == 1
}

**  Summarize CashHoldings for each scheme and group, and test mean and median
*   equality

matrix output = J(9,4,.)
matrix colnames output = "Mean" "Median" "Std. Dev." "N. Obs."
matrix rownames output = 1A 1B pvalue 2A 2B pvalue 3A 3B pvalue

local schemes scheme1 scheme2 scheme3
local i = 0
foreach scheme of local schemes {
    local ++i
    qui summ CashHoldings if `scheme' == "constrained", d
        qui matrix output[`i',1] = r(mean)
        qui matrix output[`i',2] = r(p50)
        qui matrix output[`i',3] = r(sd)
        qui matrix output[`i',4] = r(N)
    local ++i
    qui summ CashHoldings if `scheme' == "unconstrained", d
        qui matrix output[`i',1] = r(mean)
        qui matrix output[`i',2] = r(p50)
        qui matrix output[`i',3] = r(sd)
        qui matrix output[`i',4] = r(N)
    local ++i
    qui ttest CashHoldings, by(`scheme')
        qui matrix output[`i',1] = r(p)
    qui ranksum CashHoldings, by(`scheme')
        qui matrix output[`i',2] = 1-normal(abs(1-r(z)))
}
mat list output
putexcel set "`filename'", sheet (T2) modify
putexcel A1 = matrix(output), names

********************************************************************************
*************          Model 1 (baseline model) analyses           *************
********************************************************************************

* Define Model 1
local yvar d.CashHoldings
local xvar CashFlow Q Size
```

```
* Use the Hausman test to confirm that a fixed effects model is appropriate
matrix Hausman = J(6,1,.)
matrix colnames Hausman =   "chi-squared p-value"
matrix rownames Hausman =   scheme1constr scheme1unconstr ///
                            scheme2constr scheme2unconstr ///
                            scheme3constr scheme3unconstr

local schemes scheme1constr scheme1unconstr scheme2constr scheme2unconstr ///
      scheme3constr scheme3unconstr
local i = 1

foreach scheme of local schemes {
    qui xtreg `yvar' `xvar'     if `scheme'== 1, re
        estimates store `scheme'random
    qui xtreg `yvar' `xvar'     if `scheme'== 1, fe
        estimates store `scheme'fixed
    qui hausman `scheme'fixed `scheme'random
    matrix Hausman[`i',1] = r(p)
    local ++i
}

matrix list Hausman

* (Result: Proceed with fixed effects models)


* Run the model 1 regression for all subsamples
local schemes scheme1constr scheme1unconstr scheme2constr scheme2unconstr ///
      scheme3constr scheme3unconstr

foreach scheme of local schemes {
    qui xtreg `yvar' `xvar'     if `scheme'==1, fe r
        matrix M1`scheme' = r(table)
        putexcel set "`filename'", sheet(M1`scheme') modify
            putexcel B10 = matrix(M1`scheme'), names
            putexcel B4=("Number of obs")   C4=(e(N))
            putexcel B5=("F")               C5=(e(F))
            putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
            putexcel B7=("R-squared")       C7=(e(r2))
            putexcel B8=("Adj R-squared")   C8=(e(r2_a))
}


* Define alternative baseline model, assuming missing div means no div

cap drop div2 CF
gen div2 = 0 if div == .
gen CF = (netinc + depr * (1-0.28) - div2)/totassets
replace CF = (netinc + depr *(1-0.27) - div2)/totassets if yr >= 2014

local yvar d.CashHoldings
local xvar CF Q Size

local schemes scheme2constr scheme2unconstr

foreach scheme of local schemes {
    qui xtreg `yvar' `xvar'     if `scheme'==1, fe r
        matrix altM1`scheme' = r(table)
        putexcel set "`filename'", sheet(altM1`scheme') modify
            putexcel B10 = matrix(altM1`scheme'), names
            putexcel B4=("Number of obs")   C4=(e(N))
            putexcel B5=("F")               C5=(e(F))
            putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
            putexcel B7=("R-squared")       C7=(e(r2))
            putexcel B8=("Adj R-squared")   C8=(e(r2_a))
}

********************************************************************************
************         Model 2 (augmented model) analyses            ************
********************************************************************************

* Define Model 2
local yvar d.CashHoldings
local xvar CashFlow Q Size Expenditures Acquisitions d.NWC d.ShortDebt

```

```
* Run the model 2 regression for all subsamples
local schemes scheme1constr scheme1unconstr scheme2constr scheme2unconstr ///
      scheme3constr scheme3unconstr

foreach scheme of local schemes {
    qui xtreg `yvar' `xvar'     if `scheme'==1, fe r
        matrix M2`scheme' = r(table)
        putexcel set "`filename'", sheet(M2`scheme') modify
            putexcel B10 = matrix(M2`scheme'), names
            putexcel B4=("Number of obs")   C4=(e(N))
            putexcel B5=("F")               C5=(e(F))
            putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
            putexcel B7=("R-squared")       C7=(e(r2))
            putexcel B8=("Adj R-squared")   C8=(e(r2_a))
}










********************************************************************************
******                         ANALYSES FOR H2                           ******
********************************************************************************

clear all
set more off, perm
use "Data\CCGR\A. CCGR AS and ASA, CPI adjusted, incl industry codes.dta"
xtset cid yr
sort cid yr


********************************************************************************
*****************   Data cleaning, full sample   ******************************
********************************************************************************

drop if industrycode == "D" //utilities firms
drop if industrycode == "K" //financial and insurance companies


cap drop cash totassets CashHoldings
gen cash = (item_76 + item_71 + item_72 + item_73)
gen totassets = item_63 + item_78
drop if cash > totassets
drop if totassets < 0


gen CashHoldings = cash / totassets
drop if CashHoldings == .
drop if CashHoldings < 0


** Generate variable for asset growth
cap drop assetgrowth
gen assetgrowth = (totassets - L.totassets)/L.totassets * 100

* Drop firmyears where asset growth exceeds 100 %
drop if assetgrowth > 100 & assetgrowth != .

** Generate variable for sales growth
gen sales = item_9
gen salesgrowth = (sales - L.sales)/L.sales * 100

* Drop firmyears where sales growth exceeds 100 %
drop if salesgrowth > 100 & salesgrowth != .

* Find the number of private and public firms
tab orgtype

save "Data\CCGR\B. CCGR cleaned.dta", replace

```

```
****************************************************************************
**************       Find sample of matched private firms       ****************
****************************************************************************


** Create file of private firms only
use "Data\CCGR\B. CCGR cleaned.dta"
keep if orgtype == "AS"
drop if industrycode == ""
keep cid yr industrycode totassets orgtype
xtset cid yr
sort industrycode yr
save "Data\CCGR\CCGR AS.dta", replace

** Create file of public firms only
use "Data\CCGR\B. CCGR cleaned.dta"
keep if orgtype == "ASA"
drop if industrycode == ""
keep cid yr industrycode totassets orgtype
xtset cid yr
sort industrycode yr
save "Data\CCGR\CCGR ASA.dta", replace

**  For each public firm, find all private firms with the same industry code in
*   the same year
rename cid ASA_cid  // rename company identifier for public firms
rename totassets ASA_totassets  // rename the total assets variable
joinby industrycode yr using "Data\CCGR\CCGR AS.dta"    // find all matches
format %15.0g ASA_totassets
format %15.0g totassets

**  Keep only matched private firms with total assets +/- 20 % relative to the
*   public firm
cap drop ratio
gen ratio = totassets/ASA_totassets
drop if ratio < 1/1.2 | ratio > 1.2
sort ASA_cid yr

**  Find the absolute value of the difference in total assets for all matches
gen delta = abs(totassets - ASA_totassets)

**  At this point, each private firm appears several times in a year if it
*   has been matched with multiple public firms. I do not want any firm to
*   appear more than once in a year. Therefore, I rank each private firm by
*   delta each year, and keep the observation with the smallest delta.
sort cid yr delta
by cid yr (delta), sort: keep if _n == 1

**  Now, I want to find the best match for each public firm each year. Thus, for
*   each public firm I rank the matched private firms by delta each year and
*   keep the match with the smallest delta.
by ASA_cid yr (delta), sort: keep if _n == 1
drop ratio delta

* Save new file of best matches
save "Data\CCGR\C. CCGR best matches.dta", replace



**  Now, each public firm has one matched private firm each year. However, the
*   matched companies may alter every year. This alteration will not allow me to
*   capture potentially influential factors like firms' responses to
*   macroeconomic changes. It will also make it difficult to conduct the
*   analysis because at least two years of consecutive data is needed to
*   construct the change in CashHoldings. Therefore, I use the best match for
*   the first year of data for each public firm, and keep it until it exits the
*   sample.

**  Find the best matched private firm in the first year of data for each public
*   firm.

* Order matches (do not count missing values)
sort ASA cid yr
by ASA_cid: gen match_i = sum(!mi(cid))
```

```
* Drop years until the first match
drop if match_i == 0

* The overall matched firm is the first found
by ASA_cid: gen final_match = cid[1]
format %12.0g final_match

* Save the final matched pairs in a new file
save "Data\CCGR\D. CCGR final matches.dta", replace


*   Rename the identifier in the private firms sample and save a new file.
use "Data\CCGR\CCGR AS.dta"
rename cid final_match
save "Data\CCGR\E. CCGR AS final.dta", replace

**  Check each year if the best match from the first year has exited the sample.
*   If the matched private firm has exited the sample, replace it with the best
*   match for that year.
use "Data\CCGR\D. CCGR final matches.dta"
local more 1
while `more' {
    qui merge m:1 final_match yr ///
    using "Data\CCGR\E. CCGR AS final.dta", keep(master match)
    bysort ASA_cid (yr): gen has_exit = sum(_merge != 3)    // 3 == merged
    replace has_exit = 1 if has_exit > 1
    count if has_exit
    if r(N) {
        bysort ASA_cid has_exit (yr): replace final_match = cid[1] if has_exit
    }
    else local more 0
    drop _merge has_exit
}

duplicates report final_match yr
duplicates tag final_match yr, gen(dup)
sort dup final_match yr
drop if dup > 0

rename cid best_match
drop totassets ASA_totassets dup
save "Data\CCGR\D. CCGR final matches.dta", replace

** Create a file with all data on the matched, private firms
use "Data\CCGR\B. CCGR cleaned.dta"
keep if orgtype == "AS"
drop if industrycode == ""
xtset cid yr
rename cid final_match
merge m:1 final_match yr ///
using "Data\CCGR\D. CCGR final matches.dta", gen(ASmerge) keep(match)
rename final_match cid
gen matched = "matched private"
save "Data\CCGR\F. CCGR AS matched.dta", replace

** Create a file with all data on the matched, public firms
use "Data\CCGR\B. CCGR cleaned.dta"
keep if orgtype == "ASA"
drop if industrycode == ""
xtset cid yr
rename cid ASA_cid
merge m:1 ASA_cid yr ///
using "Data\CCGR\D. CCGR final matches.dta", gen(ASAmerge) keep(match)
rename ASA_cid cid
gen matched = "matched public"
save "Data\CCGR\G. CCGR ASA matched.dta", replace

** Combine data on both public and private matched firms in one file
append using "Data\CCGR\F. CCGR AS matched.dta"
xtset cid yr
sort cid yr
drop cpi2016 _merge best_match match_i final_match ///
    ASAmerge ASA_cid ASmerge
save "Data\CCGR\G. CCGR Final Matched Sample.dta", replace
```

```
** Make final full sample:
use "Data\CCGR\B. CCGR cleaned.dta"
drop cpi2016 _merge
drop if industrycode ==""
merge m:1 cid yr using "Data\CCGR\G. CCGR Final Matched Sample.dta"
xtset cid yr
sort cid yr
save "Data\CCGR\H. CCGR Cleaned and Matched Final Full Sample.dta", replace




clear all
use "Data\CCGR\H. CCGR Cleaned and Matched Final Full Sample.dta"
xtset cid yr
sort cid yr

********************************************************************************
*************          Generate variables for Model 1             *************
********************************************************************************

*   Generate underlying variables
cap drop depr div netinc
gen depr = - item_15    // Item_15 (depreciation) is reported as
                                    // a negative number
gen div = - item_41         // Item_41 (dividends) is reported as
                                    // a negative number
gen netinc = item_35
gen ppe = item_51
gen capex = d.ppe + depr

**  Generate Model 1 (baseline model) variables
*   (CashHoldings is already defined as cash/totassets)

cap drop CashFlow Size
gen CashFlow = (netinc + depr * (1-0.28) - div)/totassets
replace CashFlow = (netinc + depr *(1-0.27) - div)/totassets if yr >= 2014
gen InvOpp = capex/ppe
gen Size = ln(totassets)

** Summarize
summ CashHoldings d.CashHoldings CashFlow InvOpp Size, d

** Winsorize
winsor2 CashHoldings CashFlow InvOpp Size, cuts(2.5 97.5) by(yr) suffix(_win)

local vars CashHoldings CashFlow InvOpp Size
foreach var of local vars {
    replace `var' = `var'_win
}

********************************************************************************
*************          Generate variables for Model 2             *************
********************************************************************************

**  Generate underlying variables
cap drop currassets currliabilities capex
gen currassets = item_78
gen currliabilities = item_109

** Generate Model 2 variables
cap drop NWC ShortDebt Expenditures
gen NWC = (currassets - cash - currliabilities) / totassets
gen ShortDebt = currliabilities / totassets
gen Expenditures = capex / totassets

* Summarize
summ NWC ShortDebt Expenditures, d

* Winsorize
winsor2 NWC ShortDebt Expenditures, cuts(2.5 97.5) by(yr) suffix(_win)

local vars NWC ShortDebt Expenditures
foreach var of local vars {
    replace `var' = `var'_win
```

```
}

save "Data\CCGR\I. CCGR Full Sample.dta", replace
*******************************************************************************






clear all
use "Data\CCGR\I. CCGR Full Sample.dta"
xtset cid yr
sort cid yr
********************************************************************************
**************                Summary statistics                ****************
********************************************************************************
local filename "Data\Output files\Regressions.xlsx"


* Full sample
matrix summary = J(8,4,.)
matrix colnames summary =   "Mean" "Median" "Std. Dev." "N. Obs."
matrix rownames summary =   "CashHoldings" "D_CashHoldings" "CashFlow" ///
                            "InvOpp" "Size" "Expenditures" "D_NWC" "D_Shortdebt"

local vars  CashHoldings d.CashHoldings CashFlow InvOpp Size ///
            Expenditures d.NWC d.ShortDebt
local i = 1

foreach var of local vars {
    qui summ `var', d
        qui matrix summary[`i',1] = r(mean)
        qui matrix summary[`i',2] = r(p50)
        qui matrix summary[`i',3] = r(sd)
        qui matrix summary[`i',4] = r(N)
    local ++i
}

matrix list summary
putexcel set "`filename'", sheet (SumStatsCCGR) modify
putexcel A1 = matrix(summary), names

* matched sample - summary statistics and histograms

matrix assets = J(6,3,.)
matrix colnames assets = "Private" "Matched private" "Public"
matrix rownames assets = "mean" "t-test" "median" "ranksum" "sd" "N"


qui summ totassets if orgtype == "AS", d
        qui matrix assets[1,1] = r(mean)
        qui matrix assets[3,1] = r(p50)
        qui matrix assets[5,1] = r(sd)
        qui matrix assets[6,1] = r(N)
qui ttest totassets, by(orgtype)
    qui matrix assets[2,1] = r(p)
qui ranksum totassets, by(orgtype)
    qui matrix assets[4,1] = 1-normal(abs(r(z)))
qui summ totassets if matched == "matched private", d
        qui matrix assets[1,2] = r(mean)
        qui matrix assets[3,2] = r(p50)
        qui matrix assets[5,2] = r(sd)
        qui matrix assets[6,2] = r(N)
qui summ totassets if matched == "matched public", d
        qui matrix assets[1,3] = r(mean)
        qui matrix assets[3,3] = r(p50)
        qui matrix assets[5,3] = r(sd)
        qui matrix assets[6,3] = r(N)
qui ttest totassets, by(matched)
    qui matrix assets[2,2] = r(p)
qui ranksum totassets, by(matched)
    qui matrix assets[4,2] = 1-normal(abs(r(z)))
matrix list assets

```

```
local filename "Data\Output files\Regressions.xlsx"
putexcel set "`filename'", sheet (CCGRtotassets) modify
putexcel A1 = matrix(assets), names


encode industrycode, generate(indcode)

hist indcode, by(orgtype) discrete fraction gap(50) xlabel(1(1)19, valuelabel)
graph save Graph "Data\Output files\Histogram indcode all.gph", replace

hist indcode, by(matched) discrete fraction gap(50) xlabel(1(1)19, valuelabel)
graph save Graph "Data\Output files\Histogram indcode matched.gph"



* private, matched private, public

matrix summary_match = J(16,12,.)
matrix colnames summary_match = "mean priv" "median priv" "sd priv" "N priv" ///
                            "mean match" "median match" "sd match" "N match" ///
                                "mean publ" "median publ" "sd publ" "N publ"

matrix rownames summary_match = ///
"CashHoldings" "test" "D_CashHoldings" "test" "CashFlow" "test" ///
"InvOpp" "test" "Size" "test" "Expenditures" "test" "D_NWC" "test" ///
"D_Shortdebt" "test"

cap drop d_CashHoldings d_NWC d_ShortDebt
gen d_CashHoldings = d.CashHoldings
gen d_NWC = d.NWC
gen d_ShortDebt = d.ShortDebt

local vars CashHoldings d_CashHoldings CashFlow InvOpp Size ///
            Expenditures d_NWC d_ShortDebt
local i = 1
foreach var of local vars {
    qui summ `var' if orgtype == "AS", d
        qui matrix summary_match[`i',1] = r(mean)
        qui matrix summary_match[`i',2] = r(p50)
        qui matrix summary_match[`i',3] = r(sd)
        qui matrix summary_match[`i',4] = r(N)
    qui summ `var' if matched == "matched private", d
        qui matrix summary_match[`i',5] = r(mean)
        qui matrix summary_match[`i',6] = r(p50)
        qui matrix summary_match[`i',7] = r(sd)
        qui matrix summary_match[`i',8] = r(N)
    qui summ `var' if matched == "matched public", d
        qui matrix summary_match[`i',9] = r(mean)
        qui matrix summary_match[`i',10] = r(p50)
        qui matrix summary_match[`i',11] = r(sd)
        qui matrix summary_match[`i',12] = r(N)
    local ++i
            qui ttest `var', by(orgtype)
                qui matrix summary_match[`i',1] = r(p)
            qui ranksum `var', by(orgtype)
                qui matrix summary_match[`i',2] = 1-normal(abs(r(z)))
            qui ttest `var', by(matched)
                qui matrix summary_match[`i',5] = r(p)
            qui ranksum `var', by(matched)
                qui matrix summary_match[`i',6] = 1-normal(abs(r(z)))
    local ++i
}
matrix list summary_match
putexcel set "`filename'", sheet (SumStatsCCGRsplit) modify
putexcel A1 = matrix(summary_match), names


********************************************************************************
*************          Model 1 (baseline model) analyses           *************
********************************************************************************


* Baseline model

local yvar d.CashHoldings
```

```
local xvar CashFlow InvOpp Size

xtreg `yvar' `xvar' if orgtype == "AS", fe r
    putexcel set "`filename'", sheet(AS_base) modify
    matrix AS_base = r(table)
    putexcel B10 = matrix(AS_base), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))

xtreg `yvar' `xvar' if matched == "matched private", fe r
    putexcel set "`filename'", sheet(matched_base) modify
    matrix matched_base = r(table)
    putexcel B10 = matrix(matched_base), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))

xtreg `yvar' `xvar' if orgtype == "ASA", fe r
    putexcel set "`filename'", sheet(ASA_base) modify
    matrix ASA_base = r(table)
    putexcel B10 = matrix(ASA_base), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))


* Baseline model - public dummy - full sample
gen public = (orgtype == "ASA")

local yvar  d.CashHoldings
local xvar  public CashFlow InvOpp Size  ///
            c.CashFlow#i.public c.InvOpp#public c.Size#i.public

xtreg `yvar' `xvar', fe r
    putexcel set "`filename'", sheet(base_dummy_full) modify
    matrix base_dummy_full = r(table)
    putexcel B10 = matrix(base_dummy_full), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))

* Baseline model - public dummy - matched sample
gen public_m = .
replace public_m = 1 if matched == "matched public"
replace public_m = 0 if matched == "matched private"

local yvar d.CashHoldings
local xvar  public_m CashFlow InvOpp Size  ///
            c.CashFlow#i.public_m c.InvOpp#public_m c.Size#i.public

xtreg `yvar' `xvar', fe r
    putexcel set "`filename'", sheet(base_dummy_match) modify
    matrix base_dummy_match = r(table)
    putexcel B10 = matrix(base_dummy_match), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))


********************************************************************************
*************       Model 2 (augmented model analyses            *************
********************************************************************************


```

```
* Augmented model

local yvar d.CashHoldings
local xvar CashFlow InvOpp Size Expenditures d.NWC d.ShortDebt

xtreg `yvar' `xvar' if orgtype == "AS", fe r
    putexcel set "`filename'", sheet(AS_aug) modify
    matrix AS_aug = r(table)
    putexcel B10 = matrix(AS_aug), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))

xtreg `yvar' `xvar' if matched == "matched private", fe r
    putexcel set "`filename'", sheet(matched_aug) modify
    matrix matched_aug = r(table)
    putexcel B10 = matrix(matched_aug), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))

xtreg `yvar' `xvar' if orgtype == "ASA", fe r
    putexcel set "`filename'", sheet(ASA_aug) modify
    matrix ASA_aug = r(table)
    putexcel B10 = matrix(ASA_aug), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))


* Augmented model - public dummy - full sample
gen D_NWC = d.NWC
gen D_ShortDebt = d.ShortDebt

local yvar  d.CashHoldings
local xvar  public CashFlow InvOpp Size Expenditures D_NWC D_ShortDebt  ///
            c.CashFlow#public c.InvOpp#public c.Size#public ///
            c.Expenditures#public c.D_NWC#public c.D_ShortDebt#public

xtreg `yvar' `xvar', fe r
    putexcel set "`filename'", sheet(aug_dummy_full) modify
    matrix aug_dummy_full = r(table)
    putexcel B10 = matrix(aug_dummy_full), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))


* Augmented model - matched dummy - matched sample
local yvar d.CashHoldings
local xvar  public_m CashFlow InvOpp Size Expenditures D_NWC D_ShortDebt  ///
            c.CashFlow#public_m c.InvOpp#public_m c.Size#public_m ///
            c.Expenditures#public_m c.D_NWC#public_m c.D_ShortDebt#public_m

xtreg `yvar' `xvar', fe r
    putexcel set "`filename'", sheet(aug_dummy_match) modify
    matrix aug_dummy_match = r(table)
    putexcel B10 = matrix(aug_dummy_match), names
        putexcel B4=("Number of obs")   C4=(e(N))
        putexcel B5=("F")               C5=(e(F))
        putexcel B6=("Prob > F")        C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")       C7=(e(r2))
        putexcel B8=("Adj R-squared")   C8=(e(r2_a))
```

```


******************************************************************************
******                        ANALYSES FOR H3                          ******
******************************************************************************

local filename "Data\Output files\Financial Crisis final.xlsx"

**  Generate dummy variables for each period

cap drop before during after
gen before = (yr < 2007) if !missing(yr)
gen crisis = (yr == 2007 | yr == 2008) if !missing(yr)
gen after = (yr > 2008) if !missing(yr)

** Test the baseline model for all periods separately

local yvar d.CashHoldings
local xvar CashFlow InvOpp Size

local periods before crisis after

foreach period of local periods{
xtreg `yvar' `xvar' if `period' == 1 & orgtype == "ASA", fe r
    putexcel set "`filename'", sheet(base_`period'_ASA) modify
    matrix base_`period'_ASA = r(table)
    putexcel B10 = matrix(base_`period'_ASA), names
        putexcel B4=("Number of obs")    C4=(e(N))
        putexcel B5=("F")                C5=(e(F))
        putexcel B6=("Prob > F")         C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")        C7=(e(r2))
        putexcel B8=("Adj R-squared")    C8=(e(r2_a))
}


* Baseline model - crisis dummy - public and private
local yvar d.CashHoldings
local xvar c.CashFlow##crisis InvOpp c.InvOpp#crisis Size c.Size#crisis

xtreg `yvar' `xvar' if orgtype == "ASA", fe r
    putexcel set "`filename'", sheet(base_crisis_ASA) modify
    matrix base_crisis_ASA = r(table)
    putexcel B10 = matrix(base_crisis_ASA), names
        putexcel B4=("Number of obs")    C4=(e(N))
        putexcel B5=("F")                C5=(e(F))
        putexcel B6=("Prob > F")         C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")        C7=(e(r2))
        putexcel B8=("Adj R-squared")    C8=(e(r2_a))

xtreg `yvar' `xvar' if orgtype == "AS", fe r
    putexcel set "`filename'", sheet(base_crisis_AS) modify
    matrix base_crisis_AS = r(table)
    putexcel B10 = matrix(base_crisis_AS), names
        putexcel B4=("Number of obs")    C4=(e(N))
        putexcel B5=("F")                C5=(e(F))
        putexcel B6=("Prob > F")         C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")        C7=(e(r2))
        putexcel B8=("Adj R-squared")    C8=(e(r2_a))


* Augmented model - crisis dummy - public and private
local yvar  d.CashHoldings
local xvar  crisis CashFlow InvOpp Size Expenditures D_NWC D_ShortDebt  ///
            c.CashFlow#crisis c.InvOpp#crisis c.Size#crisis ///
            c.Expenditures#crisis c.D_NWC#crisis c.D_ShortDebt#crisis

xtreg `yvar' `xvar' if orgtype == "ASA", fe r
    putexcel set "`filename'", sheet(aug_crisis_ASA) modify
    matrix aug_crisis_ASA = r(table)
    putexcel B10 = matrix(aug_crisis_ASA), names
        putexcel B4=("Number of obs")    C4=(e(N))
        putexcel B5=("F")                C5=(e(F))
        putexcel B6=("Prob > F")         C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")        C7=(e(r2))
        putexcel B8=("Adj R-squared")    C8=(e(r2_a))

xtreg `yvar' `xvar' if orgtype == "AS", fe r
    putexcel set "`filename'", sheet(aug_crisis_AS) modify
    matrix aug_crisis_AS = r(table)
    putexcel B10 = matrix(aug_crisis_AS), names
        putexcel B4=("Number of obs")    C4=(e(N))
        putexcel B5=("F")                C5=(e(F))
        putexcel B6=("Prob > F")         C6=(Ftail(e(df_m), e(df_r), e(F)))
        putexcel B7=("R-squared")        C7=(e(r2))
        putexcel B8=("Adj R-squared")    C8=(e(r2_a))
```