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The Effects of Financial Constraints on Business Fundamentals and Asset Returns

Evidence from a small open economy

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Executive Summary

In this thesis we investigate whether financially constrained firms are fundamentally riskier than unconstrained firms, whether this risk is priced in the form of a financial constraint factor, and whether the financial constraint factor represents an independent source of return movements. The investigation will be in the context of the Norwegian economy and securities markets.

Using various measures of financial constraints, we form portfolios of constrained and unconstrained firms in a similar fashion to Fama and French (1992). Following Campello and Chen (2010) we estimate differences in the real business risk of constrained and unconstrained firms by regressing their median real operating earnings- and investment growth on macroeconomic and credit market variables. We test whether the risk is priced by subtracting the monthly stock market returns of constrained firms from unconstrained firms, creating a financial constraint factor. Finally, following Lamont et al. (2001), we investigate whether the financial constraint factor represents an independent source of movement in returns by regressing it on benchmark asset pricing models, including Sharpe (1964) and Lintner (1965)'s CAPM, the Fama and French (1992) three-factor model and the Fama and French (2015) five-factor model.

We find evidence that financially constrained firms are fundamentally riskier than unconstrained firms, and that this risk is priced in the form of a financial constraint factor. The results point to financial constraints being time-varying and binding more in downturns than expansions. We find that a negative oil price shock is associated with increasing financial constraints in the Norwegian economy. Furthermore, we find that financially constrained firms in Norway behave in a similar fashion to constrained firms in the US, suggesting that financial constraints are not significantly different across various economic settings. Finally, the combined real-financial results point to the existence of a macroeconomy-equity valuation channel along the lines of Gertler and Bernanke (1989).

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1 Introduction

The aim of this thesis is to answer two key questions at the intersection of macroeconomics and finance. First, are financially constrained firms fundamentally riskier than unconstrained firms? Second, is this risk priced in securities markets in the form of an independently identifiable financial constraint factor? We examine these questions in the context of the Norwegian economy and securities markets.

Business cycles appear to be large, persistent, and asymmetric relative to the shocks hitting the economy (Acemoglu and Scott (1997)). This observation suggests the existence of an asymmetric amplification and propagation mechanism, which transforms the shocks into the observed movements in aggregate output. We investigate whether this mechanism is linked to financial constraints. Gertler and Bernanke (1989) show that the existence of asymmetric information gives rise to agency costs associated with external capital, which depend on a firms financial position. Firms which are dependent on external capital and are affected by financing imperfections in such a way that they cannot fund all desired investments, are financially constrained. Since the financial position of firms are typically procyclical, so are agency costs, and thus financial constraints. If this is the case, the real operating earnings- and investment growth of constrained firms should fluctuate significantly more than those of unconstrained firms in response to changing macroeconomic and credit market conditions. This amounts to asking whether financially constrained firms are fundamentally riskier than unconstrained firms.

If financially constrained firms show greater covariation with systematic factors because these firms are disproportionately affected by financing imperfections, then financial constraints represent an independent source of real risk. Asset pricing models which do not take this into account will overprice constrained firms relative to unconstrained firms. If the risk is priced, we should be able to earn an independently identifiable return stream by purchasing the stocks of constrained firms and selling the stocks of unconstrained firms. This amounts to asking whether we can identify a financial constraint factor in Norwegian securities markets.

To answer our first question, we form annually updated portfolios of constrained and unconstrained firms using various measures of financial constraints. We regress the median real operating earnings- and investment growth of these portfolios on proxies of the macroeconomic and credit market conditions. Using a SUR-system, we test whether the responses of constrained firms are significantly larger than those of the unconstrained firms. We find evidence that financially constrained firms are fundamentally riskier than unconstrained firms, in the sense that the real operating earnings- and investment growth of constrained firms falls significantly more in response to adverse macroeconomic and credit market conditions than those of unconstrained firms. The evidence also points to financial constraints being time-varying and binding more in downturns, which means constrained firms behave in a procyclical fashion.

We answer the second question in two parts. First, we construct a financial constraint factor[1] by subtracting the returns of a portfolio of constrained firms from the returns of a portfolio of unconstrained firms. Note that unlike much of the traditional asset pricing literature, we create factor mimicking portfolios not to match anomalies in the data, but to measure an economically meaningful concept. We find that constrained firms earn a significant risk premium over unconstrained firms, indicating the existence of a financial constraint factor. Furthermore, we show that the financial constraint factor varies with macroeconomic conditions in such a way that the stock returns of financially constrained firms underperform those of unconstrained firms in times when financial constraints are more likely to bind, i.e. downturns and tight credit conditions, and outperform when constraints are likely to be relaxed.

A key finding of this thesis is the relationship between real business fundamentals, the financial constraint factor and macroeconomic variables, which point to a macroeconomy-equity valuation channel[2] that works along the lines of Gertler and Bernanke (1989), Carlstrom and Fuerst (1997), and Bernanke et al. (1999). For example, a negative macroeconomic shock will reduce the equity valuation of all firms as future expected cash flows decline. However, for financially constrained firms the reduced net worth increases agency costs, increasing the external finance premium which leads to a decline in investment- and earnings growth. Forward looking asset prices such as stocks will then

[1]A factor is an explanatory variable which helps explain cross-sectional movements in stock returns.
[2]This was first pointed out for the US by Campello and Chen (2010).

decline more for financially constrained firms than unconstrained firms, increasing agency costs again, resulting in a financial accelerator effect.

Second, we test whether financial constraints represent an independent source of return movements by regressing the financial constraint factor on three benchmark asset pricing models. We find that the returns of the financial constraint factor as estimated by two of the financial constraint measures, cannot be explained by known empirical factors. In sum, the financial results point to the existence of a financial constraint factor which represents an independent source of return movements.

Our results indicate that financial constraints amplify and propagate real economic shocks. Discussing the policy implications of this is beyond the scope of the thesis. We note however, that Gertler and Karadi (2011) show that in periods of tight credit conditions, i.e. when financial constraints likely bind the most, the benefits of central bank credit intermediation to offset disruptions in private financial intermediation can be substantial. They reason that the key advantage of the central bank is that it can elastically obtain funds by issuing riskless government debt and then use these funds to lend to financially constrained firms, reducing the subsequent drop in investments and aggregate demand, thus limiting the amplification of shocks to the economy.

With our thesis we make the following contributions to the literature. First, by investigating financial constraints in a small open economy we test whether results on financial constraints found in the US hold generally across different economic environments and time-frames. We conclude that this seems to be the case. Second, we investigate the interplay between the oil price and financial constraints in an oil-exporting country. Specifically, we use SIC codes to create an oil sector with both oil production and exploration companies, and oil service companies. We find a negative relationship between financial constraints and the oil price, such that when the oil price is low, financial constraints seem to bind more and when the oil price is high, financial constraints bind less. We show that one part of this result stems from the market structure of the oil sector which leads to heterogeneous responses in the financial positions of firms following oil price shocks. Our results indicate that the other part of this negative relationship is a consequence of constrained firms being more sensitive to economic fluctuations than unconstrained firms. Additionally, as far as we know, financial constraints in Norway were last investigated by Johansen

(1994).[3] We update his findings using a new and more complete method over a longer sample period.

This thesis is structured as follows. In section 2, we review work on financial constraints, asset pricing and macroeconomics. In section 3 we provide an explanation of how we construct our dataset, variables and portfolios. In section 4, we examine the real business risk of financially constrained and unconstrained firms. In section 5, we construct the financial constraint factor, examine its relation to business and credit cycles and test whether financial constraints represent an independent source of return movements. In section 6 we summarize and present conclusions.

[3]Johansen uses data from 1977 – 1990, while our sample period is 1996 – 2018. Furthermore, he applies Euler equation estimates to reach his conclusions, a method different from ours and which is sensitive to the choice of specification and tend to have poor small-sample properties (Gilchrist and Himmelberg (1995)).

2 Literature and Theory Review

In this chapter we highlight the relevant literature for our thesis. We will review earlier work to feature the relevance of the topic and construct a basis for the methodology and hypotheses of our research.

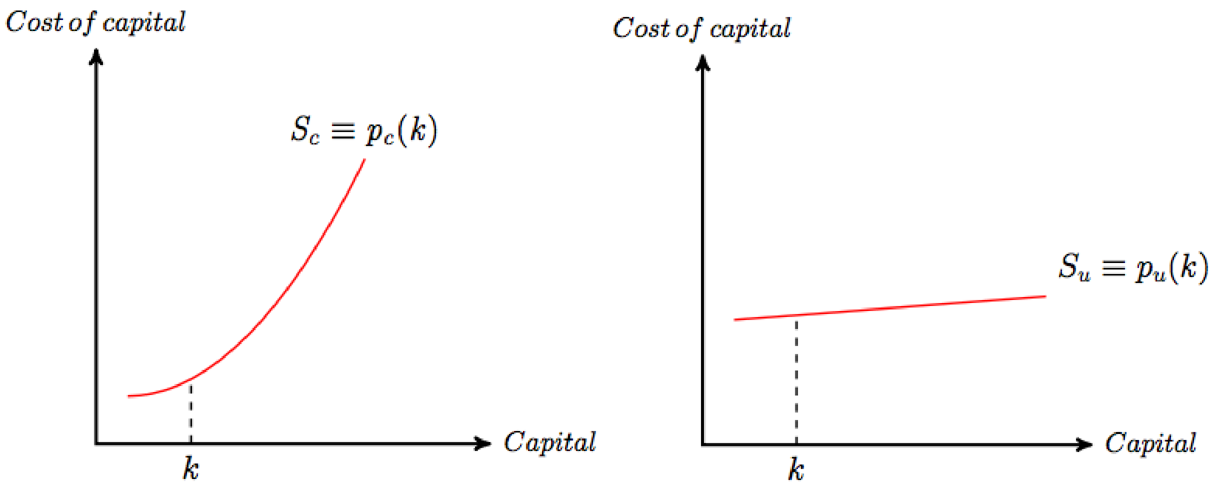
2.1 Financial Constraints Introduction

Financial constraints are not directly observable, hence it is difficult to provide a precise definition of what financial constraints are and which firms are financially constrained. Lamont et al. (2001) simply define financial constraints as frictions that prevent firms from funding all desired investments. These frictions typically include asymmetric information, agency costs and incomplete contractibility. Furthermore, they emphasize that financial constraints are not the same as financial distress- and bankruptcy costs, even though the two are indisputably correlated. Tirole (2010) explains that financial constraints arise due to frictions in the supply of capital, with the key friction being information asymmetries between investors and the firm. Supply frictions decrease the elasticity of the supply of the external capital curve, driving a wedge between the internal and external cost of capital. Along these lines, Almeida and Campello (2001) observe that "constrained firms are at the point where the supply of capital becomes inelastic."

We follow Farre-Mensa and Ljungqvist (2016) and briefly formalize these general observations. Denote a firms capital supply curve by $p(k)$, which specifies the price at which a firm with k units of capital can raise an incremental unit of capital externally. The extent of financial constraints is then characterized in terms of the elasticity of $p(k)$. The steeper, i.e. more inelastic, the supply curve, the more financially constrained the firm. From the general definitions above, a firm is financially constrained if it faces a highly inelastic supply curve, such that

$$\frac{\frac{\partial p(k)}{\partial k}}{\frac{k}{p(k)}} >> 0 \tag{2.1}$$

Figure 2.1 illustrates this definition graphically.



(a) Constrained Firms (b) Unconstrained Firms

Figure 2.1: The figure shows the supply of capital curves faced by two hypothetical firms, both currently holding k units of capital. The firm on the left is financially constrained. The firm on the right is financially unconstrained.

The capital supply curve is not readily observable, such that measuring financial constraints precisely is empirically challenging. Therefore, the literature instead attempts to infer the elasticity of the capital supply curve indirectly, by looking at what managers say, firm performance and characteristics, and the action managers take, i.e. pay out dividends or obtain a credit rating. We note that capital markets comprise of both debt and equity markets. A firm may for example find that that it is unable to issue bonds or shares in public markets but is able to obtain debt financing through syndicate bank loans at a reasonable cost, which in turn means that the firm is not financially constrained.

With a more precise definition of financial constraints in hand, we turn to the relationship between financial constraints and risk. Livdan et al. (2009) link financial constraints, firm risk and expected stock returns theoretically by extending the neoclassical investment framework to incorporate retained earnings, debt, costly equity, and collateral constraints on debt capacity. They define firms as financially constrained when there is a gap between a firms optimal investment and its ability to obtain the necessary funding. A key result of their model is that collateral constraints prevents firms from financing all desired investments, which restricts the flexibility of firms in smoothing dividend streams in the face of aggregate shocks, thereby increasing firm risk. Specifically, it is the inflexibility caused by financial constraints which generate an independent source of real risk.

2.2 Financial Constraints and Business Cycles

In this section we provide an overview of the literature linking financial constraints and business cycles. Several researchers have modelled the effect of financing imperfections on business cycles(see Bernanke et al. (1996) for a review), chief among them Gertler and Bernanke (1989)'s agency-cost model. These models typically show that asymmetric information gives rise to agency costs, causing some firms to be more financially constrained than others, affecting investment and thereby linking the real- and financial sides of an economy. Carlstrom and Fuerst (1997) calibrate Bernanke and Gertler's model and find that it replicates the empirical fact that output displays positive autocorrelation at short horizons, indicating that financial constraints may be an important propagation and amplification mechanism.

The connection between business cycles and financial constraints can be traced back to Townsend (1979)'s costly verification problem. In his model, entrepreneurs need to borrow from lenders to finance projects. However, only entrepreneurs can freely observe the realized return of their projects. Lenders can observe the return by purchasing a costly audit. If the lenders find auditing necessary, they will increase the cost of capital to cover the increased auditing cost, driving a wedge between the entrepreneurs internal and external cost of capital. Of particular interest is the case of two possible payoff states, one low and one high. In the high payoff state, the project output is enough to cover the cost of capital in full, leaving the rest to the entrepreneur. In the low state, the output is not enough to cover the cost, such that the entrepreneur is bankrupt. Townsend (1979) shows that more auditing is necessary when

1. The input required to complete a project is high. This means the entrepreneur must borrow more, which means repayment in the good state is higher. As a result, the entrepreneur has an increased incentive to lie about the project outcome, such that he can claim a larger part of the output to himself. As a result, lenders must spend more on costly auditing.

2. The cost of auditing is high. In this case the lenders need more resources to pay the audit costs, which means they require a higher payment in the good state to cover these costs, which again incentivizes the entrepreneur to lie.

3. The difference in output between the high and low states is large. This will also incentivize the entrepreneur to lie in the high state.

Auditing costs in this model represent agency costs in a general sense. Agency costs arise when lenders ('principles') are unable to ensure that borrowers ('agents') act in the lender's best interests.

Gertler and Bernanke (1989) embed the costly state verification model in a real business cycle framework with overlapping generations. This information asymmetry makes the Modigliani-Miller theorem inapplicable. They show that the condition of borrowers' balance sheets, i.e. net worth, is a source of output dynamics. The steps in the chain are typically described as follows

1. A positive productivity shock hits the economy, increasing entrepreneurs labor income and savings.

2. With higher savings, i.e. higher net worth, entrepreneurs borrow less to finance projects. This reduces the cost of monitoring and thus, the cost of capital.

3. Lower costs of capital result in entrepreneurs receiving higher payoffs from projects, which increases their net worth. This means they require less borrowing to fund the next project, again lowering the cost of capital, resulting in a financial accelerator effect.

4. With more projects completed, capital increases and the marginal product of capital decreases until the entrepreneurs are indifferent to saving or doing projects again.

The essence of Gertler and Bernanke (1989)'s model is that when there is asymmetric information, agency costs depend on the net worth of the borrower. This has two main macroeconomic implications. First, we should see a decline in agency costs and thus financial constraints in expansions and a rise in recessions as borrower net worth is likely to be procyclical. They show that this is sufficient to introduce investment fluctuations and cyclical persistence into an environment exhibiting neither of these characteristics when agency costs are not present. Second, real fluctuations can now be initiated by shocks to borrower net wort which are independent of aggregate output. If the price of a certain type of asset, for example an oil rig, falls in response to environmental concerns and the rigs are used as collateral, then there is a decline in borrower net worth. The agency costs associated with lending to the rig owners then increase, resulting in a fall in investment, which in turn may have negative effects on aggregate demand and supply.

Hall (2001), in reviewing the literature of models embedding asymmetric information, find that there are two key transmission mechanisms between financial constraints and business cycles

1. **Corporate cash flow**. For example, a negative aggregate shock will cause a decline in cash flows, which will raise the proportion of projects that must be financed from external funds. For financially constrained firms this will increase expected agency costs and the external finance premium, reducing investment and subsequent output, exacerbating the downturn.

2. **Asset prices**. A tightening of monetary policy or a negative productivity shock will reduce the demand for physical capital, leading to a decline in asset prices. This reduces the value of collateral available to back loans and raises the external finance premium, which in turn reduces current investment and subsequent output. Forward-looking asset prices such as stocks will decline as expectations of lower future cash flows are internalized, again exacerbating the downturn.

An important question in which there has yet to emerge a consensus, is whether financial constraints bind more in expansions or downturns. Gertler and Hubbard (1988), Kashyap et al. (1994) and Gertler and Gilchrist (1994) all show that credit constraints seem to bind more during recessions or when monetary policy is tight. On the other hand, researchers also argue that during recessions, investment opportunities are generally poorer and therefore external financing does not represent a binding constraint. They argue that it is in good times, when there are plenty of positive NPV projects, that financing frictions hinder the performance of constrained firms the most. Livdan et al. (2009) show that partial equilibrium investment models cannot generate procyclical financial constraints because they typically assume constant discount factors. This means that aggregate and firm-specific shocks affect investment symmetrically. However, using a stochastic discount rate, they show that financial constraints are procyclical. Empirically, Campello and Chen (2010) find that financially constrained firms' real earnings- and investment growth decline more than those of unconstrained firms in response to adverse changes in macroeconomic and credit market conditions, supporting the view that constraints bind more in downturns. Furthermore, Gomes et al. (2003) show that the implied shadow price of new funds is procyclical in several well-known general equilibrium models (e.g. Gertler and Bernanke (1989); Carlstrom and Fuerst (1997); Bernanke et al. (1999)).

2.3 The Financial Constraint Factor

In this section we give a brief review of asset pricing theory, which will motivate both why financially constrained firms should earn a risk premium over unconstrained firms and our empirical method of identifying the financial constraint factor. Finally, we review empirical evidence on the existence of a financial constraint factor.

2.3.1 Asset Pricing

The value of an asset depends on the delay and of the risk of its future payments (Cochrane (2009)). Cochrane advocates a discount factor view of asset pricing, summarizing its the core concepts in two equations[4]

$$p_t = E(m_{t+1}x_{t+1}) \tag{2.2}$$

$$m_{t+1} = f(data, parameters) \tag{2.3}$$

where p_t is the time t asset price, x_{t+1} is the next period asset payoff and m_{t+1} is the stochastic discount factor. For stocks, the one-period payoff is the next period asset price plus dividends $x_{t+1} = p_{t+1} + d_{t+1}$, where x_{t+1} is a random variable since investors do not know the future value of the investments. Investors are however assumed to be able to assess the probability of possible outcomes. Furthermore, x_{t+1} is the experienced value of the asset payoff at time $t+1$ to a common investor, which can be modeled through a utility

[4]See Cochrane (2009) for details on the methodology.

function. The utility function is defined over current and future values of consumption, and typically assumed to be neo-classical, taking the general form

$$U(c_t, c_{t+1}) = u(c_t) + \beta E_t[u(c_{t+1})] \tag{2.4}$$

where β is the discount factor, $u(c_t)$ is the utility from consuming c_t units at time t, and $E_t[u(c_{t+1})]$ is the time t expected next period utility. By maximizing the utility function, Eq.2.4, subject to the budget constraints

$$\begin{aligned} c_t &= e_t - p_t\xi \\ c_{t+1} &= e_{t+1} + x_{t+1}\xi \end{aligned} \tag{2.5}$$

where e is the original consumption level (if the investor bought none of the asset), and ξ is the amount of the asset he chooses to buy, we get the asset pricing formula

$$p_t = E_t\left[\beta \frac{u'(c_{t+1})}{u'(c_t)} x_{t+1}\right] \tag{2.6}$$

This formulation illustrates the role of investor risk aversion and impatience. Using the definition of covariance and substituting in the risk-free rate equation[5] one can rewrite Eq.2.6 as

$$p_t = \frac{E_t(x_t)}{R_t^f} + \frac{cov[\beta u'(c_{t+1}), x_{t+1}]}{u'(c_t)} \tag{2.7}$$

Eq.2.7 links investors desire smooth consumption and an assets ability to smooth consumption. We see that asset prices rise with the covariation of the investor's future marginal utility and the assets future payoff, such that the higher the payoff in bad times, the higher the price. A key aspect of asset pricing is that investors should be compensated for taking systematic risk. Cochrane illustrates this through a special case of the basic asset pricing formula, $p_t = E_t(m_{t+1}x_{t+1})$

$$1 = E_t(m_{t+1}R_{t+1}) \tag{2.8}$$

where R_{t+1} is an assets gross return. Eq.2.8 formulates asset returns in terms of consumption with the price normalized to one. Expanding the expectation, Eq.2.8

[5]See Cochrane (2009) section 1 for further elaboration.

can be written as

$$1 = E_t(m_{t+1})E_t(R^i_{t+1}) + Cov_t(m_{t+1}, R^i_{t+1}) \tag{2.9}$$

and using $R^f_t = \frac{1}{E_t(m_{t+1})}$ we can rewrite Eq.2.9 as

$$E_t(R^i_t) - R^f_t = -\frac{Cov_t[u'(c_{t+1}), R^i_{t+1}]}{E_t[u'(c_{t+1})]} \tag{2.10}$$

Eq.2.10 is the standard asset pricing formula, which tells us that assets which have payoffs that covary positively with the state of the economy must compensate with a positive risk premium to motivate investors to hold them. According to Cochrane, all asset pricing models amount to different functions of the stochastic discount factor m_{t+1}. Factor pricing models attempt to model investors marginal utility in terms of indirect variables. They specify that the stochastic discount factor is a linear function of a set of proxies

$$m_{t+1} = a + b_A f^A_{t+1} + b_B f^B_{t+1} + \ldots \tag{2.11}$$

where f_i are factors and a, b_i are parameters. A key factor model in the literature is the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965), which can be written as

$$m_{t+1} = a + bR^W_{t+1}, \tag{2.12}$$

where R^W_{t+1} is the rate of return on a claim to total wealth, often proxied by a broad-based stock portfolio. By expanding the model with size and book-to-market risk factors, Fama and French (1992) arrive at the three-factor model,[6] which has subsequently become a standard asset pricing model in the literature. In a similar fashion to Eq.2.11, the three-factor model is typically formulated as

$$R_{jt} - R^f_t = \alpha_{jt} + \beta_1(R^M_t - R^f_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{jt} \tag{2.13}$$

There have been many extensions and variations of such factor models. The most common factors are usually related to firm or stock characteristics such as book-to-market or earnings-price ratios (Basu (1977, 1983), Fama and French (1992, 2006)), firm size (Banz

[6]Their research suggests that the market beta does not explain the cross-section of average returns, and find that including size as measured by market equity (ME) and book-to-market factors provide a better characterization of the cross-section of average stock returns for their sample period (1963-1990).

(1981) and Reinganum (1981)), co-skew with the market portfolio (Harvey and Siddique (2000)), liquidity (Pástor and Stambaugh (2003)), default risk (Vassalou and Xing (2004)), volatility (Ang et al. (2006)), and profitability and investment (Fama and French (2015)).

To relate factor pricing models to financial constraints, note Livdan et al. (2009)'s theoretical result that financial constraints cause cash flows and dividends to vary in a procyclical fashion; a result empirically supported by Campello and Chen (2010). According to the asset pricing theory just reviewed, this procyclical variation means a financial constraint factor should exist, and that it should be an explanatory variable in asset pricing models. Since factors are interpreted as linear proxies of the stochastic discount factor, the factors should be linearly independent. Thus, if the constraint factor is indeed linearly independent, regressing it on standard asset pricing models should result in a positive and significant intercept. Lamont et al. (2001) regress the financial constraint factor on several asset pricing models[7] and find that the financial constraint factor generates a significant positive intercept in each model. They therefore add the constraint factor to the Fama-French five-factor model and show that two corporate finance anomalies - IPO's and dividend omissions - are partially explained by the constraint factor.

2.3.2 Evidence of the Financial Constraint Factor

Generally, the literature points to the existence of a financial constraint factor although the results have been mixed. Lamont et al. (2001) find that the stock returns of financially constrained firms are on average lower than the stock returns of unconstrained firms, however, their estimates are not significant. Whited and Wu (2006) use an alternative index and find that constrained firms earn higher average returns than less constrained firms, although this difference is also insignificant. Campello and Chen (2010) find that constrained firms earn a significant risk premium over unconstrained firms and show that the results of Lamont et al. (2001) can be attributed to the use of a single financial constraint measure and their specific sample period.

Livdan et al. (2009) show theoretically that financially constrained firms should earn higher expected returns than less financially constrained firms. Furthermore, they find that constrained firms typically have a small scale of production and low firm-specific

[7] These include the CAPM, and Fama-French three- and five-factor models.

productivity. These theoretical predictions lend support to Chan and Chen (1991) and Perez-Quiros and Timmermann (2000), who find that small firms and relatively unprofitable firms earn higher average returns than larger more profitable firms. They interpret their evidence as suggesting that these firms are more adversely affected by lower liquidity in tight credit market conditions. Livdan et al. (2009) also find that after controlling for size, the significance of the financial constraint premium disappears. These results are largely consistent with the evidence of Lamont et al. (2001) and Whited and Wu (2006). They find that the financial constraint premium is significant in univariate sorts but not in bivariate sorts, likely a result of financial constraints being jointly determined with size and book-to-market in equilibrium. Finally, a new branch of research on financial constraints has emerged, where textual analysis is used together with annual reports and public company filings to identify financially constrained firms. Using this approach, Buehlmaier and Whited (2018) find that financially constrained firms earn a positive risk premium and that the premium cannot be explained by the Fama and French (2015) five-factor model.

2.4 Financial Constraints Identification in Practice

There are no agreed upon definitions of financial constraints which can be readily applied directly to data to classify firms as financially constrained or unconstrained. The literature has therefore resorted to applying various measures of financial constraints to classify firms. In this section we give an overview of the most common methods.

The earliest empirical studies of the real effects of financial constraints where by Fazzari et al. (1988), who employed investment-cash flow sensitivities as a measure of financial constraints, a methodology which has since been extensively challenged.[8] Lamont et al. (2001) use the qualitative studies of Kaplan and Zingales (1997) to form an index used to classify firms into discrete categories depending on their estimated degree of financial constraints. The index is a linear combination of five accounting ratios, where a higher index value indicates that the firm is more financially constrained. The index is given by

[8]See Kaplan and Zingales (2000, 1995) and Cleary et al. (2007).

the equation

$$KZ_{jt} = -1.002CF_{jt} + 3.139TLTD_{jt} - 39.368TDIV_{jt} - 1.315CASH_{jt} + 0.283Q_{jt} \quad (2.14)$$

where CF is cash flow to total assets, $TLTD_{jt}$ is the ratio of long-term debt to total assets, $TDIV_{jt}$ is the ratio of total dividends to assets, $CASH_{jt}$ is the ratio of liquid assets to total assets and Q_{jt} is Tobin's q.

Another widely used index is the WW-index constructed by Whited and Wu (2006). The index is constructed via a generalized method of moments (GMM) estimation of an investment Euler equation. Their model predicts that financial constraints affect the intertemporal substitution of investment today via the shadow price of scarce external funds. Their index is given by

$$\begin{aligned} WW_{jt} = -0.091CF_{jt} - 0.062DIVPOS_{jt} + 0.021TLTD_{jt} - 0.044LNTA_{jt} \\ +0.102ISG_{jt} - 0.035SG_{jt} \end{aligned} \quad (2.15)$$

where CF_{jt} is the ratio of cash flow to total assets, $DIVPOS_{jt}$ is an indicator that takes the value of one if the firm pays cash dividends, $TLTD_{jt}$ is the ratio of long-term debt to total assets, $LNTA_{jt}$ is the natural log of total assets, ISG_{jt} is the firm's three-digit industry sales growth and SG_{jt} is firm sales growth.

Another prevalent measure in the literature is the Size-Age-Index published by Hadlock and Pierce (2010). To test and compare the relative merits of the KZ- and WW-Indexes, Hadlock and Pierce use textual analysis on SEC filings to classify firms as constrained and unconstrained. Using this categorization, they estimate an ordered logit model predicting constraints as a function of different quantitative factors. Comparing their categorization to the KZ-Index, they find that the correlation is essentially zero, hence they advise against the use of the KZ-Index. For the WW-Index they find a higher correlation but assign most of the correlation to the fact that the index includes firm size. The main finding of the paper, however, is the relevance of size and age in categorizing firms as constrained. They propose an index solely based on the non-linear relationship between size, age and financial constraints, which is given by

$$SA_{jt} = (0.737 \times Size_{jt}) + (0.043 \times Size_{jt}^2)(0.040 \times Age_{jt}) \tag{2.16}$$

where $Size_{jt}$ is defined as the logarithm of a firms market capitalization and Age_{jt} is defined as $Min(Age_{jt}, 37)$.

A simpler and more practical approach is the use of proxies. By definition, a variable is a good proxy if it is highly correlated with financial constraints (Silva and Carreira (2012)). A good measure of financial constraints should reflect that financial constraints are firm-specific and time-varying. Examples of commonly used proxies include cash-flow metrics, cash-holdings, size, age, exports, research and development intensity, leverage, dividend payout ratio and group membership (Silva and Carreira (2012)). Several researchers (see for example Campello and Chen (2010) and Lamont et al. (2001)) have resorted to aggregating such proxies into composite measures in order to increase the robustness of their classifications.

An unsettled debate in the literature is the relationship between cash holdings and financial constraints. Kaplan and Zingales (1997) argue that low cash holdings are associated with financial constraints, as constrained firms must use more of their internal cash-holdings to finance projects. On the other hand, high cash holdings may reflect precautionary savings from firms which do not have easy access to external capital. Several economists find evidence of the latter. For instance, Acharya et al. (2012) find a positive correlation between corporate cash holdings, credit spreads and the long-term probability of default.[9] Another example includes McVanel and Perevalov (2008)'s study of Canadian non-financial firms in the period 1980-2006, where they conclude that the desired level of cash holdings is likely to be higher for financially constrained firms.

The literature is also divided on the relationship between leverage and financial constraints. Both Kaplan and Zingales (1997), and Hadlock and Pierce (2010) find that leverage and financial constraints are positively correlated. On the other hand, McVanel and Perevalov (2008) find evidence of a negative relationship between a firm's leverage ratio and its degree of financial constraints. They argue that firms with high leverage have been able to borrow

[9] See also Opler et al. (1999) and Hadlock and Pierce (2010).

at some point, and thus positive leverage may indicate that a firm is unconstrained, a result found by several other researchers(see for example Cleary (1999)). Farre-Mensa and Ljungqvist (2016) use dividends, credit ratings, the WW-Index, SA-Index and KZ-Index to classify firms as constrained and unconstrained. For all classification criteria except the KZ-Index, they find that constrained firms are less levered and hold more cash.

In the same paper, Ferra-Mensa and Ljungqvist point out that many popular measures of financial constraints which are based on accounting data, such as the KZ-Index and WW-Index, are likely flawed. Using US data they show that firms classified as constrained by these measures are able to borrow more when optimal, maintain borrowing levels when banks lending in its home state are hit with a tax shock that shifts the local supply of bank loans, and raise equity and at the same time increase its payouts to shareholders. As these behavioral patterns are not consistent with firms which are financially constrained, they advise caution in blindly applying such indexes to classify firms as financially constrained.

3 Data Construction and Description

In this section we describe our our choice of variables and how we construct the various data sets. To better understand the data construction process, it will be useful to first restate the general steps of our analysis. We start by forming portfolios of constrained and unconstrained firms using various classification schemes. The median real earnings- and investment growth of these portfolios are then regressed on macroeconomic and credit market variables. We then test if there is a difference in stock market returns between constrained and unconstrained firms by calculating their return difference, creating a financial constraint factor. The financial constraint factor is then regressed on the same macroeconomic and credit market variables as in the first regressions. Finally, we test if the financial constraint factor can be priced using various asset pricing models.

3.1 Macroeconomic Variables

The macroeconomic variables we use include the unemployment rate, industrial production and the oil price, which serve as proxies for the state of the economy. We use industrial production and the unemployment rate to make our results comparable to those of the US, as reported by Campello and Chen (2010). To correct for the fact that the macroeconomic movements and changes in the stance of monetary policy often coincide, we have included Norges Bank's key policy rate as a proxy for monetary policy (MP). To incorporate specific characteristics of the Norwegian economy, we will also include the NOK trade-weighted currency index and the US ten-over-two year yield spread as control variables. Before discussing our choice of credit market variables, we briefly explain why we include the oil price, the NOK trade-weighted currency index and the US yield-spread.

We include the oil price because several studies show that the state of the Norwegian economy and the oil price are closely connected. For example, Bjørnland (2000) use a structural vector autoregression (VAR) model to analyze the linkages between energy prices and the aggregate economy of four OECD countries. They find that for Norway, a positive oil price shock increases output at all horizons, although the results are not significant in the long run. Similarly, Mork et al. (1994) finds that the Norwegian economy benefits significantly from oil price increases but does not seem to be hurt by oil price declines.

We include the NOK trade-weighted currency index and the US ten-over-two year yield spread to isolate macroeconomic conditions in Norway from foreign disturbances. For example, by comparing the studies of Furlanetto et al. (2013) and Aastveit et al. (2011), Aastveit et al. (2013) conclude that foreign disturbances explain more than 50% of the fluctuations in the Norwegian macroeconomic variables. Specifically, we include the NOK trade-weighted index to account for exogenous fluctuations in import and export prices. The index is calculated on the basis of NOK-exchange rates against the currencies of Norway's 25 main trading partners.[10] We include the US ten-over-two year yield spread to account for business cycle variations in Norway's most important economic counterparts. It is well documented that business cycles in the US are correlated with those of other major economies such as the Eurozone area and the UK, which means that including the US yield spread should account at least in part for these economies as well.[11] An important reason for choosing the US yield spread is that it is available from 1996. We are unable to find reliable economic indicators for the Eurozone, the UK, Germany, China and other Norwegian trade partners, which stretches back to 1996. An alternative would be to shorten the time-frame of our analysis to account for the lack of economic data, however, we view the US yield spread as adequate in capturing business cycle variations outside the US, and the loss of information by shortening our time horizon as too costly.

3.2 Credit Market Variables

We use the Norwegian two-year swap spread[12] and the credit-to-GDP growth rates as proxies for the credit market conditions.[13] For robustness, we also run the regressions using the NIBOR-spread and Norges Bank's credit-gap series as proxies for credit market conditions, and note that the results do not change meaningfully, however the coefficients

[10] Geometric average using the OECD's trade weights, chain-linked. The index is set at 1990=100. Not seasonally adjusted. A rising index value denotes a depreciating krone exchange rate.

[11] See for example Benedictow and Johansen (2005).

[12] An interest rate swap is a contract between two parties to exchange one stream of interest payments for another over a specified period. Regular interest rate swaps exchange fixed-rate payments, i.e. the swap rate, for floating rate payments based on benchmark interest rates such as the LIBOR or NIBOR. The swap spread is the difference between the swap rate and the yield on a government bond of the same maturity.

[13] Credit is calculated as the sum of C2 households and C3 non-financial enterprises (all non-financial enterprises pre-1995) for mainland Norway.

are smaller and less significant,[14] see appendix section A4. Figure 3.1 illustrates the similarities in the measures.

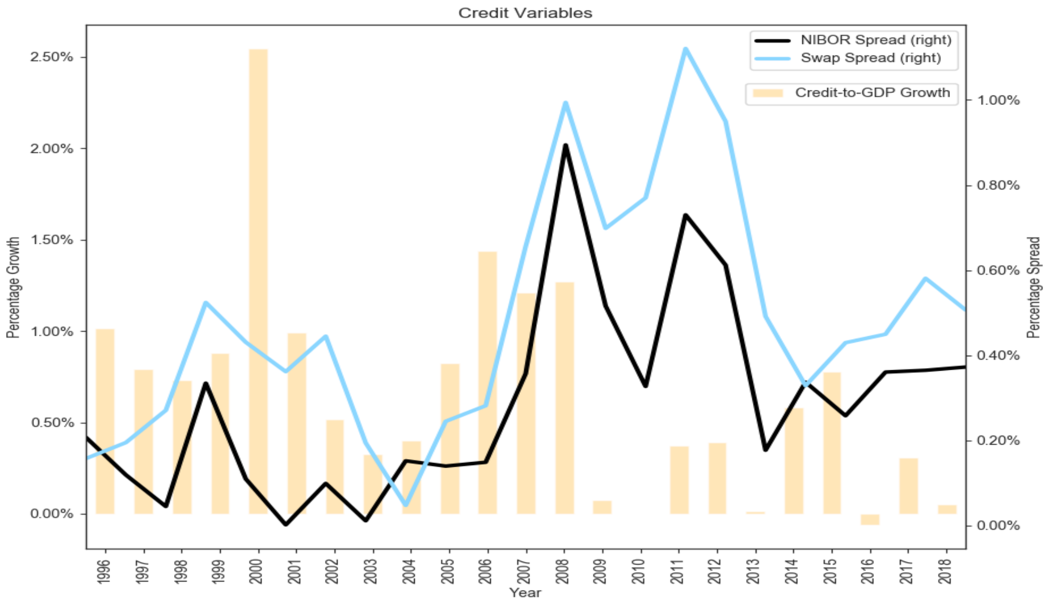


Figure 3.1: Illustration of the similarities between the Credit-to-GDP Growth, NIBOR spread and the two-year swap spread. The NIBOR- and swap spreads are illustrated via the line graphs (RHS), while the credit-to-GDP growth is illustrated via the columns (LHS).

We here briefly explain our choice of credit variables. Generally, higher swap spreads indicate increased risk aversion in the market; when investors seek to hedge interest rate risk through swaps, the swap spread widens. Furthermore, the swap spread is an important indicator of how both default and liquidity risk influence security returns (Liu et al. (2002)). Thus, to gauge investor sentiment in the credit markets, the swap spread seems to be a good measure. We use the credit-to-GDP ratio as it is one of the four indexes used by Norges Bank to assess financial imbalances in Norway (NorgesBank (2019)). Periods of easing credit conditions should result in the credit-to-GDP ratio increasing while periods of general distress should see it decreasing, as we see in Figure 3.1.

[14]The NIBOR spread is calculated by subtracting the yield on three-month government bills from the three-month NIBOR rate. The Credit-Gap is calculated as the the total credit of mainland Norway as a share of mainland GDP.

3.3 Data Construction

We use three main data sources: accounting data, stock market data and economic data. The accounting and stock market data are collected from the Compustat Global database, while the economic variables are collected from Datastream, Macrobond and Norges Bank. The variable names, descriptions, ID codes and database are listed in Table 3.2. We start by constructing three sperate datasets of stock market, accounting, and economic data. The economic dataset is then merged into the accounting dataset. Finally, we merge the stock market and accounting datasets, making sure that both sets include the same firms over the same periods, leaving us with one monthly and one yearly dataset. The data construction steps are listed in Table 3.1 and described in detail below.

Table 3.1: This table illustrates the development of the number of observations in our sample from the original sample to the final data set. See section 3.3.1 and 3.3.2 for a detailed description of each step.

Panel A: Security data	Observations		Companies	Months
	Number	Diff	Number	Number
Compustat file	50951		415	287
Day > 25	48506	-2445	413	287
Return calculation	40231	-8275	406	286
Omit penny stocks	38064	-2167	403	286
Omit financial companies	30184	-7880	311	286
Merge with macrodata	29853	-331	311	279
Panel B: Accounting data	Observations		Companies	Years
	Number	Diff	Number	Number
Compustat file	4005		377	24
Omit financial companies	3993	-12	375	24
Omit at < 0	3971	-22	375	24
Omit lt < 0	3967	-4	375	24
Omit BE < 0	3850	-117	375	24
Omit empty classification variables	2978	-872	355	22
Panel C: Merged file	Observations		Companies	Years
	Number	Diff	Number	Number
Merge files	2048		272	22
Allign ME at june with t - 1	1898	-150	253	22
Match with return data	20613		253	257*

* Months

Table 3.2: An overview of the sample variables. The ID variables column reports the variable names from their respective database.

Variables	Content	Database
ID Variables		
datedate	Date	Compustat
conm	Company Name	Compustat
gvkey	Global Company Key	Compustat
Security variables		
ajexdi	Adjustment Factor	Compustat
cshoc	Shares Outstanding	Compustat
iid	Issue ID	Compustat
prccd	Daily Close Price	Compustat
tpci	Issue Type Code	Compustat
Accounting variables		
fyear	Fiscal Year	Compustat
fyr	Fiscal Year-End Month	Compustat
at	Total Assets	Compustat
lt	Total Liabilities	Compustat
revt	Total Revenue	Compustat
seq	Stockholders Equity	Compustat
txdb	Total Deferred Taxes	Compustat
xint	Total Interest Epense	Compustat
xopr	Total Operating Expenses	Compustat
Macro and credit variables		
norate0001	Norges Bank Policy Rate	Datastream
no2ygov	Goverment Benchmark 2 Year Yield	Macrobond
nok2yswap	2 Year Swap Rate	Macrobond
NIBOR	One Month Norwegian Interbank Rate	Norges Bank
no3mnibor	Three Month Norwegian Interbank Rate	Macrobond
noprod001	Monthly Industrial Production Norway	Datastream
nolama0546	Monthly Unemployment Rate Norway	Datastream
Credit/GDP	Indicator of Financial Imbanances from Norgres Bank	Norges Bank
wocaes 0074	Daily Brent ICE Close	Macrobond
NWXTW..NF	Trade Weighted NOK Index, 1990=100	Datastream
nopric0001	Consumer Price Index, 2015=100	Macrobond
USAIYN.R	US YIELD CURVE (10y minus 2y)	Datastream

3.3.1 Data Construction – The Economic Dataset

We merge data from Datastream, Norges Bank and Macrobond, creating a dataset containing both macroeconomic and credit market variables. The variables we use are listed under macro and credit variables in Table 3.2. The variables noky2swap, no2ygov and NIBOR rates are daily price series, which we convert into monthly series by extracting the end-of-month observations. For consistency, we follow the procedure outlined in section 3.3.2, defining the reported last day of the month to be end-of-month observations if they fall on the 26^{th} or later. Credit-to-GDP is reported quarterly, while the remaining variables are reported monthly. The Norwegian two-year swap rate is the shortest time series, starting August 1995, which becomes the starting point for the dataset. We merge all the individual data series and omit observations before August 1995.

3.3.2 Data Construction – The Stock Market Dataset

We start by extracting daily stock market data from the Compustat Global database. General practice in the asset pricing literature is to test factor models using monthly stock market returns, see Fama and French (2015). We therefore convert the daily data into a dataset of monthly observations. There are several instances where a stocks' last recorded trading day differs from the final day of the month. We sidestep the issue by defining the reported last day of the month to be end-of-month observations if they fall on the 26^{th} or later.[15] Monthly individual stock returns are then calculated as

$$r_{jt} = \frac{\frac{p_{jt}}{adj_{jt}}}{\frac{p_{jt-1}}{adj_{jt-1}}} - 1 \tag{3.1}$$

where p_{jt} is the monthly closing price of stock i and adj_{jt} is the Compustat adjustment factor which adjusts prices for stock splits and dividends. We omit return values which are exactly zero as this is an indication of improper reporting. Looking at the subset of firms which have monthly returns of exactly zero confirms our suspicions as they typically have no recorded accounting data in the relevant period. We remove all observations with a share price under one NOK for two reasons. First, the Oslo Stock Exchange delists firms with a share price under one NOK for more than six months (OsloBørs (2019)). Second, due to the low price of these stocks, a small increase or decrease in the share price can cause large movements in the return calculations, skewing the results. Following Fama and French (1992), we exclude financial firms because high leverage for these firms typically does not have the same interpretation as for non-financial firms, where higher leverage signals financial distress.

[15] We find that the number of observations with an end-of-month day lower than the 26^{th} is significantly lower than the number of observations with an end-of-month day higher than the 26^{th}.

We follow the asset pricing literature (see for example Aharoni et al. (2013) or Novy-Marx (2013)) and do a 0.5 percent and 99.5 percent winsorization[16] of the dataset. Table 3.3 provides the sample characteristics before and after the sample adjustment.

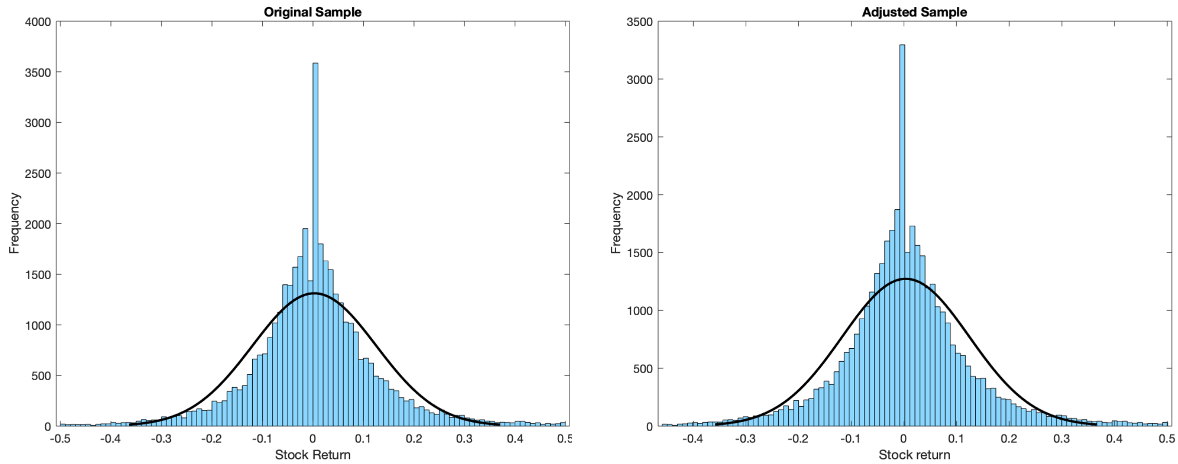
Table 3.3: This table shows the sample characteristics of the end-of-month stock returns for the original and adjusted datasets covering the period of July 1996 to December 2018. The individual stock returns are calculated by Eq.3.1. The adjusted sample is winsorized with 0.5 and 99.5 percent. Both samples exclude return values of exactly zero. In addition, penny stocks, firms with negative book-equity, assets and debt, as well as firms without sufficient accounting data to construct the ranking variables are omitted.

	Original Sample	**Adjusted Sample**
Mean	0.98%	0.70%
Min	-93.93%	-45.83%
Max	987.46%	66.90%
Stdv	17.62%	13.12%
Kurtosis	400.00	2.97
Skewness	9.96	0.62
JB test p-value	0.00	0.00

The Jarque-Bera test[17] indicates that neither the returns of the original nor adjusted sample are drawn from normal distributions, which is in line with most other findings concerning stock return distributions (see for example Rachev et al. (2005) for an overview). Figure 3.2 plots the sample return distribution as a histogram together with a theoretical normal distribution which has the same mean and standard deviation as the sample data. We see that neither of the sample distributions quite fit their corresponding theoretical normal distribution.

[16] Winsorizing amounts to setting all outliers to a specified percentile of the data to increase the robustness of the applied estimators.

[17] The null hypothesis of a Jarque-Bera test is that the population the sample is drawn from has zero skew and zero excess kurtosis, which is the case for a normal distribution.



(a) Original sample

(b) Adjusted sample

Figure 3.2: Sample return distribution for the original and adjusted sample. Return is calculated by Eq.3.1. The adjusted sample is winsorized with 0.5 and 99.5 percent. Both samples exclude return values of exactly zero. In addition, penny stocks, firms with negative book-equity, assets and debt, as well as firms without sufficient accounting data to construct the ranking variables are omitted.

3.3.3 Data Construction – The Accounting Dataset

We extract full year accounting data for Norwegian firms with fiscal year-end in December from the Compustat Global database. Financial companies are omitted from the dataset, as is done for the stock market dataset. Firms with negative total assets or total leverage are also omitted. Negative total assets and negative leverage are not possible and are therefore signs of improper accounting. We also omit firms with negative book-equity as we use an operating profitability measure which divides operating profits by book-equity. Distressed firms are typically unprofitable, which may result in having both negative book-equity and negative operating earnings, giving a positive value for the operating profitability measure. The result would be to blend profitable and unprofitable firms, distorting the results. Furthermore, omitting negative book-equity firms will help us isolate the results on financial constraints from the effects of bankruptcy or financial distress.

In section 4.2 we describe the ranking variables we construct to classify firms as constrained and unconstrained. We omit observations which have empty ranking variables as a result of missing accounting data, and then merge the economic and accounting datasets.

3.3.4 Data Construction – The Complete Datasets and Timeline

We merge the stock market and accounting datasets such that our sample only contains firms which have both fundamental- and security data. This merged file is the final stock market dataset, which contains both monthly stock market data, monthly economic data, and yearly accounting data. From this dataset we calculate yearly averages of the economic data and then extract these yearly averages together with the yearly accounting data to create the final accounting dataset.

The start of our sample is restricted by the two-year swap spread variable, which starts August 1995. Since the holding period starts in July of each year, we investigate returns from July 1996 to December 2018. As described in detail in section 4.1, several accounting variables in our analysis require a two-year time lag. We therefore collect data from the Compustat global database starting from fiscal year-end 1993. The number of unique firms in our sample over time is illustrated in the appendix section A1.

3.4 Industry Sector Classifications and Reclassifications

The Compustat Global database provides Standard Industrial Classification codes for all firms. We use the codes to divide the sample into four industry groups including oil companies, transportation companies, manufacturing companies and other companies. Table 3.4 provides an overview of the SIC codes used in each industry group. The original column states the original range of SIC codes for an industry group. The SIC Inn column lists SIC codes we add to an industry group while SIC Out lists the SIC codes we remove from an industry group.

Oil companies are not an individual group under SIC classifications but rather a collection of smaller groups under the general category of mining. We define oil companies more broadly to include both oil and exploration companies as well as the oil service sector. This entails reclassifying firms which were classified as transportation or manufacturing companies to oil companies, as well as selecting the relevant SIC code groups from the mining group category. Firms not classified in the oil, transportation or manufacturing group are placed in the other companies' group. Other firms are also directly reclassified, see appendix section A8 for further details. We report the descriptive statistics of each industry sector and the number of observations classified as constrained or unconstrained per industry group for each classification scheme, see appendix Table A8.1 and A8.2.

Table 3.4: This table gives an overview of the original and reclassified SIC codes. The Standard Industrial Classification (SIC) codes are four-digit codes that indicate the company's type of business (Securities and Commission (2019)). The Original column reports the SIC codes of firms originally classified in the denoted industry sector. The SIC Inn column reports the SIC codes which are added to the denoted sector, while SIC Out reports the SIC codes which are taken out of the relevant industry group. For example, firms with the SIC code 4400 were originally classified as transportation companies, however we reclassify them as oil companies becasue firms in this category are offshore suppliers and seismic companies, and we define the oil sector to include oil service companies.

Oil Companies			**Transportation Companies**			**Manufacturing Companies**		
Original	SIC Inn	SIC Out	Original	SIC Inn	SIC Out	Original	SIC Inn	SIC Out
1311	4400		4000-4999	1382	4400	2000-3999	900	3730
1381	3533			1382	4812			3533
1389	8711			3730	4911			2711
1700	2911				4832			2911
					4899			
					4931			

4 Methodology

4.1 Portfolio Construction and Variable Definitions

In this section we explain our portfolio construction and updating process, and define all relevant variables. We start by constructing portfolios of constrained and unconstrained firms based on four financial constraint classification schemes which we detail below in section 4.2. Following the asset pricing literature (see for example Fama and French (1992)), we update these portfolios at the end of June each year, resulting in a twelve-month holding period over which, we calculate monthly returns. This approach ensures that the information we use to explain future returns is known, avoiding a "look ahead bias". The financial constraint classification schemes use accounting variables and firm age as inputs, which are calculated at fiscal-year end of year $t-1$, as well as firm size which is calculated at the end of June year t. Real investment- and operating earnings growth are calculated from fiscal year-end at time $t-2$ to $t-1$. We create the Fama-French SMB, HML, CMA, RWA factor mimicking portfolios, see appendix section A9, in a similar fashion to the constrained and unconstrained portfolios. Figure 4.1 illustrates the timeline and portfolio dynamics.

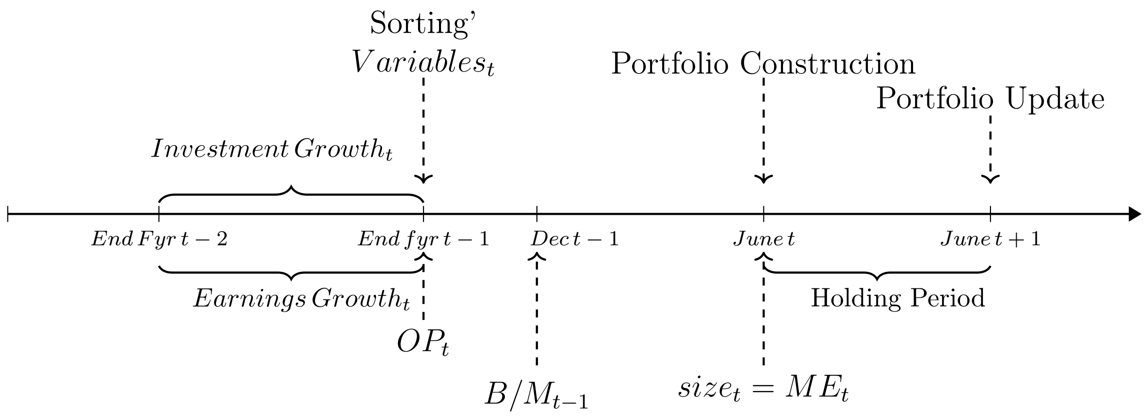


Figure 4.1: Illustration of the portfolio construction. For each financial constraint classification scheme we construct portfolios of constrained and unconstrained firms. The portfolios are updated at the end of June each year. The accounting variables and firm age are calculated at fiscal-year end of year $t-1$. Firm size is calculated at the end of June year t. Real investment- and operating earnings growth are calculated from fiscal year-end at time $t-2$ to $t-1$. The portfolio is held for twelve months over which we calculate monthly returns.

We follow much of the asset pricing literature and report both value-weighted and equal-weighted returns (see for example Fama and French (1993, 1992)). For a given portfolio of stocks, the returns of the value-weighted and equal-weighted portfolios are calculated as

$$R_t^{PF} = \sum_{j=1}^{n} \frac{r_{jt} \times ME_{jt}}{ME_t^{PF}} \tag{4.1}$$

$$R_t^{PF} = \frac{1}{n} \sum_{j=1}^{n} r_{jt} \tag{4.2}$$

where R_t^{PF} is the average monthly return of a portfolio of n stocks, r_{jt} is the monthly return of stock j as calculated in Eq.3.1, ME_{jt} the market capitalization of stock j and ME_t^{PF} is the market capitalization of the portfolio.

For a detailed discussion on differences of value-weighted and equal-weighted portfolios, see Plyakha et al. (2014). We note that the choice of value-weighted against equal-weighted is not linked to theoretical measurements of financial constraints, rather the choice simply depends on how an investor prefers to rebalance the portfolio.

4.1.1 Financial Constraints Sorting Variables

These variables are used to create the various measures of financial constraints. They include leverage, cash holdings, the interest coverage ratio, total assets, firm age, and size, and are defined as follows

i. Leverage is defined as total debt at time $t-1$ over total assets at time $t-1$

$$\frac{total\, debt_{t-1}}{total\, assets_{t-1}} \tag{4.3}$$

ii. Cash holdings is defined as cash holdings at time $t-1$ over total assets at time $t-1$

$$\frac{cash\, holdings_{t-1}}{total\, assets_{t-1}} \tag{4.4}$$

iii. Coverage ratio is defined as operating earnings at time $t-1$ over total interest expenses at time $t-1$

$$\frac{EBIT_{t-1}}{interest\,expenses_{t-1}} \tag{4.5}$$

iv. Assets is defined as total assets at time $t-1$

$$Total\,assets_{t-1} \tag{4.6}$$

v. Age is defined as the number of years since the first trading day in our sample.[18]

vi. Size is defined as the market capitalization at the end of June of year t, calculated as

$$Market\,cap_t = share\,price_t \times shares\,outstanding_t \tag{4.7}$$

4.1.2 Fama-French Sorting Variables

In order to construct the Fama-French SMB, HML, CMA and RWA factors we must define size, book-to-market, operating profitability and investment. They are defined as follows

i. Size is defined as in section 4.1.1, Eq.4.7.

ii. Book-to-market is defined as the ratio of a firms book equity at the end of fiscal year $t-1$ and its market equity at the end of December of year $t-1$

$$B/M_t = \frac{book\,equity_{t-1}}{market\,equity_{Dect-1}} \tag{4.8}$$

where market equity (ME) is calculated as in Eq. 4.7 . Book equity is calculated as

$$\begin{aligned} Book\,equity_t = {} & stock\,holder\,equity_{t-1} + deferred\,taxes_{t-1} \\ & + investment\,tax\,credit_{t-1} \end{aligned} \tag{4.9}$$

[18]The Compustat Global Database provides as IPO variable which could be used to more accurately calculate firm age, however it is either empty, wrong or contradictory for most firms in our sample.

iii. Operating profitability is defined as operating profit less interest expenses relativity to book equity, where all variables are measured at fiscal year-end $t-1$

$$OP_t = \frac{total\,revenues_{t-1} - total\,operating\,expenses_{t-1} - interest\,expenses_{t-1}}{book\,equity_{t-1}} \quad (4.10)$$

V. Investment is defined as the book asset growth from year $t-2$ to year $t-1$

$$Investment_t = \frac{total\,assets_{t-1} - total\,assets_{t-2}}{total\,assets_{t-2}} \quad (4.11)$$

4.2 Measures of Financial Constraints

In this section we detail the construction of our financial constraints classification criteria. Our general approach to identifying financially constrained firms is to sort firms by characteristics believed to be associated with financial constraints. As the literature has yet to reach a consensus on which variables best measure financial constraints we resort to using several measures. Specifically, we construct four measures of financial constraints including size, the SA-index and the Composite I and Composite II Indexes. These measures are used to form portfolios of constrained (C), middle (M), and unconstrained (U) firms using 30% and 70% cutoff points.

4.2.1 Definition of the Classification Schemes

1. Size

At the end of June each year we classify each firm into three groups using that months market capitalization with 30% and 70% cutoffs, where the firms in the lowest group are classified as constrained and firms in the highest group are classified as unconstrained. We define size for firm j as in section 4.1.1, Eq.4.7

$$Market\,cap_{jt} = share\,price_{jt} \times shares\,outstanding_{jt} \quad (4.12)$$

2. The SA Index

At the end of June each year we calculate the SA-Index score for all firms. Next, using 30% and 70% cutoff points we classify each firm into one of three groups, where firms in the highest group are ranked as constrained and firms in the lowest group as unconstrained. The SA-Index score for firm j is given by

$$SA_{jt} = (-0.737 \times Size_{jt}) + (0.043 \times Size_{jt}^2) - (0.04 \times Age_{jt}) \tag{4.13}$$

where $Size_{jt}$ is defined as the natural logarithm of a firms market capitalization, while Age_{jt} is defined as in section 4.1.1.[19]

3. Composite I Index

At the end of June each year we separately sort firms based on: size, age, leverage, cash holdings, coverage ratio and total assets using 20% quantile breakpoints. We then assign a score from 1 to 5 for each of those rankings, with a lower number indicating a higher likelihood of being financially constrained. The Composite I Index score for each firm j is created by adding together the firms individual variable scores. Using the Composite I Index scores we divide the sample into three groups using 30% and 70% cutoff points, where firms in the lowest group are ranked as constrained and firms in the highest group as unconstrained. Specifically, smaller firms, in terms of market size and total assets are ranked as more constrained. Younger firms are ranked as more constrained. The lower the leverage and coverage ratio and the higher the cash holdings, the more constrained the firm is ranked.

As discussed in section 2.4, the literature is divided on how leverage and cash holdings are related to financial constraints. We find it convincing that firms which are highly levered but not in distress must have had access to external capital previously and are therefore less likely to be truly constrained. Furthermore, we find it likely that constrained firms will hold more cash in order to finance larger parts of projects using internal capital, as external capital may be prohibitively expensive. Cash is likely also held as a precautionary measure for the same reason.

[19]Hadlock and Pierce (2010) define Age_{jt} as $Min(Age_{jt}, 37)$, due to the essentially flat relationship between constraints and size/age for very large mature firms. We do not use this definition as our sample period is too short.

4. Composite II Index

The algorithm used to compute the Composite II Index is the same as that of Composite I, however we reduce the variables to leverage, cash holdings and the coverage ratio.

Choice of classification schemes

Size is a standard measure of financial constraints (see for example Gertler and Gilchrist (1994) and Campello and Chen (2010)). Furthermore, as Livdan et al. (2009) shows, size and financial constraints are determined endogenously, which means although size is not a pure measure of financial constraints, it should be closely correlated with financial constraints, which is exactly what Lamont et al. (2001) find empirically. We note that size has been linked to several other risk factors, including a stock market illiquidity premium, and an information premium, see section 5.2 for details.

Hadlock and Pierce (2010) find that size and age are particularly useful predictors of financial constraints, and that the relationship between financial constraints, size and age are non-linear. For a more detailed description of the SA-Index, see section 2.4. We note that the SA-Index is based on a specific functional form and that its coefficients are estimated using a relatively small number of firms over a short period of time, suggesting caution in applying the index blindly to our dataset. We therefore view our use of the SA-Index as an exploratory investigation of the ability of US-estimated indexes to correctly identify financial constraints outside the US.

The Composite I Index is simply a collection of firm-specific factors which have been empirically documented to be associated with financial constraints. We find this measure interesting because it combines firm characteristics, i.e. size and age, with information on firm performance via accounting measures and management decisions in the form of asset size and cash holdings. Furthermore, including leverage and the coverage ratio provides information on how the firm is affected by variations in external borrowing costs.

In the Composite II Index, we limit the variables to firm-specific accounting measures for two reasons. First, we exclude size and age because they are considered separately above. Total assets are excluded because it is closely related to firm size. Second, this allows us to test whether a firm's capital structure and liquidity situation can be used to identify financially constraints.

4.2.2 Data Limitations

The Compustat reporting of cash flow statements and dividends for Norwegian companies are poor. We are therefore unable to use accounting measures related to dividends or the cash flow statement in the analysis. There are two drawdowns to this. First, as several researchers point out, dividends and cash flows are some of the most important variables in determining how financially constrained a firm is. Second, we are unable to test benchmark indexes such as the KZ- and WW-Indexes. Despite the controversy in blindly applying these indexes, using them would both allow a comparison with our current constraint measures and test their fit to Norwegian data. The data issue can be illustrated by constructing the KZ index, and creating a table similar to Table 3.1, see appendix A7, Table A7.1, the sample size is almost halved.

Another data limitation is tied to the availability of credit metrics and ratings of Norwegian companies. After shadow ratings were banned in 2016 Norwegian banks stopped publishing credit ratings. The Compustat Global database includes a credit quality ranking from the S&P ratings agency; however, the variable is empty for all Norwegian firms. Furthermore, we were unable to obtain any aggregate credit indices. These limitations mean we are unable to create financial constraint measures similar to those of Campello and Chen (2010) and Lamont et al. (2001). This also means we are unable to measure credit market conditions in a similar fashion, making our results less comparable to those of the US.

4.3 Do the Classification Criteria Measure Financial Constraints?

Since we do not have an exact measure of financial constraints, but rather a set of proxies, we seek to validate that the classification criteria measure financial constraints. We validate the measures along three dimensions. First, we test if the classification schemes measure the same thing. Second, we check if the characteristics of firms classified as constrained and unconstrained match those previously found in the literature. Finally, we test whether the classification schemes capture variations in the elasticity of the supply curve of external capital.

The key findings in this section are that size captures, at least in part, financial constraints and since the Composite I Index behaves similarly to size in the firms it classifies as constrained, it too likely captures financial constraints. On the other hand, it seems unlikely that the SA-Index correctly identifies financially constrained firms, while it is unclear whether accounting variables alone, as characterized by the Composite II Index, is enough to identify financial constraints.

4.3.1 Do the classification schemes measure the same thing?

To answer this question, we look at the overlap in constrained and unconstrained classifications, which are reported in Table 4.1. If the classification schemes measure the same thing then we should see a high number of overlapping classifications and a low number of contradictory cases where a firm is labeled constrained by one measure and unconstrained by another. We see that size and the Composite I Index are the closest measures, while the Composite II Index and SA-Index have several contradictory classifications. Furthermore, we see that the Composite II Index has the lowest number of overlapping classifications.

Table 4.1: This table displays firm-year cross-classifications for the various criteria used to categorize firms as either financially constrained or unconstrained. Firms are ranked independently at the end June each year by the four applied measures; Size, SA-Index, Composite I and Composite II. See section 4.2 for an elaboration of the classification schemes. The sample period stretches from July 1996 to December 2018.

Financial Constraints		Size		SA-Index		Composite I		Composite II	
Criteria		(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
1. Size									
Constrained	(C)	554							
Unconstrained	(U)		560						
2. SA-Index									
Constrained	(C)	302	79	548					
Unconstrained	(U)	70	276		560				
3. Composite I									
Constrained	(C)	306	7	334	20	466			
Unconstrained	(U)	9	388	59	298		505		
4. Composite II									
Constrained	(C)	202	76	229	82	327	6	462	
Unconstrained	(U)	97	180	73	153	4	244		400

4.3.2 Do the characteristics of firms classified as constrained and unconstrained match those previously found in the literature?

As a reference point, we provide an overview of the full sample characteristics in Table 4.2. We see that the average yearly growth in real operating earnings has been negative, while asset growth has been positive. Furthermore, on average, firms finance half of their assets using debt.

Table 4.2: Descriptive statistics of the full sample over the period July 1996 to December 2018. For computation of the variables see section 4.1.1 and 4.1.2. Market capitalization and total assets are denoted in MNOK.

	Total Sample				
	Mean	**Stdv**	**Median**	**Min**	**Max**
Earnings growth	-0.10	5.48	0.02	-92.98	64.26
Investment growth	0.30	2.60	0.04	-0.95	92.16
Market capitalization	18,883	105,179	1,284	14	1,875,589
Total assets	13,963	60,324	1,705	6	1,007,816
Debt-to-Assets	0.55	0.19	0.58	0.02	1.04
Book-to-Market	0.90	1.30	0.59	0.00	27.76
N	1854				

Panel A and B of Table 4.3 provides an overview of the characteristics of the constrained and unconstrained firms, as classified by each of the four classification schemes. We see that for the size and Composite I classification schemes, constrained firms are less profitable and invest less than unconstrained firms. These observations are in line with Livdan et al. (2009)'s theoretical prediction as well as most empirical observations (see for example Hadlock and Pierce (2010)). On the other hand, we note that both the SA-Index and Composite II Index report that constrained firms are on average more profitable and invest more than unconstrained firms, opposing the findings of both the size and Composite I classification schemes.

In Table 4.7 we split our sample into five groups using firm size and 20% quantile break-points, and report the associated characteristics of each portfolio. We see that profitability, age, and the coverage ratio all decrease monotonically with firm size, while the book-to-market values and cash holdings increase as firms become more constrained. Farre-Mensa and Ljungqvist (2016) show that when classifying firms by dividends, credit

Table 4.3: This table gives an overview of the characteristics of the constrained and unconstrained firms for each of the four classifications schemes. Size is defined as $Market\,cap_{jt} = share\,price_{jt} \times shares\,outstanding_{jt}$. The SA-Index is calculated as $(-0.737 \times size) + (0.043 \times size^2) - (0.04 \times age)$. The Composite I Index is calculated by ranking the variables size, age, leverage, cash coverage rate and assets from 1-5 using 20% quantile breakpoints. The ranking scores are added together and firms are then sorted into three groups using 30% and 70% cutoff points, where constrained (C) firms are in the bottom group and unconstrained (U) firms are in the top group. The Composite II Index is constructed in the same was as the Composite I Index but excludes the variables size, age and total assets. For further elaboration on the construction of the classification schemes and variables see section 4.2 and 4.1.1. Market capitalization and total assets are denoted in MNOK.

Panel A: Individual Measures

	Size Classified										SA-Index Classified									
	Constrained					Unconstrained					Constrained					Unconstrained				
	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max
Earnings growth	-0.47	5.28	-0.12	-55.72	25.85	0.21	3.30	0.09	-39.31	40.48	0.09	2.72	0.04	-24.26	18.59	-0.19	5.51	0.00	-74.48	53.94
Investment growth	0.23	2.10	-0.01	-0.95	45.49	0.33	3.95	0.06	-0.90	92.16	0.28	1.22	0.05	-0.95	16.28	0.19	2.04	0.03	-0.88	45.49
Market capitalization	302	201	269	14	1,168	61,316	187,104	10,024	1,598	1,875,589	37,437	169,706	511	14	1,875,589	11,433	28,460	3,692	78	212,999
Total assets	771	1,437	368	6	18,126	41,396	105,261	10,905	158	1,007,816	24,267	103,720	270	6	1,007,816	10,316	18,666	4,285	226	142,111
Debt-to-Assets	0.53	0.21	0.55	0.03	0.99	0.56	0.16	0.58	0.03	0.95	0.47	0.21	0.48	0.02	1.04	0.57	0.17	0.60	0.03	1.02
Book-to-Market	1.06	1.08	0.74	0.01	7.40	0.65	0.68	0.45	0.01	6.74	0.67	1.02	0.36	0.00	15.99	0.94	1.51	0.68	0.02	27.76
N	554					560					548					560				

Panel B: Composite Measures

	Composite I Classified										Composite II Classified									
	Constrained					Unconstrained					Constrained					Unconstrained				
	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max
Earnings growth	-0.24	3.87	-0.14	-43.78	18.59	0.19	5.36	0.07	-74.48	64.26	0.03	3.66	-0.14	-39.31	35.99	-0.18	4.72	0.08	-74.48	17.10
Investment growth	0.39	2.55	-0.01	-0.95	45.49	0.53	4.14	0.05	-0.90	92.16	0.49	2.64	0.03	-0.95	45.49	0.14	0.65	0.04	-0.88	11.05
Market capitalization	780	1,233	392	14	10,846	64,289	198,147	8,025	227	1,875,589	3,155	8,187	785	14	113,692	46,557	182,724	2,242	41	1,515,752
Total assets	554	1,002	271	6	8,261	44,135	110,250	11,439	405	1,007,816	2,857	8,164	785	6	89,514	32,094	111,164	3,729	56	1,007,816
Debt-to-Assets	0.40	0.19	0.42	0.02	1.02	0.62	0.13	0.63	0.08	0.93	0.36	0.18	0.69	0.02	0.98	0.68	0.11	0.69	0.31	1.01
Book-to-Market	0.79	1.11	0.45	0.00	15.99	0.82	1.00	0.58	0.02	9.89	0.79	1.10	0.62	0.00	15.99	0.81	0.74	0.59	0.02	7.24
N	466					505					462					400				

ratings and the SA- or WW-Indexes, constrained firms are younger and smaller compared to unconstrained firms, carry more cash on their balance sheet, have higher book-to-market values and are more likely to be unprofitable. Lamont et al. (2001) and Hadlock and Pierce (2010) also find that constrained firms are typically young, small and unprofitable firms with high book-to-market values. These observations closely match the theoretical predictions of Livdan et al. (2009).

Using the size classification scheme we find that constrained firms are slightly less levered than unconstrained firms and rely more on short-term debt. Ferra-Mensa and Ljungqvist also find that constrained firms are less leveraged, rely more on short-term debt, and more often have no long-term debt at all. The negative relationship between leverage and financial constraints has been found by several others, see section 2.4. On the other hand, Hadlock and Pierce (2010) and Lamont et al. (2001), both find that leverage and financial constraints are positively correlated. Additionally, Livdan et al. (2009) make the theoretical prediction that financially constrained firms are likely to be highly levered. Thus, it is unclear whether the size classification scheme matches the findings in the literature regarding the relationship between leverage and financial constraints. We note that the SA-Index also finds that constrained firms are less levered than unconstrained firms, while for the Composite I and II Indexes, constrained firms are less levered by construction.

In sum, the descriptive statistics show that constrained firms classified by size best match the theoretical and empirical descriptions of financially constrained firms. The Composite I Index is similar to the size in the firms it classifies as constrained, however, we note that constrained and unconstrained firms have approximately the same book-to-market values using this measure. Firms classified as constrained by the SA-Index do not seem to have characteristics typically associated with constraints. The Composite II Index finds that constrained firms are young and small, but that they are both more profitable and invest more than unconstrained firms. Thus, constrained firms classified by the Composite II Index share some of the characteristics typically associated with constrained firms, while contradicting others.

4.3.3 Do the classification schemes capture variations in the elasticity of the supply curve of external capital?

We divide this investigation into two parts. First, we investigate the classification criteria's ability to identify variations in firms' access to equity markets. Second, we investigate the classification criteria's ability to identify variations in firms' access to- and cost of debt. We note that these tests are only indicatory, and it is unlikely that an entire portfolio of firms classified as constrained, are truly financially constrained.

Equity Markets

To test if the measures capture firms changing access to equity markets, we create a dataset of the 175 firms which both enter and exit the sample from June 1996 to December 2018. Firms which both enter and exit are firms which delist from the OSE. We have excluded firms with negative book-equity and penny stocks, such that the delisting's should not be related to bankruptcies, but rather signal that the firms are unable to access public equity markets for capital.

Table 4.4 provides an overview of the characteristics of these firms the year they enter and the year they exit the sample. We see that firms entering the sample have on average negative earnings growth and a lower than average investment growth. Furthermore, these firms are typically smaller than average. The year a firm exits the sample, its average earnings growth and investment growth have fallen considerably along with its market capitalization. In the literature, these are characteristics associated with increasing financial constraints.

Table 4.4: This table provides an overview of the characteristics of firms which both enter and exit the sample over the period July 1996 to December 2018. Market capitalization and total assets are denoted in MNOK.

	Year Entering Sample					Year Exiting Sample				
	Mean	**Stdv**	**Median**	**Min**	**Max**	**Mean**	**Stdv**	**Median**	**Min**	**Max**
Earnings growth	-0.10	4.76	0.07	-43.78	14.61	-0.43	7.16	-0.03	-55.72	25.03
Investment growth	0.16	0.27	0.15	-0.37	0.46	0.05	0.24	0.01	-0.37	0.46
Market capitalization	2,382	9,066	728	17	113,692	1,954	3,210	742	32	21,080
Total assets	3,170	8,091	776	26	83,315	3,219	6,670	877	25	44,056
Debt-to-Assets	0.52	0.19	0.55	0.05	0.93	0.58	0.19	0.61	0.04	1.02
Book-to-Market	0.92	0.87	0.75	0.03	5.76	1.04	1.16	0.71	0.00	7.40

Table 4.5 reports the number of firms classified as financially constrained and unconstrained in the year they enter and exit the sample. If the classification schemes capture changes in access to public equity markets, than each measure should see an increase the number of firms it classifies as constrained, relative to itself, when moving from the year of entry to the year of exit. Similarly, the number of unconstrained firms should decrease.

Table 4.5: This table reports the number of firms classified as financially constrained and unconstrained in the year they enter and exit the sample for each of the classification scheme.

	Size		**SA-Index**		**Composite I**		**Composite II**	
	(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
Year Entering Sample	71	25	101	14	53	23	50	47
Year Exiting Sample	92	14	62	30	74	15	57	36

We see that size and the Composite I respond correctly to the data, classifying more firms as constrained and less as unconstrained in the year of exit. The SA-Index moves the opposite way, decreasing the number of firms classified as constrained, while the Composite II Index moves slightly in the correct direction. This indicates that size and the Composite I Index best capture changes in firms access to equity markets over time, while it casts doubt on the ability of the SA-Index to correctly classify firms. A weakness of this simple test is that we are unable to separate whether changes in access to capital markets reflects frictions in financial markets or firm-specific problems.

Credit Markets

The Composite I and II Indexes both use debt-to-assets as a ranking metric, hence we cannot measure the effect of changes in access to credit markets independently for these classification schemes. We are left with the size and SA-Index, which we now explore in greater detail.

SA-Index

We start our investigation by constructing five decile portfolios using the SA-Index and 20% breakpoints. The portfolios range from the least to most constrained and the associated characteristics of each portfolio are reported in Table 4.6.

We see that the more constrained firms are both larger and younger than less constrained firms, and that they on average invest more. Specifically, we see that the most constrained

Table 4.6: In this table we use the SA-index to split the sample into five groups ranging from least to most constrained using 20% quantile breakpoints, and report the associated characteristics of each decile portfolio. Market capitalization and total assets are denoted in MNOK.

SA-Index	Book-to-Market	Profitability	Investment	Market capitalization	Total assets
Least constrained	0.93	0.20	0.11	9,825	9,578
2	0.97	0.18	0.27	10,574	9,785
3	1.12	0.12	0.25	7,698	9,474
4	0.90	0.16	0.60	25,359	12,328
Most constrained	0.61	-0.03	0.27	39,601	28,133
SA-Index	**Debt-to-Assets**	**Cash-to-Assets**	**Coverage ratio**	**Age**	**N**
Least constrained	0.56	0.10	12.27	18	380
2	0.60	0.11	13.58	12	366
3	0.59	0.13	8.47	7	366
4	0.55	0.17	11.40	5	366
Most constrained	0.44	0.24	0.87	4	376

have been able to finance almost half the asset growth through debt. Firms which are young and large with high investment rates must have good access to capital markets, which in turn means they are not financially constrained, making classification by the SA-Index contradictory. We note this same contradiction above, when the SA-Index decreases, the number of firms classified as constrained although less firms have access to equity markets. Using their SA-Index, Hadlock and Pierce (2010) find that size and age move together. Specifically, they find that financial constraints fall sharply as young and small firms start to mature and grow, and that eventually these relations level off. The SA-Index applied to our dataset shows age and size moving in opposite directions. Taken together, these considerations heighten our suspicions that the SA-Index is unable to correctly identify financially constrained firms when applied to Norwegian data.

Size

If size adequately captures financial constraints, we should find that constrained firms experience large increases in the cost of debt as they increase their debt-to-asset ratio relative to unconstrained firms. Campello and Chen (2010) find that the intensity of financial constraints likely varies with time and that they are more likely to bind in bad times. Thus, the slope of the supply curve of external capital should vary with time, being steeper in downturns and flatter in periods of growth. Specifically, constrained firms should experience larger increases in interest rates as they increase debt in bad times, relative to good times. Table 4.7 reports the characteristics of five decile portfolios, from least to most constrained, constructed using firm size.

Table 4.7: In this table we use the firm size to split the sample into five groups ranging from least to most constrained using 20% quantile breakpoints, and report the associated characteristics of each decile portfolio. Market capitalization and total assets are denoted in MNOK.

Size	Book-to-market	Profitability	Investment	Market capitalization	Total assets
Least constrained	0.60	0.26	0.22	88,880	57,271
2	0.78	0.19	0.53	4,967	7,506
3	0.97	0.13	0.35	1,567	2,959
4	1.06	0.22	0.29	617	1,503
Most constrained	1.12	-0.07	0.21	213	624
Size	**Debt-to-assets**	**Cash-to-assets**	**Coverage ratio**	**Age**	**N**
Least constrained	0.55	0.10	19.42	12	376
2	0.56	0.13	12.92	10	366
3	0.56	0.18	9.28	8	362
4	0.51	0.18	7.18	8	370
Most constrained	0.54	0.17	-2.14	7	380

We see that financially constrained firms are on average only slightly less levered than unconstrained firms. However, we make the following three observations. First, the cost of debt increases monotonically with size. Second, the variability of the cost of debt increases monotonically with size. Third, the variability of debt-to-assets increases monotonically with size. These observations indicate that the most constrained firms typically have debt of shorter maturities, and that the availability and cost of debt financing varies considerably more over time than for the least constrained firms. A simple test of the ability of size to capture differences in the supply curve of external capital between the most and least constrained firms, is to graph the average cost of debt and the average debt-to-asset ratios for the most and least and least constrained firms, as is done in Figure 4.2.

Figure 4.2 shows that the most constrained firms in general experience larger increases in their cost of debt when increasing the debt-to-asset ratio relative the least constrained firms. For example, from 2003 to 2004, the most constrained firms increased their debt-to-asset ratio from 48% to 53%, while the average cost of debt increased from 6.7% to 9%. In percentage terms, this means that a 10% increase in debt-to-assets triggered an approximately 35% increase in the cost of debt. Similarly, from 1996 to 1997, the least constrained firms saw an increase in debt-to-assets from 50% to 55%, followed by an increase in the cost of debt from 5% to 5.5%. This means that a 10% increase in debt-to-assets was followed by a 10% increase in the cost of debt. Furthermore, the figure shows that movements in the cost of debt relative to movements in the debt-to-asset ratios are more sensitive in bad times than good times. The results also indicate that the capital supply curve shows more time-variation for constrained firms than unconstrained firms.

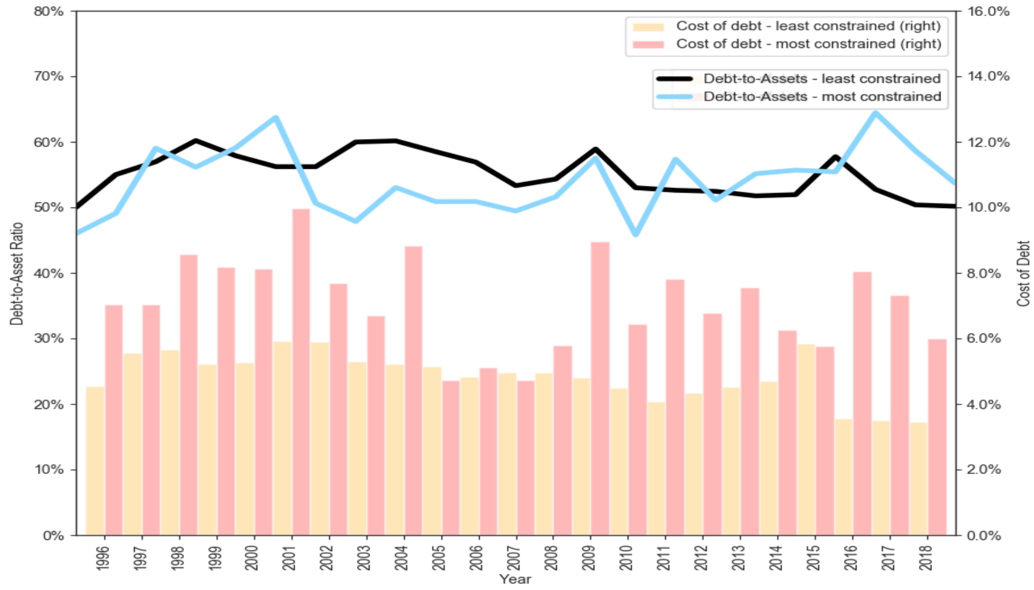


Figure 4.2: Illustration of the average cost of debt and the debt-to-asset ratio for the most and least constrained firms in our sample from July 1996 to December 2018. The debt-to-asset ratios are illustrated via the line graphs (LHS), while the cost of debt is illustrated via the bars (RHS). The cost of debt is defined as interest expenses over total liabilities.

These findings suggest that during economic and credit expansions, constrained firms increase their borrowing relatively more than unconstrained firms. According to Gertler and Bernanke (1989), these are periods in which the value of collateral increases, while agency costs and the external finance premium declines. Then during cyclical downturns, periods in which the value of collateral typically declines, and agency costs rise, they find it more difficult to borrow. Thus, as they repay their debt, and are unable to refinance to their previous debt levels, their debt-to-asset ratios decline. Taken together, it seems that the size classification scheme is able to identify both differences in the slope of the supply curve of external capital between constrained and unconstrained firms, and how this curve changes over time.

5 Results

5.1 Financial Constraints and Real Business Risk

In this section we look at whether financially constrained firms are fundamentally riskier than unconstrained firms. If financial constraints work a long the lines of Gertler and Bernanke (1989), then constraints have real business affects and serve to amplify and propagate economic shocks. We investigate this by regressing the yearly median real operating earnings- and investment growth of portfolios of constrained and unconstrained firms on various proxies of macroeconomic and credit market conditions. These proxies include the growth rates[20] of industrial production, the unemployment rate, the real oil price, the credit-to-GDP ratio and the two-year swap spread. The right-hand side variables are normalized so that they have zero mean and standard deviation equal to one. Furthermore, we sign all macro variables such that a positive change signals a deterioration in macroeconomic activity or credit market conditions.

Specifically, for each portfolio of constrained or unconstrained firms we regress the median real operating earnings- and investment growth γ_t, on the macroeconomic and credit market proxies, denoted $MACRO_t$. The change in the Norwegian policy rate, the trade-weighted NOK currency index and the ten-over-two-year US yield spread are included as control variables, denoted $CONTROL_t$. The regression equation is given by

$$\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t \tag{5.1}$$

Our main interest is in the size and sign of φ, in addition to the associated p-values, which are computed via Newey and West (1987) coefficients. In order to investigate whether financially constrained firms are riskier than unconstrained firms we must test whether the estimates of φ are significantly different for the two groups. We do this by subtracting the unconstrained from the constrained estimates of φ, resulting in a set of difference coefficients. Furthermore, following Campello and Chen (2010), we estimate the standard

[20] For industrial production, the unemployment rate, the oil price and the two-year swap spread we first calculate the monthly growth rates, then average these over the full year. For the credit-to-GDP ratio we calculate quarterly growth rates and average these over the full year, as this variable is published on a quarterly basis.

errors of these difference coefficients using a SUR-system.[21]

The fundamental regression results, estimated by Eq.5.1 are provided in Table 5.2. The table consists of two panels; Panel A reports the regression results when the median real operating earnings growth is used as the dependent variable, while Panel B reports the results when the median real investment growth is used as the dependent variable. We find two key results in this section.

First, the operating earnings- and investment growth of constrained firms decline more in response to adverse macroeconomic and credit market conditions than those of unconstrained firms, as demonstrated by the negative difference coefficients. During expansions this result is reversed. This means that financially constrained firms are fundamentally riskier than unconstrained firms. Furthermore, the results show that financing imperfections in Norway leads to heterogeneous firm responses to macroeconomic shocks, a result supported by several theoretical findings (see for example Gertler and Bernanke (1989), Carlstrom and Fuerst (1997), Bernanke et al. (1999), and Livdan et al. (2009)).

Second, we find that financial constraints are time-varying and bind more in downturns than expansions, as indicated by the negative difference coefficients. This means financially constrained firms behave in a significantly more procyclical fashion than unconstrained firms. These results are in line with Gertler and Hubbard (1988), Kashyap et al. (1994) and Gertler and Gilchrist (1994), who all show that credit constraints are time-varying and seem to bind more during recessions or when monetary policy is tight.

5.1.1 Earnings Growth

For constrained firms, the coefficients on industrial production, unemployment and credit-to-GDP are negative for all classification criteria. This means that a fall in industrial production and credit-to-GDP, or a rise in unemployment leads to a reduction in the real operating earnings of constrained firms. The oil price coefficient is negative and significant for three out of four regressions, a result we discuss in detail below. For the size group, an oil price coefficient of -0.16 means that for a one standard deviation fall in the average

[21] For details, see appendix section A3.

growth rate of the oil price, the real earnings growth of constrained firms falls by sixteen percent. Surprisingly, the coefficient on the swap spread is positive and significant in three out of four cases.

For unconstrained firms, the sign on the industrial production-, unemployment-, credit-to-GDP-, and swap spread coefficients are negative. This means that the real earnings growth of unconstrained firms falls unequivocally in response to adverse macroeconomic and credit-market conditions. We note that the coefficients are generally smaller and less significant than for constrained firms. The oil price coefficient is positive in three of the regressions, however the coefficients are not significant and close to zero for all cases.

The difference coefficients indicate that constrained firms are more procyclical than unconstrained firms. In Table 5.2 for example, the coefficient for industrial production equals -0.08 for financially constrained firms and -0.04 for unconstrained firms. This means the operating earnings of constrained firms are two times more procyclical than the operating earnings of unconstrained firms. The direct interpretation is that for a one standard deviation decline in industrial production, the decline in the real operating earnings growth of financially constrained firms is 8% per year, while for unconstrained firms it is 4%. The difference coefficients are negative for all variables except the swap spread and thirteen of the twenty difference coefficients are significant.

The swap spread coefficients in Table 5.2 indicate that the operating earnings of financially constrained firms increase when credit conditions worsen, a result we do not find economically reasonable. Furthermore, this contradicts our findings for the credit-to-GDP variable. We re-run the regression in Table 5.2, omitting 2008 and 2009 from the dataset to check whether the positive coefficients are driven by abnormal movements during the financial crises. The coefficients on the swap spread, as estimated by each of the classification criteria, are reported in Table 5.1.

Table 5.1: Earnings growth coefficient on the two-year swap spread, ex. 08-09
This table reports the earnings growth coefficients on the two-year swap spread as estimated by the various classification schemes after re-running the fundamental regression equation $\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t$, and omitting all observations in 2008 and 2009 from the dataset. The original results are reported in Table 5.2, while the full regression tables excluding 2008 and 2009 are reported in the appendix section A6.

	Size		**SA-Index**		**Composite I**		**Composite II**	
	(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
Swap Spread	-0.01	-0.06***	-0.02	-0.04**	0.00	-0.05**	-0.01	-0.05**
p-value	(0.11)	(0.00)	(0.57)	(0.03)	(0.23)	(0.03)	(0.14)	(0.02)

We see that the swap spread coefficient for constrained firms now varies between 0.00 and -0.02, depending on the classification scheme. Furthermore, the coefficients on the other macro and credit variables do not change meaningfully, leaving our previous conclusions intact, see appendix A6. This indicates that the positive swap spread coefficients were primarily driven by a period of positive correlation between earnings and the swap spread for at least some financially constrained firms from 2008-2009.

5.1.2 Investment Growth

The investment responses to changes in the macroeconomic and credit market conditions are in general smaller and less significant than for operating earnings. The coefficients on industrial production, unemployment and credit-to-GDP are either negative or zero for both constrained and unconstrained firms. However, the coefficients for constrained firms are in general smaller than those of unconstrained firms, resulting in negative difference coefficients. Only three of the sixteen difference coefficients are positive, however these are not significant. We also note that only four difference coefficients are significant but these are all negative. Thus, although the results for investment growth are statistically weaker, they still point to financially constrained firms being fundamentally riskier than unconstrained firms.

Table 5.2: Responses of Business Fundamentals to Macroeconomic Shocks
This table provides the results from regressing the median real operating earnings- and investment growth of portfolios of constrained and unconstrained firms on various macroeconomic and credit market variables. The results are provided in Panel A and B respectively. Specifically, the regression equation is given by $\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t$. The macroeconomic and credit market variables include the growth rates of industrial production (Ind Prod), the unemployment rate (Unempl), the oil price, the credit-to-GDP ratio (Credit/GDP) and the two-year swap spread (Swap Spread). The control variables include the change in the Norwegian policy rate, the trade-weighted NOK currency index and the ten-over-two year US yield spread. See section 3.1 and 3.2 for a further elaboration on the macroeconomic variables, and section 4.1.1 and 4.2 for the construction of the various classification schemes. The right-hand side variables are normalized so they have zero mean and standard deviation equal to one. The independent variables are signed such that a positive value represents a worsening of macroeconomic conditions or tightening of credit markets. Difference coefficients across regressions are estimated via a SUR-system. The p-values of the original coefficients are reported in the parenthesis and are computed via Newey and West (1987) coefficients. The 10%, 5%, and 1% significance level is given by *, ** and *** respectively.

Panel A: Earnings Growth

		Macroeconomic Variables				
Financial Constraints Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size						
Constrained	(C)	-0.08**	-0.19***	-0.16***	-0.12**	0.11**
		(0.05)	(0.00)	(0.00)	(0.04)	(0.02)
Unconstrained	(U)	-0.04	-0.09***	0.02	-0.03	-0.16***
		(0.16)	(0.00)	(0.49)	(0.34)	(0.00)
Difference	(C) - (U)	-0.04	-0.10**	-0.18***	-0.09*	0.27***
		(0.44)	(0.05)	(0.00)	(0.09)	(0.00)
SA-Index						
Constrained	(C)	-0.04	-0.14***	-0.05	-0.11***	0.06
		(0.12)	(0.00)	(0.14)	(0.00)	(0.18)
Unconstrained	(U)	-0.02	-0.07***	0.01	-0.05***	-0.01
		(0.51)	(0.00)	(0.87)	(0.00)	(0.43)
Difference	(C) - (U)	-0.02	-0.07*	-0.05	-0.06	0.07**
		(0.16)	(0.07)	(0.26)	(0.15)	(0.04)
Composite I						
Constrained	(C)	-0.12***	-0.22**	-0.19***	-0.30***	0.15*
		(0.00)	(0.05)	(0.00)	(0.01)	(0.07)
Unconstrained	(U)	-0.02	-0.04***	0.01	-0.11	-0.03***
		(0.48)	(0.00)	(0.69)	(0.9)	(0.00)
Difference	(C) - (U)	-0.10	-0.18**	-0.20***	-0.19***	0.18***
		(0.14)	(0.02)	(0.01)	(0.00)	(0.00)
Composite II						
Constrained	(C)	-0.24	-0.12***	-0.13***	-0.25***	0.17***
		(0.12)	(0.00)	(0.01)	(0.00)	(0.01)
Unconstrained	(U)	-0.01	-0.03	-0.02	0.00	-0.03
		(0.74)	(0.16)	(0.22)	(0.98)	(0.24)
Difference	(C) - (U)	-0.23	-0.09***	-0.11	-0.25***	0.20***
		(0.15)	(0.01)	(0.17)	(0.00)	(0.00)

Panel B: Investment Growth

		Macroeconomic Variables				
Financial Constraints Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size						
Constrained	(C)	0.00	-0.07***	-0.03**	-0.04*	-0.01
		(0.88)	(0.00)	(0.04)	(0.09)	(0.65)
Unconstrained	(U)	-0.01*	-0.04***	0.00	-0.02	0.00
		(0.08)	(0.00)	(0.76)	(0.18)	(0.64)
Difference	(C) - (U)	0.01	-0.03**	-0.02	-0.02	-0.01
		(0.71)	(0.03)	(0.20)	(0.32)	(0.73)
SA-Index						
Constrained	(C)	-0.03***	-0.03***	-0.02	-0.05***	0.00
		(0.00)	(0.01)	(0.29)	(0.00)	(0.77)
Unconstrained	(U)	0.00	-0.03***	-0.02	-0.02***	0.00
		(0.51)	(0.00)	(0.87)	(0.00)	(0.43)
Difference	(C) - (U)	-0.03***	0.00	0.00	-0.03**	0.00
		(0.00)	(0.71)	(0.90)	(0.05)	(0.55)
Composite I						
Constrained	(C)	-0.04**	-0.04***	-0.03**	-0.06***	0.00
		(0.03)	(0.01)	(0.03)	(0.00)	(0.57)
Unconstrained	(U)	-0.01	-0.04***	-0.01	-0.02	0.00
		(0.34)	(0.00)	(0.75)	(0.39)	(0.67)
Difference	(C) - (U)	-0.03	0.00	-0.02	-0.04*	0.00
		(0.20)	(0.88)	(0.19)	(0.08)	(0.75)
Composite II						
Constrained	(C)	-0.02	-0.03*	-0.02	-0.06*	0.01
		(0.54)	(0.09)	(0.20)	(0.07)	(0.14)
Unconstrained	(U)	0.00	-0.05***	-0.01*	-0.03	0.00
		(0.83)	(0.00)	(0.09)	(0.45)	(0.69)
Difference	(C) - (U)	-0.02	0.02	-0.01	-0.03	0.01
		(0.33)	(0.34)	(0.69)	(0.31)	(0.89)

5.1.3 The Oil Price

In Panel A we see that the oil price coefficients for earnings growth are negative and statistically significant for constrained firms, while for unconstrained firms they are not significantly different from zero. In Panel B, the oil price coefficient on investment growth is either negative or zero and slightly larger for constrained firms, resulting in negative but insignificant difference coefficients. These results can be explained in two parts.

First, the companies which are classified as both oil companies and financially constrained are almost entirely oil service companies, rather than oil exploration and production companies. Examples include offshore suppliers, seismic companies and companies providing various engineering solutions. These companies derive their earnings from the oil companies' capital expenditures. Oil companies will change their capital expenditures in response to changes in the oil price. A sharp reduction in the oil price usually leads to reductions in capital spending, and the percentage drop in capital spending is often larger than the percentage drop in the oil price. Small oil service companies typically have shorter contract durations, but large fixed costs. When oil companies reduce capital spending there are fewer contracts to compete for, making contract bids more competitive. In addition, fewer firms receive contracts at all. Since the firms must cover their fixed costs, operating earnings typically drop considerably in periods with low oil prices.

Unconstrained firms also classified as oil companies include a mix of oil exploration and production companies and large oil service companies. An oil exploration and production company will typically experience a loss in operating profits in proportion to the fall in oil price, usually avoiding an acute drop in operating earnings. Larger oil service companies will typically have both longer contracts and more pricing power to compete for the available contracts. The effect of lower capital spending therefore takes a longer time to reduce earnings for large oil service companies. Thus, these firms do not impact the unconstrained sample in the extreme way in which constrained oil companies affect their sample.

Second, non-oil companies classified as constrained are more sensitive to the oil price than non-oil companies classified as unconstrained. We re-run the regressions in Table 5.2, omitting oil companies from the sample. The oil price coefficients are reported in Table 5.3 for both earnings- and investment growth, while the full regression table is reported in the appendix section A5.

Table 5.3: Earnings- and investment growth excluding oil companies
This table reports the earnings- and investment growth coefficients for the oil price as estimated by the various classification schemes after re-running the fundamental regression equation $\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t$, and excluding oil companies from the dataset. The original regression results are reported in Table 5.2, while the full regression tables with oil companies omitted are reported in the appendix section A5.

	Size		**SA-Index**		**Composite I**		**Composite II**	
Earnings Growth	(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
Oil Price	-0.07***	0.03	-0.01	0.03	-0.08***	0.05***	-0.06	0.00
p-value	(0.00)	(0.90)	(0.13)	(0.70)	(0.00)	(0.00)	(0.23)	(0.68)

	Size		**SA-Index**		**Composite I**		**Composite II**	
Investment Growth	(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
Oil Price	-0.01***	0.00	0.00	0.01	-0.01	0.02*	0.00	0.03
p-value	(0.00)	(0.84)	(0.11)	(0.23)	(0.16)	(0.10)	(0.79)	(0.51)

For constrained firms, the coefficient on the oil price increases, however it is still negative and significant. The oil price coefficient for unconstrained firms also increases slightly, however remains positive and insignificant. As discussed in section 3.1, a positive oil price shock tends to increase GDP over the following year, i.e. a positive aggregate demand effect. The higher oil price sensitivity of financially constrained non-oil companies likely captures that these firms are more sensitive to changes in aggregate demand. This is the same conclusion we draw from the industrial production and unemployment variables.

5.1.4 A Comparison of Financial Constraints in Norway and the US

We compare our difference coefficients from Table 5.2 with those of the US, as reported by Campello and Chen (2010), to investigate whether differences in economic environments and time periods materially impact the real effects of financial constraints. In Table 5.4 we report the average difference coefficients across all classification criteria for Norway and the US. Note that our classification criteria are partly different from those of Campello and Chen.[22] Additionally, the credit variables we use are not directly comparable to those of Campello and Chen, hence we focus on industrial production and unemployment.

Our main conclusion from this section is that the economic environment, nor time period seem to have material impacts on the real effects of financial constraints. We see this by noting that as measured by operating earnings, constrained firms in Norway are more procyclical then their US counterparts. However, as measured by investments, constrained firms in the US are more procyclical than constrained firms in Norway.

Table 5.4: This table reports the average difference coefficients on industrial production and unemployment/employment for Norway and the US. The average difference coefficients for Norway are calculated from 5.2. The US results are calculated by averaging Campello and Chen (2010)'s difference coefficient estimates. Campello and Chen (2010) use firms listed on the NYSE, NASDAQ, and AMEX from January 1963 to December 2006, while we use firms listed on the OSE from July 1996 to December 2018.

	Norway		**US**	
	Earnings	Investment	Earnings	Investment
Industrial Production	-0.098	-0.018	-0.055	-0.030
Unemployment/ Employment	-0.110	-0.003	-0.035	-0.023

[22]The financial constraint criteria used in their analysis are the KZ-Index, size, the Composite I Measure (the KZ-Index, size, coverage ratio, and dividend payout ratio) and the Composite II Measure (coverage ratio, dividend payout ratio, commercial paper rating, and bondrating). Both composite measures are computed with the same algorithm as this study. See section 2.4 for definition of the KZ-Index.

The coefficients in Table 5.4 are interpreted equivalently to the coefficients in Table 5.2. For example, the earnings growth of constrained firms in Norway fall on average by 9.8% more than the earnings growth unconstrained firms in response to a one standard deviation fall in industrial production. The corresponding number for the US is 5.5%. We note that in Norway the difference coefficients are most sensitive to unemployment, while in the US they are most sensitive to industrial production. The higher sensitivity to employment in Norway may be due to differences in the employment measures used,[23] the difference in sample periods, or differences in classification schemes. Importantly, our sample includes the financial crisis, while Campello and Chen's sample does not.

We note that the higher sensitivity of investment growth in the US may be due to differences in the way firms obtain debt financing. In Europe, bank lending is the most important source of debt funding, while in the US, bond markets are dominant.[24] This would in turn mean that when macroeconomic conditions worsen, financing new investments with debt is more expensive in the US than in Europe, causing higher investment sensitivities to changing economic conditions in the US. A further investigation into the viability of this explanation is beyond the scope of this thesis and we leave it to future research. The relatively smaller magnitude of the difference coefficients on industrial production in Norway may also reflect that we include the oil price in our analysis, while Campello and Chen (2010) does not.

5.1.5 Conclusions from Financial Constraints and Real Firm Performance

In sum our results show that financially constrained firms are fundamentally riskier than unconstrained firms in the sense that they exhibit stronger covariation with systematic factors than unconstrained firms. Furthermore, our results indicate that financial constraints are time-varying and that they bind the most in downturns. These findings are consistent with theories which emphasize the role of financial frictions in amplifying and propagating economic shocks. Our results are also in line with what Campello and Chen (2010) find for their US sample. Specific to Norway, we find a negative relationship between financial constraints and the oil price, such that when the oil price is low, financial

[23] We use monthly NAV-numbers, while Campello and Chen (2010) use non-farm payrolls.
[24] See Farrell et al. (2005) and Brecht (2015).

constraints seem to bind more and when the oil price is high, financial constraints bind less. We show that one part of this result stems from the market structure of the oil sector, which leads to heterogeneous responses in the financial positions of firms following an oil price shock. Our results indicate that the other part of this negative relationship is a consequence of constrained firms being more sensitive to economic fluctuations than unconstrained firms.

5.2 The Financial Constraint Factor

The real-side results show that financially constrained firms are fundamentally riskier than unconstrained firms, which according to standard asset pricing theory, should be reflected in asset valuations in the form of a financial constraint factor. Specifically, we expect constrained firms to earn a positive risk premium over unconstrained firms reflecting the fact that investors require higher returns to hold the stocks of riskier firms. In this section we investigate whether we can identify such a financial constraint factor in Norwegian securities markets.

To construct the financial constraint factor we calculate both value-weighted and equal-weighted monthly stock returns for portfolios of constrained (C), middle (M), and unconstrained (U) firms for each of the classification schemes. We then subtract the returns of the constrained portfolio from the unconstrained portfolio and average this difference over the sample period. These are the one-way sorted results, which are reported on the left-hand side of Table 5.5 for each of the classification schemes separately.

We follow the asset pricing literature and report double-sorted financial constraint premiums using book-to-market portfolios. Specifically, we sort firms into three book-to-market categories, high (H), middle (M) and low (L), using 30% and 70% cutoffs and then interact the financial constraint categories (C, M, U) with the book-to-market categories (H, M, L), creating nine portfolios. We then calculate the book-to-market neutralized constraint factor as ((CH + CM + CL) – (UH + UM + UL))/3, where for example, CL represents the monthly equity return of a portfolio of constrained firms with low book-to-market values. Note that the book-to-market portfolios do not change; however, the constrained and unconstrained portfolios change depending on the classification scheme.

These results are the book-to-market neutralized results, which reported one the right-hand side of Table 5.5 for each of the classification schemes separately.

The first key result from Table 5.5 is that the real risk associated with financial constraints are priced in the stock market in the form of a financial constraint factor. For example, for portfolios created by the Composite I Index, we find that the yearly growth in operating earnings of constrained firms fall on average by 10% more than those of unconstrained firms in response to negative macroeconomic shocks. On the financial side, the stocks of the same portfolio of constrained firms will earn on average 1.3% more than the unconstrained portfolio per month, which amounts to a 15.6% risk-premium per year. We note that all the financial constraint premiums are positive when they are book-to-market neutralized, and six of the eight premiums are significant. In total, only two of the sixteen risk premiums are negative.

As a specific example of the real-financial connection we use portfolios constructed with the Composite I Index and look at how the operating earnings- and investment growth of constrained and unconstrained firms change from 2007 to 2008, and how these changes were reflected in financial markets. The results are reported in Table 5.6. We see that both operating earnings and investment fall more for constrained than unconstrained firms in response to adverse macroeconomic and credit market conditions. This is reflected in financial markets as the stock returns of constrained firms fall by 8%, while the returns of unconstrained firms only fall by 5%, which indicates that the size of the financial constraint factor declines in downturns but remains positive.[25]

Table 5.6: This table illustrates the real-financial connection by looking at the change in the operating earnings- and investment growth rates for constrained and unconstrained firms, relative to the change in stock returns from 2007 to 2008. The growth rates and financial returns are based on portfolios constructed with the Composite I Index.

	2007		**2008**		**Difference**	
	(C)	(U)	(C)	(U)	(C)	(U)
Operating Earnings	0.15	0.34	0.00	0.22	-0.15	-0.12
Investment	0.14	0.18	0.06	0.15	-0.09	-0.03
Average Monthly Stock Returns	0.03	0.00	-0.05	-0.06	-0.08	-0.05

[25] Specifically, in 2007 the monthly size of the financial constraint factor was on average 3% (0.03-0.00), while in 2008 it was on average 1% (-0.05-(-0.06)), as estimated by the Composite I Index.

Table 5.5: We report the financial constraint factor and associated t-statistics as estimated by each of the four classification schemes for both the one-way and double-sorted cases. Panel A reports the financial constraint factor calculated using value-weighted stock returns, while Panel B reports the financial constraint factor for equal-weighted stock returns. The sample period covers July 1996 to December 2018. We denote the 10% , 5% and 1% significance level by *, ** and *** respectively.

	One-Way Sorted				**Neutralized with Book-to-Market**			
	Size	**SA-Index**	**Composite I**	**Composite II**	**Size**	**SA-Index**	**Composite I**	**Composite II**
Panel A: Weighted Average								
Monthly risk premium	0.015***	-0.002	0.013***	0.007	0.012***	0.008*	0.016***	0.008*
t-statistic	4.04	-0.66	2.72	1.56	3.16	1.94	3.98	1.85
Yearly risk premium	0.180	-0.024	0.156	0.084	0.144	0.096	0.228	0.096
Panel B: Arithmetic Average								
Monthly risk premium	0.004	0.004	0.003	-0.001	0.003	0.009***	0.008	0.004
t-statistic	0.97	1.31	0.71	-0.12	0.67	2.73	1.13	0.82
Yearly risk premium	0.048	0.048	0.036	-0.012	0.036	0.108	0.096	0.048

The second key result is that the size effect represents a large component of the financial constraint premium. In financial literature, the size effect refers to the observation that smaller firms earn on average higher returns than larger firms after controlling for market risk, as first observed by Banz (1981). The literature generally views the size effect as a proxy for risk, however no consensus has emerged on the underlying source of risk. Several researchers suggest that size is a proxy for a firm's degree of financial constraints, see for example Livdan et al. (2009) and Gertler and Gilchrist (1994). Liu (2006) argues that the premium reflects the lower stock market liquidity of smaller stocks and suggests investors require higher returns for accepting the liquidity risk. Zhang (2006) suggests that size may also reflect information uncertainty, as smaller firms typically provide poorer overall information to investors.

We illustrate the size effect on our results by changing the ranking variables in the one-way sorted Composite I Index. First, we omit the size variable from the ranking procedure. The risk premium falls to 0.011, remaining significant at the 0.05-level. The Composite I Index still contains a total assets component, which is strongly linked to firm size. Removing total assets leaves us with age, leverage-to-assets, cash-to-assets and the coverage ratio as the ranking variables. The risk-premium falls to 0.009 with a p-value of 0.07. Dropping the age variable leaves us at Composite II. The declining risk-premiums suggest that the size effect drives much of the results. However, the book-to-market neutralized Composite II Index does have a positive and significant risk-premium, indicating that size is not the only effect driving the results.

Since the Composite I- and the SA-Index both contain a size component, while the Composite II Index does not, the results more strongly lean towards financial constraints being priced if one accepts size as a good measure of financial constraints. However, if one views firm-specific characteristics such as cash, leverage, and interest coverage as the key factors, while size being a proxy for other risk factors, then the results do not necessarily indicate a financial constraint risk premium.

The double sorting procedure, using book-to-market, is done to isolate financial constraint factor from confounding effects. To see this, note that high book-to-market firms earn a positive risk premium over low book-to-market firms in our sample, see Table 5.8. The observation that high book-to-market firms earn higher returns than low book-to-market firms after controlling for market risk and size, is known as the value effect (Fama and French (2015, 1993, 1992); Chen and Zhang (1998)). The literature has proposed two main explanations for the value effect, although several others exist. First, Fama and French (1992) suggest that the value effect exists because book-to-market reflects a firm's degree of financial distress risk. They show that firms with high book-to-market values typically have earnings problems and relatively high levels of financial leverage. This explanation contends that the premium attached to value firms (high BE/ME) are the rational result of the higher financial distress risk inherent in these firms. The second explanation suggests that the effect is due to irrational pricing as investors become overly optimistic or pessimistic about the prospects of firms exhibiting certain "growth-or value-related" characteristics (Lakonishok et al. (1994); Daniel and Titman (1997)). Dichev (1998) and Griffin and Lemmon (2002) find evidence suggesting that the mispricing associated with BE/ME exists even after controlling for bankruptcy risk.

For the one-way sorted sample, a part of the risk-premium found in Table 5.5 is not attributable to financial constraints, but rather to the value effect, likely reflecting either financial distress, investor irrationality or both. Double sorting removes this extra effect. We therefore view the book-to-market neutralized financial constraint premiums as the most important in Table 5.5. For example, we find that small firms have high book-to-market values while large firms have lower book-to-market values. The difference in returns between small and large firms can therefore in part be attributed to the value effect. Double sorting adjusts for this effect such that the constraint factor for size should fall, which we see is the case. On the other hand, unconstrained firms classified by the SA-Index have higher book-to-market values than constrained firms, see Table 4.3. Double sorting should should then increase the financial constraint premium because the value effect favors unconstrained firms, which we see is the case.

Livdan et al. (2009)'s theoretical model predicts that constrained firms have higher leverage and lower liquidity than unconstrained firms. As discussed in section 4.3.2 this does not seem to be the case in our sample. Nonetheless, we test the prediction by reversing our leverage and cash variable rankings and re-calculate the financial constraint premium for the Composite II Index. This means firms with lower leverage and higher cash holdings are ranked as less financially constrained. In this case the risk premium is negative and not significant.

The SA-Index aims to capture the non-linear relationship between size, age and financial constraints. For the SA-Index, the fundamental regression gives some indication that constrained firms are more risky than unconstrained firms, leading us to expect a positive risk premium. On the other hand, the descriptive statistics of constrained and unconstrained firms classified by the SA-Index lead us to expect a negative financial constraint premium, see Table 4.3, which is the case for the market weighted financial constraint premium. However, neutralizing with book-to-market results in a marginally positive and significant risk premium. The equal-weighted financial constraint factor is also positive and becomes strongly significant when neutralizing with book-to-market. It seems that the SA-Index captures some non-linearities in the data which are not reflected in the descriptive statistics. We view these results as mixed and difficult to interpret.

5.3 Macroeconomic Shocks and the Financial Constraint Factor

In this section we examine whether the financial constraint factor is correlated with macroeconomic and credit market conditions. We do this by regressing the various estimates of the financial constraint factor on proxies of the macroeconomic and credit market conditions. There are two reasons why these regressions are interesting. First, the regressions check for consistency. Ex-ante, we expect the coefficients to have the same sign as in the fundamental regression. For example, an increase in the unemployment rate decreases the operating earnings of financially constrained firms more than those of unconstrained firms. This means that the stock prices of financially constrained firms should fall more than the stock prices of unconstrained firms, which would in turn decrease the size of the financial constraint factor. Second, the first moment of the return generating process, i.e. the financial constraint factor, is much more sample-dependent and therefore harder to measure precisely than higher moments of the return generating process, see Merton (1980). Thus, regression-based tests that revolve around higher moments such as covariances will serve as a quality check to the risk-premiums found earlier.

Specifically, we use the same macroeconomic-, credit market- and control variables[26] as in the real-side regression estimated by Eq.5.1, and sign all explanatory variables such that a positive change signals a deterioration in macroeconomic activity or credit market conditions. The equity return data now allows us to work with monthly frequency. Following Campello and Chen (2010), we include two lags and report the summed coefficients per quarter. The following model of factor returns is estimated

$$FC_t = \alpha + \sum_{i=0}^{2} \beta_i \times \triangle MACRO_{t-i} + \lambda CONTROL_t + \varepsilon_t \tag{5.2}$$

where FC_t is the financial constraint factor as estimated by one of the classification schemes, $\triangle MACRO_t$ denotes the change[27] in the macroeconomic and credit market variables, and $CONTROL_t$ denotes the control variables. We estimate Eq.5.2 for each of the four classification schemes and report the sum of the macro-variable lag coefficients and associated p-values[28] in Table 5.7. The results for the one-way sorted financial constraint factors are reported on the left-hand side, while the size-neutralized[29] results are reported on the right-hand side. The financial constraint factor used in Panel A is constructed using value-weighted stock returns, while the constraint factor in Panel B is constructed using equal-weighted stock returns. We find three key results in this section.

First, the results provided in Panel A indicate that size is the most consistent variable in capturing financial constraints in the data. For the size-based constraint factor, all variables are significant, and all variables have the same sign as in the fundamental regression, which means that the real- and financial results are consistent. The interpretation of the coefficients is straight forward; a one percent fall in the growth rate of industrial production leads to a reduction in the financial constraint factor of 0.62 percent over the following quarter. When double-sorting, the financial constraint factor should be

[26]The macroeconomic and credit market variables include industrial production, the unemployment rate, the oil price, the credit-to-GDP ratio and the two-year NOK swap spread. The control variables includes the change in the Norwegian policy rate, the ten-over-two year US yield spread, and the NOK trade-weighted currency index.

[27]For industrial production, the unemployment rate, the oil price and the two-year swap spread we use monthly growth rates, while for the credit-to-GDP ratio we use quarterly growth rates since it is only published at a quarterly frequency.

[28]The p-values are calculated using a Chi-square test with the null hypothesis that the sum of the contemporaneous and two lagged coefficients are equal to zero.

[29]The size-neutralized financial constraint factors are calculated in the same way as the book-to-market neutralized constrained factors, replacing the book-to-market portfolios with size portfolios, see section 5.2 for details.

redundant since its effect is absorbed by the endogenous variable size. We see that there is some reduction in the size and significance of the coefficients, but the double-sorting effect is marginal as the results were not strong to begin with. The equal-weighted financial constraint premiums reported in Panel B are the strongest for the Composite I and II Indexes. In this case, neutralizing with size reduces almost all significance, as expected, which supports the theoretical prediction that size and financial constraints are determined endogenously and thus, that size is a good proxy for financial constraints.

Second, the results indicate that the stock returns of financially constrained firms underperform those of unconstrained firms in downturns and periods of tight credit conditions, i.e. when financial constraints bind the most, and outperform in expansions, when constraints bind the least. To see this, note that the coefficients in Table 5.7 are generally negative, which means that the size of the financial constraint factor declines during downturns, reflecting the poorer earnings- and investment prospects of constrained firms relative to unconstrained firms. We illustrate the covariation between the financial constraint factor and macroeconomic conditions directly in figures 5.1 and 5.2, where we plot the cumulative returns of portfolio's of constrained and unconstrained firms over time. We see that on average constrained firms earn a risk premium over unconstrained firms, however, this premium declines during recessions and increases during expansions, indicating that the financial constraint factor covaries with macroeconomic and credit market conditions. In general, the evidence of a link between macroeconomic variables and the financial constraint factor have been mixed. For example, Campello and Chen (2010) find a clear connection, while Lamont et al. (2001) find only marginal evidence of such a link.

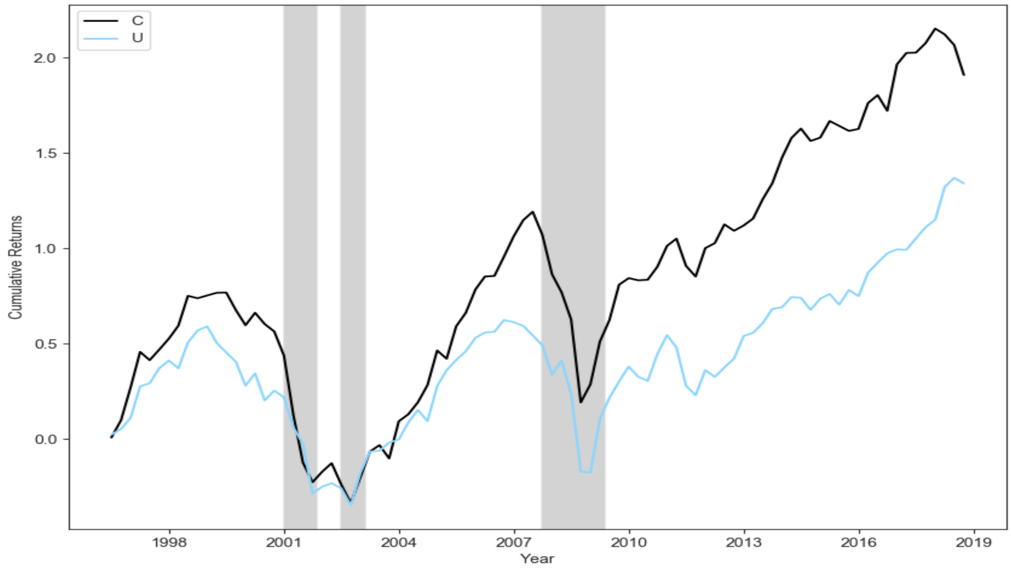


Figure 5.1: An illustration of the cumulative returns of constrained and unconstrained firms classified by **size** from July 1996 to December 2018. The shaded areas are periods of recession in Norway, as identified by Aastveit et al. (2016). The difference between the constrained and unconstrained cumulative returns equals the cumulative returns of the financial constraint factor.

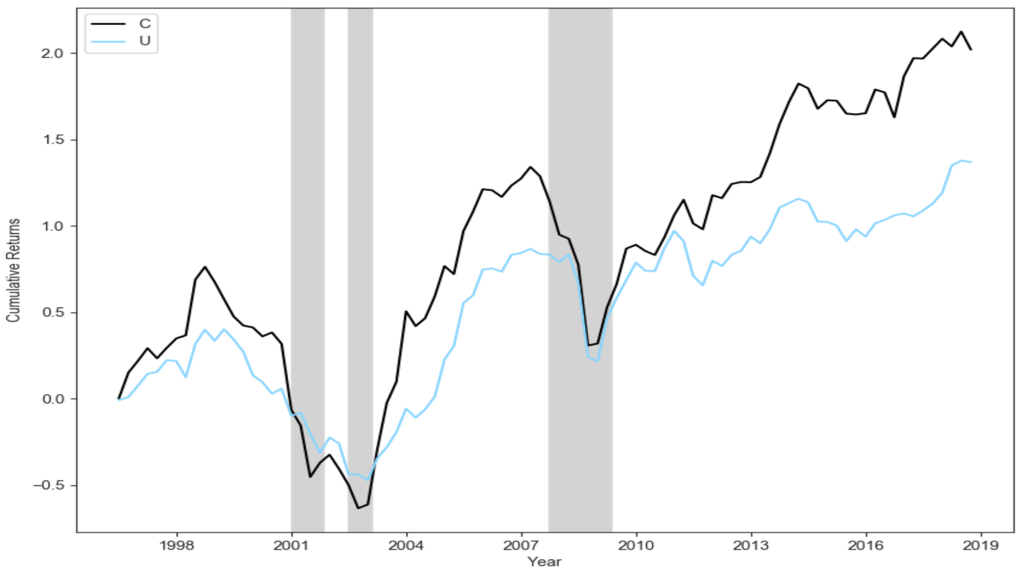


Figure 5.2: An illustration of the cumulative returns of constrained and unconstrained firms classified by the **Composite I Index** from July 1996 to December 2018. The shaded areas are periods of recession in Norway, as identified by Aastveit et al. (2016). The difference between the constrained and unconstrained cumulative returns equals the cumulative returns of the financial constraint factor.

Third, as pointed out by Campello and Chen (2010) the relationship between real business fundamentals, the financial constraint factor and macroeconomic variables indicate a macroeconomy-equity valuation channel that works along the lines of Gertler and Bernanke (1989). For example, a negative macroeconomic shock will reduce the equity valuation of all firms as future expected cash flows decline. However, for financially constrained firms, the reduced net worth will increase agency costs, increasing the external finance premium, decreasing investments, and thus, exacerbating the downturn. Specifically, there are likely two accelerator effects tied to equity valuations.

First, assume a financially constrained firm experiences a notable decline in its share price in response to a macroeconomic shock. The reduction in market value means the implied value of the firms assets are lower, which means the implied value of collateral is lower, which according to Gertler and Bernanke (1989) should raise agency costs and the external finance premium, reducing investment and earnings growth. As this same chain of reactions takes place collectively for all constrained firms, the downturn is exacerbated, which leads to a further fall in stock prices, resulting in a financial accelerator effect. Second, all else equal, a lower share price means that a lower fraction of projects can be financed by issuing equity. This in turn means that either fewer projects are initiated, or a larger fraction of projects must be financed with debt. However, as Hall (2001) notes, the borrower's stake in an investment project serves as a signal to lenders of the borrower's likely incentive to default. Borrowers with low stakes in a project will have to pay higher costs of debt to offset the greater likelihood of default. This in turn means the firm receives a lower part of the project payoff. Thus, whether the project is initiated or not, future expected cash flows fall, which in turn should lower the stock price again.

These accelerator effects are likely an important part of the reason that the operating earnings- and investment growth of constrained firms decline significantly more than those of unconstrained firms in response to macroeconomic shocks. We note from Figure 4.2 that the debt-to-asset ratios of constrained firms decline much more than those of unconstrained firms in downturns. The reductions in debt-to-assets are in general smaller than the reductions in equity values, but an accelerator affects along the lines of Gertler and Bernanke (1989) may be present on the debt side as well.

Table 5.7: This table reports the results from estimating the equation: $FC_t = \alpha + \sum_{i=0}^{2} \beta_i \times \triangle MACRO_{t-i} + \lambda CONTROL_t + \varepsilon_t$, where FC_t is the financial constraint factor as estimated by each classification scheme, $\triangle MACRO_t$ denotes the growth rate of industrial production (Ind Prod), the unemployment rate (Unempl), the oil price, credit-to-GDP (Credit/GDP) and the two-year swap spread (Swap Spread), and $CONTROL_t$ denotes the control variables including the change in the Norwegian policy rate, the NOK trade-weighted currency index and the US ten-over-two year yield spread. For each regression, we report the sum of the macro-variable lag coefficients and the associated p-values. We calculate the p-values using a Chi-square test, with the null-hypothesis that the sum of the contemporaneous and two lagged coefficients are equal to zero. See section 3.1 and 3.2 for computation and definitions of the variables. We report the results for the one-way sorted and size-neutral portfolios, where the latter are constructed in the same way as the BM-neutralized portfolios, see section 5.2, swapping size with book-to-market. Panel A calculates the financial constraint factor using value-weighted stock returns, while Panel B uses equal-weighted stock returns. We denote the 10% , 5% and 1% significance level by *, ** and *** respectively.

Panel A: Factor Returns Value-Weighted

	One-Way Sorted					Size-Neutral				
Financial Constraints Criteria	**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**	**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size										
$\sum \beta$	-0.62*	-0.73**	-1.65**	-4.02**	0.88***					
p-value	(0.10)	(0.03)	(0.03)	(0.02)	(0.00)					
SA-Index										
$\sum \beta$	-6.79**	1.04	-0.43	1.34	-0.03	-9.75**	1.58	0.85	-1.40	-0.33
p-value	(0.05)	(0.30)	(0.82)	(0.78)	(0.95)	(0.01)	(0.17)	(0.69)	(0.80)	(0.61)
Composite I										
$\sum \beta$	-3.08	-1.13	-2.24	-1.60	0.86**	-3.33	-0.91	-1.84	-2.31	0.82
p-value	(0.26)	(0.15)	(0.13)	(0.67)	(0.05)	(0.29)	(0.30)	(0.27)	(0.59)	(0.11)
Composite II										
$\sum \beta$	-1.19	-1.61	-5.18**	5.89	1.64***	-3.18	-1.59	-4.18**	2.79	1.38**
p-value	(0.77)	(0.16)	(0.02)	(0.28)	(0.01)	(0.43)	(0.17)	(0.05)	(0.61)	(0.03)

Panel B: Factor Returns Equal-Weighted

	One-Way Sorted					Size-Neutral				
Financial Constraints Criteria	**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**	**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size										
$\sum \beta$	-0.02	-0.70	-0.87	-3.50	0.49					
p-value	(0.99)	(0.30)	(0.56)	(0.31)	(0.27)					
SA-Index										
$\sum \beta$	-4.96**	-0.13	-1.26	2.47	0.33**	-7.85**	0.82	-0.13	1.29	0.48
p-value	(0.04)	(0.85)	(0.33)	(0.45)	(0.04)	(0.03)	(0.43)	(0.95)	(0.80)	(0.27)
Composite I										
$\sum \beta$	-1.27***	-0.97***	-1.38***	-3.89***	0.60***	-3.24	-0.90	-1.06	-3.43	0.54
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.12)	(0.13)	(0.33)	(0.22)	(0.11)
Composite II										
$\sum \beta$	-3.42	-1.62***	-3.07**	0.36	1.00***	-2.27	-1.14	-2.62*	0.46	0.80*
p-value	(0.15)	(0.01)	(0.02)	(0.91)	(0.00)	(0.39)	(0.13)	(0.06)	(0.89)	(0.06)

5.4 Asset Pricing and the Financial Constraint Factor

In this section we investigate whether the risk-premiums we have found represent an independent source of comovement in stock returns. We start by looking at the characteristics and correlations between the financial constraint factors, the Fama-French factors[30] and the value-weighted market portfolio. Next, we regress the various estimates of the financial constraint factor on the CAPM, the Fama-French three-factor- and five-factor models. If neither of these models can explain the return variations of the financial constraint factor, then the financial constraint factor should be an explanatory variable in asset pricing models. We will focus on the financial constraint factors constructed using value-weighted stock returns[31] as these showed greater statistical significance and are therefore more interesting to investigate.

5.4.1 Descriptive Statistics

Descriptive statistics of the returns of the Fama-French factor mimicking portfolios, the financial constraint factor estimates and the market portfolio are provided in Table 5.8. We find that all Fama-French factors but the RMW factor have a positive average return over the sample period. However, only the SMB[32] and market portfolio have monthly returns significantly greater than zero, at 1.5% and 0.80% respectively. The financial constraint factor results are discussed separately in section 5.2.

Table 5.8: This table reports descriptive statistics of the market portfolio, the Fama-French factor mimicking portfolios and the various estimates of the financial constraint factor. The book-to-market neutralized financial constraint factors are denoted BM. All reported financial constraint and Fama-French factors are constructed using one-way sorted portfolios and value-weighted stock returns. For details on the construction of the financial constraint factors, see section 4.2 and 4.1.1. For the construction of the Fama-French factors, see section 4.1.2 and A9.

	SMB	SA	Comp I	Comp II	BM SA	BM Comp I	BM Comp II	HML	CMA	RMW	RM - RF
Mean	0.015	-0.002	0.013	0.007	0.009	0.018	0.008	0.003	0.005	-0.007	0.008
T-Statistic	4,040	-0.660	2.720	1.560	2.230	3.980	1.850	0.780	1.160	-1.500	2.060
Stdv	0.061	0.057	0.076	0.076	0.058	0.075	0.067	0.061	0.063	0.076	0.058
Min	-0.195	-0.194	-0.213	-0.306	-0.188	-0.178	-0.222	-0.292	-0.155	-0.265	-0.234
Max	0.248	0.252	0.317	0.244	0.319	0.489	0.257	0.177	0.161	0.245	0.170
Cumulative	3.915	-0.615	3.260	1.883	2.212	4.689	2.102	0.759	1.179	-1.823	1.928

[30]These include the SMB, HML, CMA, RMW factors, see A9 for details.
[31]Campello and Chen (2010) use equal-weighted stock returns.
[32]Note that the Fama-French SMB factor is also the size-estimated financial constraint factor.

5.4.2 Correlations

5.4.2.1 Financial Constraint Factor Return Correlations

In Table 5.9 we report the correlations between the financial constraint factor returns. Notably the SA-Index and the book-to-market neutralized SA-index are negatively correlated with the returns of the other financial constraint factors. This is consistent with what we find in section 4.3, where we show that firms classified as constrained by the SA-Index typically share the characteristics of unconstrained firms classified by the other classification schemes. All other correlations are positive; however, the degree of correlation varies considerably. Furthermore, correlations are between 0.50 and 0.70 for the one-way sorted classifications scheme and their book-to-market neutralized counterpart, which shows the considerable effects of isolating the financial constraint factor from confounding elements.

Table 5.9: This table reports the correlations between the financial constraint factor returns for each of the classification schemes. The BM-neutralized financial constraint factors are denoted with BM. All factors are created using value-weighted stock returns.

	SMB	SA	Comp I	Comp II	BM Size	BM SA	BM Comp I	BM Comp II
SMB	1.00	-0.26	0.54	0.30	0.88	0.10	0.51	0.17
SA	-0.26	1.00	-0.21	-0.31	-0.07	0.52	-0.08	-0.13
Comp I	0.54	-0.21	1.00	0.60	0.39	0.16	0.77	0.51
Comp II	0.30	-0.31	0.60	1.00	0.14	-0.06	0.37	0.77
BM Size	0.88	-0.07	0.39	0.14	1.00	0.11	0.44	0.10
BM SA	0.10	0.52	0.16	-0.06	0.11	1.00	0.37	0.01
BM Comp I	0.51	-0.08	0.77	0.37	0.44	0.37	1.00	0.39
BM Comp II	0.17	-0.13	0.51	0.77	0.10	0.01	0.39	1.00

5.4.2.2 Factor Mimicking Portfolio Return Correlations

Table 5.10 shows the correlations between the Fama-French factor mimicking portfolio returns. Ideally, the explanatory factors should be independent of one another. This means we would prefer the correlation coefficients to be close to zero. We observe that the correlation between the Fama-French factors are in general low and evenly split between being positive and negative. There are however, two correlation coefficients which stand out: the correlation between SMB and RMW at -0.36 and the correlation between CMA and HML at 0.27. These correlations indicate that for our sample, small firms are typically unprofitable and that the average high book-to-market firm invests conservatively.

Table 5.10: This table reports the correlations between the Fama-French factor mimicking portfolio returns. All factors are created using value-weighted stock returns.

	SMB	HML	CMA	RMW	RM - RF
SMB	1.00	0.08	0.07	-0.36	-0.14
HML	0.08	1.00	0.27	-0.10	-0.02
CMA	0.07	0.27	1.00	-0.08	-0.08
RMW	-0.36	-0.10	-0.08	1.00	-0.18
RM - RF	-0.14	-0.02	-0.08	-0.18	1.00

5.4.2.3 Factor Returns Correlation Overview

In Table 5.11 we report the correlations between the various estimates of the financial constraint factor, the Fama-French factors and the market portfolio. We see that the correlation between the financial constraint factor and the HML and CMA factors are quite low. Additionally, the financial constraint factor does not seem to exhibit any clear covariation with the general market. The correlation with the RMW is stronger and for the most part negative. In sum, Table 5.11 indicates that the SMB[33] and the RMW factors should be the most important variables in explaining the return movements of the financial constraint factor. Furthermore, these correlations indicate once again that constrained firms are typically small and unprofitable.

Table 5.11: This table reports the correlations between the financial constraint factor as estimated by each of the four classification schemes, the Fama-French factors, and the value-weighted market-portfolio. BM-neutralized financial constraint factors are denoted with BM. All factors are created using value-weighted stock returns.

	SMB	SA	Comp I	Comp II	BM Size	BM SA	BM Comp I	BM Comp II	HML	CMA	RMW	RM - RF
SMB	1.00	-0.26	0.54	0.30	0.88	0.10	0.51	0.17	0.08	0.07	-0.36	-0.14
SA	-0.26	1.00	-0.21	-0.31	-0.07	0.52	-0.08	-0.13	0.02	0.07	0.25	0.12
Comp I	0.54	-0.21	1.00	0.60	0.39	0.16	0.77	0.51	-0.07	-0.05	-0.55	0.09
Comp II	0.30	-0.31	0.60	1.00	0.14	-0.06	0.37	0.77	-0.03	-0.07	-0.56	0.17
BM Size	0.88	-0.07	0.39	0.14	1.00	0.11	0.44	0.10	0.01	0.09	-0.20	-0.15
BM SA	0.10	0.52	0.16	-0.06	0.11	1.00	0.37	0.01	0.00	0.01	-0.11	0.16
BM Comp I	0.51	-0.08	0.77	0.37	0.44	0.37	1.00	0.39	-0.03	0.00	-0.37	0.07
BM Comp II	0.17	-0.13	0.51	0.77	0.10	0.01	0.39	1.00	-0.06	-0.06	-0.38	0.18
HML	0.08	0.02	-0.07	-0.03	0.01	0.00	-0.03	-0.06	1.00	0.27	-0.10	-0.02
CMA	0.07	0.07	-0.05	-0.07	0.09	0.01	0.00	-0.06	0.27	1.00	-0.08	-0.08
RMW	-0.36	0.25	-0.55	-0.56	-0.20	-0.11	-0.37	-0.38	-0.10	-0.08	1.00	-0.18
RM - RF	-0.14	0.12	0.09	0.17	-0.15	0.16	0.07	0.18	-0.02	-0.08	-0.18	1.00

[33] The SMB factor should be important in explaining the financial constraint factor as estimated by the Composite I-, Composite II and SA-Indexes.

5.4.3 Asset Pricing Regressions

We follow Lamont et al. (2001) and investigate whether standard asset pricing models can explain the return variation of the financial constraint factor. Using monthly return data, we regress the various estimates of the financial constraint factor on the CAPM, the Fama-French three-factor model and the Fama-French five-factor model. The regression equations are written as follows

i. CAPM

$$FC_t = \alpha + \beta(R_t^M - R_t^F) + \epsilon_t \tag{5.3}$$

ii. Fama-French Three Factor Model

$$FC_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_t \tag{5.4}$$

iii. Fama-French Five Factor Model

$$FC_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 CMA_t + \beta_5 RMW_t + \epsilon_t \tag{5.5}$$

where FC_t is the financial constraint factor at time t as estimated by one of the classification schemes and R_t^F is the risk-free rate[34] at time t. MKT is the value-weighted market portfolio, which we calculate as the value-weighted average excess return over the risk-free rate for the full sample. SMB, HML, CMA and RMW are the Fama-French factor mimicking portfolios, which we detail the construction of in section A9 of the appendix.

The regression results are reported in Table 5.12, where Panel A reports the results for the one-way sorted financial constraint factor, while Panel B reports the results for the book-to-market neutralized financial constraint factor. There are two things to look for in these tables. First, if a model is correctly specified and thus captures all return variation, its pricing error alpha equals zero (Merton et al. (1973)). If the intercept is significantly different from zero, the average return on the financial constraint factor is not well explained by the factors. Second, R^2 measures how much of the variation in the financial constraint factor can be explained by known systematic factors. If the R^2 is low,

[34] For the risk-free rate, we use the monthly NIBOR rate, which is available from 1986 and published by Norges Bank, to match the monthly stock market return data.

then the financial constraint factor measures some independent source of return variance.

5.4.3.1 One-Way Sorted Regressions

The CAPM misprices the Composite I constraint factor with an alpha of 2% per month. This means that buying a portfolio of firms classified as constrained and selling a portfolio of unconstrained firms as classified by the Composite I index generates a positive return which cannot be explained by general market variations. Both the SA-Index and Composite II constraint factors have zero intercepts and significantly positive coefficients on the market factor. The positive coefficients on the market factor reflects that the betas of constrained firms are higher than those of unconstrained firms. We note that although the CAPM does not misprice the SA-Index and Composite II constraint factors, hardly any of the variance is explained.

Moving from the CAPM to the Fama-French three-factor model results in Composite I's alpha falling to zero and the explained variation increasing to 32%. This means that the risk premium found in Table 5.5 for the Composite I Index reflects known empirical factors rather than a new source of independent variation. Both the SA-Index and Composite II constraint factors can also be priced using the Fama-French three factor model; however, the explained variation is still low for both models. Finally, going from the three-factor to the five-factor model mainly serves to increase the explained variation of the return movements. We note that none of the asset pricing models have an R^2 over 50%, which means there are still large sources of unexplained variance in the financial constraint factor.

To interperate the factor loadings[35] note that the financial constraint factor is created by subtracting the returns of constrained firms from unconstrained firms, which mimicks the act of buying a portfolio of constrained firms and selling a portfolio of unconstrained firms. The Fama-French factors are created in the same way. Thus, for example, the Composite I-based financial constraint factor loads significantly positive on the SMB factor and significantly negative on the RMW and HML factors. This means that the financial constraint factor returns behave like the stocks of small unprofitable firms with low book-to-market values.

[35] These are the coefficients on the Fama-French Factors and the market portfolio.

Table 5.12: Value-weighted factor regressions

This table reports the regression results from regressing the financial constraint factor on 1. the CAPM: $FC_t = \alpha + \beta(RM_t - RF_t) + \epsilon_t$, 2. the Fama-French three-factor model: $FC_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t$ and 3. the Fama-French five-factor model: $FC_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 CMA_t + \beta_5 RMA_t + \epsilon_t$. For details on the construction of the financial constraint factors see section 4.1.1 and 4.2. For details on the construction of the Fama-French factors, see section 4.1.2 and A9. Panel A reports the one-way sorted financial constraint factor, while Panel B table reports the book-to-market neutralized results. All results are calculated using value-weighted stock returns. The p-values are reported in the parenthesis and computed via Newey and West (1987) coefficients. The 10%, 5% and 1% significance level is given by *, ** and *** respectively.

Panel A: One-Way Sorted

	SA-Index						Composite I Index						Composite II Index					
	CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor	
	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
Intercept	0.00	(0.52)	0.00	(0.72)	0.00	(0.79)	0.02***	(0.00)	0.00	(0.52)	0.00	(0.42)	0.00	(0.11)	0.00	(0.82)	0.00	(0.69)
RM - RF	0.11*	(0.07)	0.09	(0.16)	0.15**	(0.02)	0.11	(0.17)	0.21***	(0.00)	0.08	(0.19)	0.22***	(0.00)	0.28***	(0.00)	0.12*	(0.09)
SMB			-0.24***	(0.00)	-0.16***	(0.01)			0.71***	(0.00)	0.51***	(0.00)			0.42***	(0.00)	0.18***	(0.01)
HML			0.04	(0.75)	-0.03	(0.62)			-0.14**	(0.03)	-0.16***	(0.00)			0.03	(0.70)	-0.08	(0.21)
CMA					0.09*	(0.06)					-0.09	(0.13)					-0.12**	(0.03)
RMW					0.18***	(0.00)					-0.41***	(0.00)					-0.51***	(0.00)
R-squared	0.01		0.10		0.13		0.01		0.33		0.47		0.03		0.14		0.35	
Adj. R-squared	0.01		0.07		0.11		0.00		0.32		0.46		0.03		0.13		0.34	

Panel B: Double Sorted

	BM-neutralized SA-Index						BM-neutralized Composite I Index						BM-neutralized Composite II Index					
	CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor	
	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
Intercept	0.01***	(0.00)	0.01	(0.15)	0.01	(0.15)	0.02***	(0.00)	0.01*	(0.09)	0.01*	(0.06)	0.01*	(0.10)	0.00	(0.46)	0.00	(0.28)
RM - RF	0.16***	(0.01)	0.19***	(0.00)	0.17***	(0.00)	0.09	(0.28)	0.18***	(0.01)	0.12*	(0.10)	0.21***	(0.00)	0.24***	(0.00)	0.14**	(0.05)
SMB			0.12**	(0.05)	0.11	(0.11)			0.65***	(0.00)	0.58***	(0.00)			0.23***	(0.00)	0.07	(0.34)
HML			-0.01	(0.99)	-0.01	(0.81)			-0.09	(0.18)	-0.10	(0.14)			-0.08	(0.71)	-0.09	(0.55)
CMA					0.01	(0.81)					-0.03	(0.71)					-0.07	(0.27)
RMW					-0.03	(0.59)					-0.20***	(0.00)					-0.31***	(0.00)
R-squared	0.03		0.04		0.05		0.01		0.28		0.32		0.04		0.08		0.18	
Adj. R-squared	0.02		0.03		0.03		0.00		0.28		0.31		0.03		0.07		0.16	

5.4.3.2 Double-Sorted Regressions

The double-sorted results are reported in Panel B of Table 5.12. We see that the CAPM is unable to price any of the double-sorted financial constraint factors. Moving to the Fama-French three factor model results in the intercepts of both the SA-Index and Composite II Index losing their significance. The intercept of the Composite I Index is still significantly greater than zero, generating a positive alpha of 1% per month. Moving to the five-factor model does not eliminate the positive alpha of the Composite I Index; in fact, its significance increases from the three-factor model. Thus, among the value-weighted financial constraint factors, only the book-to-market neutralized Composite I Index cannot be priced by standard asset pricing models. We note that the explained variance of these double-sorted portfolios is considerably lower than the one-way sorted portfolios.

5.4.3.3 Equal-Weighted Regressions

Similarly to the value-weighted regressions in Table 5.12, we report the regression results for the financial constraint factors created using equal-weighted stock returns in Table 5.13. For all financial constraint factors but the book-to-market neutralized SA-Index, the risk premiums can be explained by known empirical factors. The returns of the book-to-market neutralized SA-Index are not well explained by any of the models, as the intercept is positive and significant in all cases, and the explained variance does not rise above 30%. As reported in Table 5.13, the double-sorted SA-Index is the only equal-weighted portfolio where we find a strongly significant financial constraint factor. This further indicates that the SA-Index captures some non-linearities in the data.

5.4.3.4 Conclusions from the Asset Pricing Regressions

The results show some indication that the financial constraint premiums found in section 5.2 are indeed linked to financial constraints, as the returns of the book-to-market neutralized Composite I in Table 5.12 and the book-to-market neutralized SA-Index in Table 5.13, cannot be explained by the benchmark asset pricing models. We also test whether the size based financial constraint factor can be explained by the other risk factors by regressing the SMB factor on the CAPM and the Fama-French factor models without the SMB factor. The results are reported in Table 5.14. We see that the intercept is positive and

Table 5.13: Equal-weighted factor regressions

This table is equivalent to Table 5.12, but with the financial constraint factor returns calculated using equal-weighted stock returns. See section 4.1 for further elaboration on the differences in return calculation. The p-values are reported in the parenthesis and computed via Newey and West (1987) coefficients. The 10%, 5% and 1% significance level is given by *, ** and *** respectively.

Panel A: One-Way Sorted

	SA-Index						Composite I Index						Composite II Index					
	CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor	
	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
Intercept	0.00	(0.33)	0.00	(0.12)	0.00	(0.16)	0.00	(0.73)	0.00	(0.73)	0.00	(0.61)	0.00	(0.62)	0.00	(0.69)	0.00	(0.88)
RM - RF	0.10**	(0.04)	0.14***	(0.00)	0.09**	(0.02)	0.17**	(0.02)	0.21***	(0.00)	0.10**	(0.05)	0.19***	(0.00)	0.15**	(0.02)	0.00	(0.99)
SMB			0.40***	(0.00)	0.45***	(0.00)			-0.38***	(0.00)	0.29***	(0.00)			0.04	(0.49)	-0.03	(0.65)
HML			-0.32***	(0.00)	-0.28***	(0.00)			-0.24***	(0.00)	-0.18***	(0.00)			-0.03***	(0.00)	-0.29***	(0.00)
CMA					-0.14**	(0.02)					0.02	(0.68)					-0.06	(0.32)
RMW					-0.18***	(0.00)					-0.45***	(0.00)					-0.62***	(0.00)
R-squared	0.02		0.34		0.42		0.03		0.2		0.38		0.03		0.13		0.42	
Adj. R-squared	0.01		0.33		0.41		0.03		0.19		0.37		0.03		0.12		0.41	

Panel B: Double Sorted

	BM-neutralized SA-Index						BM-neutralized Composite I Index						BM-neutralized Composite II Index					
	CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor	
	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
Intercept	0.01***	(0.01)	0.01**	(0.02)	0.01**	(0.02)	0.00	(0.45)	0.00	(0.39)	0.00	(0.84)	0.00	(0.58)	0.00	(0.12)	0.00	(0.22)
RM - RF	0.06	(0.25)	0.12***	(0.00)	0.04	(0.42)	0.19**	(0.02)	0.23***	(0.00)	0.12**	(0.03)	0.17**	(0.02)	0.12**	(0.02)	0.04	(0.49)
SMB			0.32***	(0.00)	0.37***	(0.00)			0.36***	(0.00)	0.29***	(0.00)			-0.05	(0.45)	-0.09	(0.22)
HML			-0.12**	(0.04)	-0.06	(0.32)			-0.23***	(0.00)	-0.16**	(0.02)			-0.42***	(0.00)	-0.31***	(0.00)
CMA					-0.16***	(0.00)					0.00	(0.98)					-0.14**	(0.05)
RMW					-0.28***	(0.00)					-0.45***	(0.00)					-0.65***	(0.00)
R-squared	0.01		0.16		0.28		0.03		0.16		0.32		0.02		0.14		0.42	
Adj. R-squared	0.01		0.15		0.27		0.03		0.15		0.31		0.02		0.13		0.41	

significant in all regressions. Furthermore, the explained variance is small. The results clearly show that the size factor cannot be explained by the other risk factors. Thus, if the SMB factor is a proxy for financial constraints, then the results clearly show that financial constraints are a source of independently priced risk.

Table 5.14: This table reports the results from regressing the SMB factor on the CAPM and the Fama-French three- and five-factor models, excluding the SMB factor. The p-values are reported in the parenthesis and computed via Newey and West (1987) coefficients. The 10%, 5% and 1% significance level is given by *, ** and *** respectively.

	Size						**BM-neutralized Size**					
	CAPM		FF three-factor		FF five-factor		CAPM		FF three-factor		FF five-factor	
	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
Intercept	0.02***	(0.00)	0.02***	(0.00)	0.01***	(0.00)	0.01**	(0.02)	0.01***	(0.00)	0.01***	(0.00)
RM - RF	-0.15**	(0.02)	-0.15***	(0.00)	-0.22***	(0.00)	-0.15**	(0.02)	-0.15**	(0.02)	-0.19***	(0.00)
HML			0.07	(0.24)	0.03	(0.63)			0.01	(0.90)	-0.03	(0.59)
CMA					0.01	(0.86)					0.06	(0.28)
RMW					-0.32***	(0.00)					-0.18***	(0.00)
R-squared	0.02		0.03		0.18		0.02		0.02		0.08	
Adj. R-squared	0.02		0.02		0.16		0.02		0.02		0.07	

5.4.4 Asset Pricing Conclusions

The main finding in this section is that the portfolios created by the Composite I Index,[36] SA-Index,[37] and size classification schemes capture common comovements in stock returns not captured by factors. We note that the SA-Index likely does not capture financial constraints, which leaves us with size and the Composite I Index as our key measures. Thus, our results are partly dependent on the conviction that size is a good proxy for financial constraints.

We find it likely that the size-effect reflects, at least in part, a financial constraint risk premium for two reasons. First, as we show in section 4.3, size is able to capture variations in the supply of external capital curve over time, which in turn indicates that size can be used to identify financially constrained firms. Second, we find that the size-based financial constraint factor covaries with business and credit cycles, and that there is a clear connection to real firm performance. Zhang (2006)'s suggestion that the size effect may reflect information uncertainty seems unlikely in light of our findings. If the size

[36] As measured by the value-weighted BM-neutralized financial constraint factor.

[37] As measured by the equal-weighted BM-neutralized financial constraint factor. We note that although we find an independently verifiable risk premium using this measure, it is unlikely that the risk premium is related to financial constraints, as discussed in section 5.4.3.

effect reflects information uncertainty, then the information provided by constrained firms must vary collectively with business and credit cycles, which does not seem reasonable. On the other hand, Liu (2006)'s argument that the size effect reflects lower stock market liquidity is reasonable as stock market liquidity does fluctuate with business and credit cycles. Therefore, we cannot conclude that the entire risk premium we find is related to financial constraints, but we find it highly probable that a part of it is.

In sum, it seems likely that we have found an independently identifiable return stream generated by buying portfolios of constrained firms and selling portfolios of unconstrained firms. This serves to confirm the real-financial connection we have documented throughout the thesis and completes our analysis.

6 Conclusion

The aim of this thesis has been to answer two questions at the intersection of macroeconomics and finance. First, are financially constrained firms fundamentally riskier than unconstrained firms? Second, is this risk priced in securities markets in the form of an independently identifiable financial constraint factor? We have investigated these questions in the context of the Norwegian economy and securities markets.

The first question looks at the real effects of financial constraints. Our results show that financially constrained firms are fundamentally riskier than unconstrained firms in the sense that their earnings- and investment growth rates exhibit stronger covariation with systematic factors than those of unconstrained firms. This means that financial constraints have real effects which lead to heterogeneous firm responses to macroeconomic shocks. Furthermore, the results indicate that financial constraints are time-varying and that they bind more in downturns than expansions. This means that financial constraints, through their effect on real earnings- and investment growth, propagate and amplify shocks to the Norwegian economy. These results are generally comparable with previous results found for the US, suggesting that financial constraints have similar real effects across different time-periods and economic environments.

Specific to Norway, we find a negative relationship between the oil price and financial constraints, i.e. when the oil price is low, financial constraints bind more. We show that one part of this result stems from the market structure of the oil sector which leads to heterogeneous responses in the financial positions of firms following oil price shocks. Our results indicate that the other part of this negative relationship is a consequence of constrained firms being more sensitive to economic fluctuations than unconstrained firms.

The second question looks at the valuation effects of financial constraints. From the factor mimicking portfolios we find that financial constraints are a source of independently priced risk, as predicted by asset pricing theory. We note that this conclusion rests in part on the use of value-weighted portfolios, and in part on the conviction that firm size captures, at least in part, financial constraints. Specifically, we find that the returns of the financial constraint factor, as measured by size, the BM-neutralized Composite I Index and the

BM-neutralized SA-Index, cannot be explained by standard asset pricing models.

Taking the financial results together with the real results allows us to characterize a macroeconomy-equity valuation channel along the lines of Gertler and Bernanke (1989). For example, a negative macroeconomic shock will reduce the equity valuation of all firms as future expected cash flows decline. However, for financially constrained firms, the reduced net worth will increase agency costs, increasing the external finance premium and thus, decreasing investments which will in turn lead to a drop in future expected cash flows resulting in a decline in forward looking asset prices such as stocks. As a consequence of this accelerator effect, we find that the stock returns of financially constrained firms underperform those of unconstrained firms in downturns and periods of tight credit conditions, i.e. when financial constraints bind the most, and outperform in expansions, when constraints bind the least.

We find two interesting research directions to carry on the work on financial constraints forward. First, an important next step is the use of textual analysis to more precisely uncover the key underlying factors determining financial constraints in Norway, as is done for the US by Bodnaruk et al. (2015) and Buehlmaier and Whited (2018). These factors can then be related to firm characteristics such as size and age in order to formulate possible policy measures to mitigate the effects of financial constraints. The textual analysis results can also be used to create an index analogous to the SA-Index, KZ-Index or WW-Index for Norwegian firms, which in turn can be used to gauge how frictions in the Norwegian financial system varies over time. Second, it would be interesting to investigate how lending in Norway differs from other countries, in particular the US, and how this affects frictions in the financial system and the nature of financial constraints.

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Appendix

A1 Sample Size Evolution

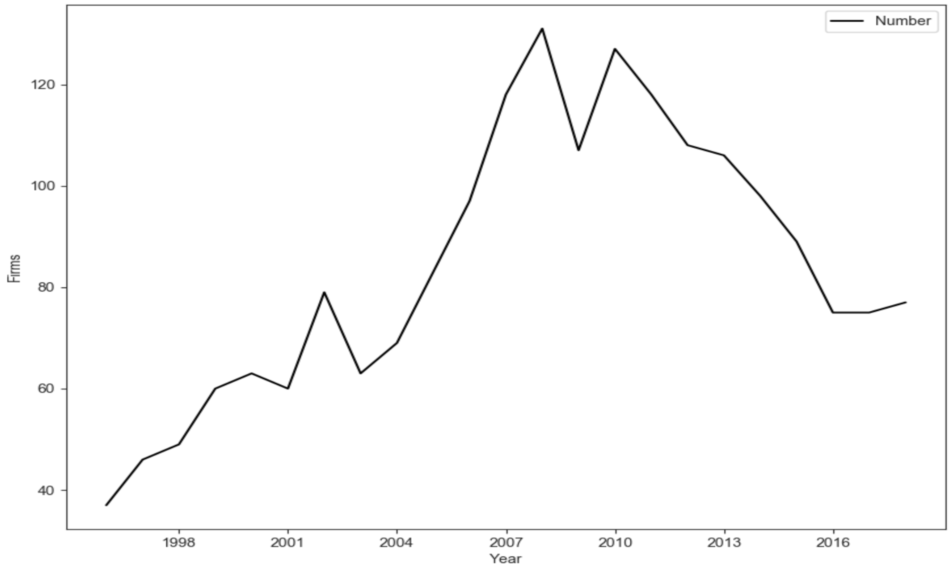

Figure A1.1: Sample size evolution
Number of unique firms in the sample in the period July 1996 to December 2018.

A2 Historical Time Series of the Oil Price

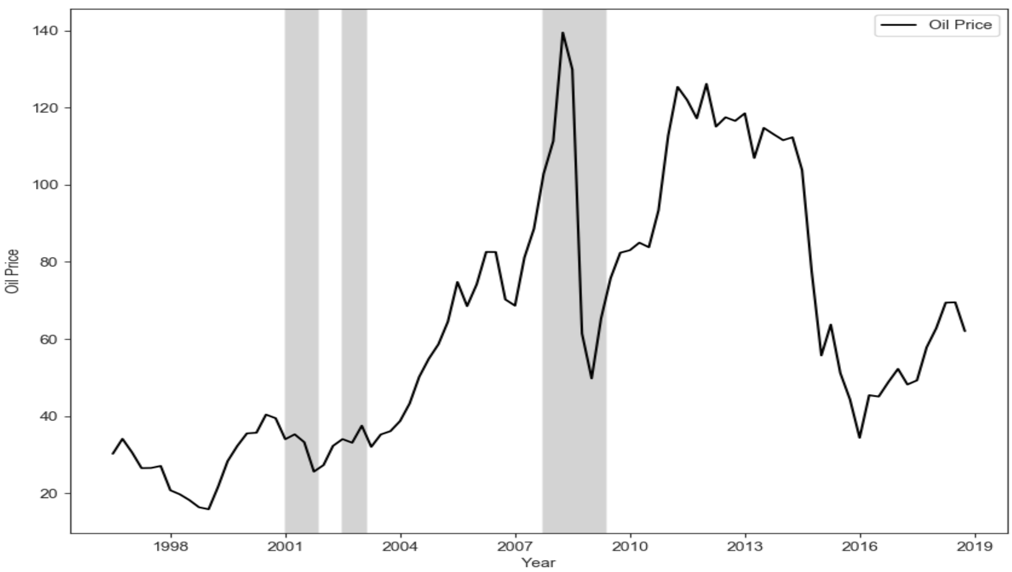

Figure A2.1: An illustration of the the average monthly oil price from July 1996 to December 2018. The shaded areas are periods of recession in Norway, periods as identified by Aastveit et al. (2016).

A3 SUR Estimation

The SUR system, first proposed by Zellner (1962), comprises of several individual relationships that are linked by the fact that their disturbances or the error terms are correlated. There are two main motivations for using an SUR-system. The first reason is to gain efficiency in estimation by combining information contained in different equations. Second, a SUR-system allows us to test restrictions that involve parameters in different equations, see Roger Moon and Perron (2006). The disturbance terms of these equations may be contemporaneously correlated because unconsidered factors that influence the disturbance term in one equation may also influence the disturbance terms in other equations. Ignoring this contemporaneous correlation and estimating these equations separately leads to inefficient estimates of the coefficients. Estimating all equations simultaneously with a generalized least squares estimator, which takes the covariance structure of the residuals into account, leads to efficient estimates.

We give a brief overview of the general steps in estimating a seemingly unrelated regression system. For a more detailed overview, see for example Zellner (1962). Suppose there are m regression equations

$$y_{ir} = x_{ir}^T \beta_i + \varepsilon_{ir}, \quad i = 1, ..., m \tag{A3.1}$$

Here i represents the equation number and $r = 1, ..., R$ is the time period. The number of observations R is assumed to be large, so that in this overview we let R $\rightarrow \infty$, while the number of equations m remains fixed. Each equation i has a single response variable y_{ir}, and a k_i - dimensional vector of regressors x_{ir}. If we stack observations corresponding to the $i - th$ equation into R-dimensional vectors and matrices, then the model can be written in vector form as:

$$y_i = X_i \beta_i + \varepsilon_i, \quad i = 1, ..., m \tag{A3.2}$$

where y_i and ε_i are R $\times 1$ vectors and X_i is a $R \times k_i$ matrix and β_i is a $k_i \times 1$ vector. Finally, if we stack these m vector equations on top of each other, the system will take the form:

$$\begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_m \end{pmatrix} = \begin{pmatrix} X_1 & \dots & 0 \\ 0 & & \\ \vdots & \ddots & \vdots \\ 0 & \dots & X_m \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_m \end{pmatrix} + \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_m \end{pmatrix} = X\beta + \varepsilon \tag{A3.3}$$

The assumption of the model is that the error terms ε_{ir} are independent across time, but may have cross-equation contemporaneous correlations. Thus we assume that

$$E[\varepsilon_{ir}\varepsilon_{is}|X] = 0\, whenever\, r \neq sE[\varepsilon_{ir}\varepsilon_{is}|X] = \sigma_{ij} \tag{A3.4}$$

Denoting $\Sigma = [\sigma_{ij}]$ the $m \times m$ skedaticity matrix of each observation, the covariance matrix of the stack error terms ε will be equal to

$$\Omega = E[\varepsilon\varepsilon^T|X] = \Sigma \otimes I_R \tag{A3.5}$$

Where I_R is the R-dimensional identity matrix and $\otimes I_R$ denotes that matrix Konecker product.

The SUR model is usually estimated using the feasible generalized least squares method. This is a two-step method where in the first step we run ordinary least squares regression for Eq. A3.3. The residuals from this regression are used to estimate the elements of matrix Σ,

$$\hat{\sigma_{ij}} = \frac{1}{R}\hat{\varepsilon_i}^T\hat{\varepsilon_i} \tag{A3.6}$$

In the second step we run a generalized least squares regression for A3.3 using the variance of the matrix $\hat{\Omega} = \hat{\Sigma} \otimes I_R$,

$$\hat{\beta} = (X^T(\hat{\Sigma}^{-1} \otimes I_R))^{-1}X^T(\hat{\Sigma}^{-1} \otimes I_R)y \tag{A3.7}$$

The estimator is unbiased in small samples assuming the error terms ε_{ir} have symmetric distribution. In large samples it is consistent and asymptotically normal.

When estimating the model, we impose cross-equational linear restrictions, testing for equality between the coefficients in the constrained and unconstrained equation. We then use a Wald-test in-order to obtain the correct p-values for the difference coefficients.

A4 Responses of Business Fundamentals to Macroeconomic Shocks using the Credit-Gap and NIBOR Spread

Table A4.1: This table provides the results from regressing the median real operating earnings- and investment growth of portfolios of constrained and unconstrained firms on various macroeconomic and credit market variables. The results are provided in Panel A and B respectively. Specifically, the regression equation is given by $\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t$. The macroeconomic and credit market variables include the growth rates of industrial production (Ind Prod), the unemployment rate (Unempl), the oil price, the credit-gap, and the three-month NIBOR spread. The control variables include the change in the Norwegian policy rate, the trade-weighted NOK currency index and the ten-over-two year US yield spread. See section 3.1 and 3.2 for a further elaboration on the macroeconomic variables, and section 4.1.1 and 4.2 for the construction of the various classification schemes. The right-hand side variables are normalized so they have zero mean and standard deviation equal to one. The independent variables are signed such that a positive value represents a worsening of macroeconomic conditions or tightening of credit markets. Difference coefficients across regressions are estimated via a SUR-system. The p-values of the original coefficients are reported in the parenthesis and are computed via Newey and West (1987) coefficients. The 10%, 5%, and 1% significance level is given by *, ** and *** respectively.

Panel A: Earnings Growth

		Macroeconomic Variables				
Financial Constraint Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit Gap**	**NIBOR Spread**
Size						
Constrained	(C)	-0.13	-0.04**	-0.06*	-0.07	0.09
		(0.63)	(0.05)	(0.06)	(0.26)	(0.14)
Unconstrained	(U)	-0.03**	-0.10***	0.04***	0.00	-0.06***
		(0.03)	(0.00)	(0.01)	(0.51)	(0.00)
Difference	(C) - (U)	-0.10	-0.06	-0.10	-0.07	0.15***
		(0.97)	(0.52)	(0.15)	(0.20)	(0.00)
SA-Index						
Constrained	(C)	-0.03	-0.10***	-0.02	-0.04	0.07
		(0.35)	(0.00)	(0.68)	(0.34)	(0.18)
Unconstrained	(U)	0.01	-0.06***	0.00	-0.02	0.00
		(0.69)	(0.00)	(0.92)	(0.24)	(0.77)
Difference	(C) - (U)	-0.04	-0.04	-0.02	-0.02	0.07**
		(0.30)	(0.28)	(0.75)	(0.78)	(0.03)
Composite I						
Constrained	(C)	-0.11	-0.09	-0.15	-0.13	0.14*
		(0.29)	(0.18)	(0.22)	(0.22)	(0.08)
Unconstrained	(U)	-0.02	-0.05**	0.03	-0.02	-0.04**
		(0.86)	(0.05)	(0.25)	(0.15)	(0.05)
Difference	(C) - (U)	-0.09	-0.04	-0.18	-0.11*	0.18***
		(0.31)	(0.69)	(0.15)	(0.08)	(0.01)
Composite II						
Constrained	(C)	-0.12	-0.10	-0.11	-0.01	0.15**
		(0.28)	(0.19)	(0.51)	(0.41)	(0.04)
Unconstrained	(U)	0.00	-0.05*	-0.04	0.00	-0.02
		(0.95)	(0.08)	(0.18)	(0.71)	(0.45)
Difference	(C) - (U)	-0.12	-0.05	-0.07	-0.01	0.17**
		(0.25)	(0.53)	(0.55)	(0.26)	(0.02)

Panel B: Investment Growth

		Macroeconomic Variables				
Financial Constraint Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit Gap**	**NIBOR Spread**
Size						
Constrained	(C)	-0.01	-0.05***	-0.02	-0.01	-0.01
		(0.86)	(0.00)	(0.27)	(0.50)	(0.95)
Unconstrained	(U)	-0.01*	-0.02***	0.00	0.00	0.00
		(0.08)	(0.00)	(0.76)	(0.18)	(0.64)
Difference	(C) - (U)	0.00	-0.03	-0.02	-0.01	-0.01
		(0.97)	(0.16)	(0.44)	(0.48)	(0.85)
SA-Index						
Constrained	(C)	-0.01	-0.02	0.02	-0.02	0.00
		(0.73)	(0.42)	(0.62)	(0.25)	(0.85)
Unconstrained	(U)	0.00	-0.02**	-0.01	0.00	0.00
		(0.28)	(0.04)	(0.48)	(0.47)	(0.48)
Difference	(C) - (U)	-0.01	0.00	0.03*	-0.02	0.00
		(0.24)	(0.86)	(0.09)	(0.11)	(0.46)
Composite I						
Constrained	(C)	-0.01**	0.00***	-0.01**	-0.03***	0.00
		(0.03)	(0.01)	(0.03)	(0.00)	(0.57)
Unconstrained	(U)	-0.01	-0.02	-0.01	0.00	0.00
		(0.43)	(0.17)	(0.89)	(0.13)	(0.59)
Difference	(C) - (U)	0.00	0.02	0.00	-0.03	0.00
		(0.81)	(0.39)	(0.53)	(0.25)	(0.15)
Composite II						
Constrained	(C)	-0.01	-0.03*	-0.01	0.00	0.01
		(0.88)	(0.07)	(0.75)	(0.96)	(0.14)
Unconstrained	(U)	0.00	-0.04***	0.00	0.01**	-0.01
		(0.56)	(0.00)	(0.36)	(0.04)	(0.43)
Difference	(C) - (U)	-0.01	0.01***	-0.01	-0.01	0.02
		(0.74)	(0.00)	(0.61)	(0.63)	(0.25)

A5 Responses of Business Fundamentals to Macroeconomic Shocks Excluding Oil Companies

Table A5.1: The table reports the results from re-running the fundamental regression reported in Table 5.2 excluding all oil companies. These are companies classified as belonging to the oil sector through SIC codes, as we show in section 3.4, and include both oil production and exploration companies, and oil service companies. The results are provided in Panel A and B respectively. Specifically, the regression equation is given by $\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t$. The macroeconomic and credit market variables include the growth rates of industrial production (Ind Prod), the unemployment rate (Unempl), the oil price, the credit-to-GDP (Credit/GDP), and the two-year swap-spread (Swap Spread). The control variables include the change in the Norwegian policy rate, the trade-weighted NOK currency index and the ten-over-two year US yield spread. See section 3.1 and 3.2 for a further elaboration on the macroeconomic variables, and section 4.1.1 and 4.2 for the construction of the various classification schemes. The right-hand side variables are normalized so they have zero mean and standard deviation equal to one. The independent variables are signed such that a positive value represents a worsening of macroeconomic conditions or tightening of credit markets. Difference coefficients across regressions are estimated via a SUR-system. The p-values of the original coefficients are reported in the parenthesis and are computed via Newey and West (1987) coefficients. The 10%, 5%, and 1% significance level is given by *, ** and *** respectively.

Panel A: Earnings Growth

		Macroeconomic Variables				
Financial Constraint Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size						
Constrained	(C)	-0.08*	-0.22***	-0.07***	-0.15***	0.11**
		(0.09)	(0.00)	(0.00)	(0.00)	(0.02)
Unconstrained	(U)	-0.04	-0.08***	0.03	-0.06***	-0.05***
		(0.22)	(0.00)	(0.90)	(0.01)	(0.00)
Difference	(C) - (U)	-0.02	-0.14**	-0.19**	-0.09	0.16***
		(0.47)	(0.02)	(0.04)	(0.17)	(0.00)
SA-Index						
Constrained	(C)	-0.06*	-0.18***	-0.01	-0.17**	0.08
		(0.18)	(0.01)	(0.13)	(0.05)	(0.11)
Unconstrained	(U)	0.03	-0.08***	0.03	-0.04**	0.00
		(0.18)	(0.00)	(0.67)	(0.02)	(0.88)
Difference	(C) - (U)	-0.09	-0.10	-0.10	-0.13**	0.08*
		(0.18)	(0.11)	(0.11)	(0.04)	(0.06)
Composite I						
Constrained	(C)	-0.15***	-0.25*	-0.08***	-0.23	0.18**
		(0.01)	(0.08)	(0.00)	(0.20)	(0.03)
Unconstrained	(U)	0.01	-0.05***	0.05***	-0.03	-0.02
		(0.32)	(0.01)	(0.00)	(0.24)	(0.55)
Difference	(C) - (U)	-0.16**	-0.20**	-0.13	-0.20***	0.20***
		(0.03)	(0.02)	(0.48)	(0.01)	(0.00)
Composite II						
Constrained	(C)	-0.08	-0.19***	-0.06	-0.17***	0.13**
		(0.42)	(0.01)	(0.23)	(0.00)	(0.02)
Unconstrained	(U)	0.00	-0.06*	0.00	-0.04	-0.01
		(0.91)	(0.08)	(0.68)	(0.15)	(0.74)
Difference	(C) - (U)	-0.08*	-0.13	-0.06	-0.13*	0.14***
		(0.08)	(0.27)	(0.98)	(0.09)	(0.01)

Panel B: Investment Growth

		Macroeconomic Variables				
Financial Constraint Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size						
Constrained	(C)	-0.01	-0.09***	-0.01***	-0.06*	0.00
		(0.97)	(0.00)	(0.00)	(0.08)	(0.99)
Unconstrained	(U)	-0.02*	-0.04***	0.00	-0.03	0.00
		(0.10)	(0.00)	(0.84)	(0.37)	(0.96)
Difference	(C)-(U)	0.01	-0.05***	-0.01*	-0.03*	0.00
		(0.43)	(0.01)	(0.06)	(0.09)	(0.98)
SA-Index						
Constrained	(C)	-0.04***	-0.05***	0.00	-0.04***	0.01
		(0.01)	(0.01)	(0.11)	(0.00)	(0.35)
Unconstrained	(U)	0.00	-0.03***	0.01	-0.03***	0.00
		(0.57)	(0.00)	(0.23)	(0.00)	(0.76)
Difference	(C)-(U)	-0.04***	-0.02	-0.01*	-0.01	0.01
		(0.00)	(0.32)	(0.07)	(0.48)	(0.34)
Composite I						
Constrained	(C)	-0.04	-0.03*	-0.01	-0.11***	0.00
		(0.19)	(0.06)	(0.16)	(0.00)	(0.98)
Unconstrained	(U)	-0.01	-0.04***	0.02*	-0.02*	0.00
		(0.33)	(0.00)	(0.10)	(0.08)	(0.54)
Difference	(C)-(U)	-0.03	0.01	-0.03	-0.09***	0.00
		(0.23)	(0.60)	(0.26)	(0.00)	(0.83)
Composite II						
Constrained	(C)	-0.01	-0.03	0.00	-0.06	0.02
		(0.93)	(0.96)	(0.79)	(0.88)	(0.94)
Unconstrained	(U)	0.00	-0.05***	0.03	-0.03	0.00
		(0.59)	(0.00)	(0.51)	(0.42)	(0.21)
Difference	(C)-(U)	-0.01*	0.02	-0.03	-0.03	0.02
		(0.09)	(0.18)	(0.18)	(0.31)	(0.17)

A6 Responses of Business Fundamentals to Macroeconomic Shocks Excluding 2008 and 2009

Table A6.1: This table reports the results from re-running the regression in Table 5.2 excluding 2008 and 2009. The results are provided in Panel A and B respectively. Specifically, the regression equation is given by $\gamma_t = \alpha + \varphi MACRO_t + \eta CONTROL_t + u_t$. The macroeconomic and credit market variables include the growth rates of industrial production (Ind Prod), the unemployment rate (Unempl), the oil price, the credit-to-GDP (Credit/GDP), and the two-year swap-spread (Swap Spread). The control variables include the change in the Norwegian policy rate, the trade-weighted NOK currency index and the ten-over-two year US yield spread. See section 3.1 and 3.2 for a further elaboration on the macroeconomic variables, and section 4.1.1 and 4.2 for the construction of the various classification schemes. The right-hand side variables are normalized so they have zero mean and standard deviation equal to one. The independent variables are signed such that a positive value represents a worsening of macroeconomic conditions or tightening of credit markets. Difference coefficients across regressions are estimated via a SUR-system. The p-values of the original coefficients are reported in the parenthesis and are computed via Newey and West (1987) coefficients. The 10%, 5%, and 1% significance level is given by *, ** and *** respectively.

Panel A: Earnings Growth

		Macroeconomic Variables				
Financial Constraint Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size						
Constrained	(C)	-0.10**	-0.13**	-0.18***	-0.14**	-0.01
		(0.03)	(0.03)	(0.00)	(0.01)	(0.11)
Unconstrained	(U)	-0.04	-0.07***	0.01	-0.05**	-0.06***
		(0.32)	(0.00)	(0.79)	(0.04)	(0.00)
Difference	(C) - (U)	-0.06	-0.06	-0.19***	-0.09	0.05***
		(0.27)	(0.24)	(0.00)	(0.13)	(0.01)
SA-Index						
Constrained	(C)	-0.10*	-0.14***	-0.11***	-0.07**	-0.02
		(0.06)	(0.00)	(0.00)	(0.03)	(0.57)
Unconstrained	(U)	0.00	-0.07***	-0.01	-0.01	-0.04**
		(0.99)	(0.00)	(0.67)	(0.32)	(0.03)
Difference	(C) - (U)	-0.10*	-0.07*	-0.10**	-0.06	0.02*
		(0.06)	(0.07)	(0.04)	(0.27)	(0.06)
Composite I						
Constrained	(C)	-0.30***	-0.28***	-0.22***	-0.08	0.00
		(0.00)	(0.00)	(0.00)	(0.12)	(0.23)
Unconstrained	(U)	-0.01	-0.02	-0.03**	-0.02	-0.05**
		(0.48)	(0.60)	(0.02)	(0.19)	(0.03)
Difference	(C) - (U)	-0.29***	-0.26***	-0.19**	-0.06	0.05**
		(0.00)	(0.00)	(0.03)	(0.62)	(0.04)
Composite II						
Constrained	(C)	-0.25***	-0.23**	-0.22***	-0.15***	-0.01
		(0.00)	(0.02)	(0.00)	(0.00)	(0.14)
Unconstrained	(U)	0.00	-0.01	-0.01	-0.01	-0.05**
		(0.51)	(0.70)	(0.68)	(0.61)	(0.02)
Difference	(C) - (U)	-0.25***	-0.09***	-0.21***	-0.14*	0.04***
		(0.00)	(0.00)	(0.00)	(0.09)	(0.01)

Panel B: Investment Growth

		Macroeconomic Variables				
Financial Constraint Criteria		**Ind Prod**	**Unempl**	**Oil Price**	**Credit/GDP**	**Swap Spread**
Size						
Constrained	(C)	-0.01	-0.06*	-0.05***	-0.04***	-0.03**
		(0.62)	(0.06)	(0.00)	(0.00)	(0.05)
Unconstrained	(U)	-0.02**	-0.03***	-0.01	-0.01	-0.01**
		(0.02)	(0.00)	(0.45)	(0.24)	(0.04)
Difference	(C) - (U)	0.01	-0.03	-0.04*	-0.03	-0.02
		(0.65)	(0.28)	(0.08)	(0.26)	(0.25)
SA-Index						
Constrained	(C)	-0.04***	-0.03**	-0.03***	-0.04**	-0.01**
		(0.00)	(0.03)	(0.01)	(0.04)	(0.02)
Unconstrained	(U)	0.00	-0.02**	-0.02	-0.02	0.00
		(0.36)	(0.02)	(0.11)	(0.23)	(0.99)
Difference	(C) - (U)	-0.04***	-0.01	-0.01	-0.02	-0.01
		(0.00)	(0.95)	(0.33)	(0.14)	(0.32)
Composite I						
Constrained	(C)	-0.08***	-0.04**	-0.08**	-0.06**	0.00
		(0.00)	(0.04)	(0.02)	(0.03)	(0.76)
Unconstrained	(U)	0.00	-0.04**	-0.02	-0.03***	-0.01
		(0.90)	(0.02)	(0.13)	(0.00)	(0.24)
Difference	(C) - (U)	-0.08***	0.00	-0.06*	-0.03	0.01
		(0.01)	(0.98)	(0.07)	(0.49)	(0.81)
Composite II						
Constrained	(C)	-0.03	-0.01	-0.02	-0.06	0.01***
		(0.26)	(0.75)	(0.70)	(0.34)	(0.00)
Unconstrained	(U)	0.02*	-0.04**	-0.02**	-0.05***	-0.01
		(0.09)	(0.04)	(0.02)	(0.00)	(0.31)
Difference	(C) - (U)	-0.05**	0.03	0.00	-0.01	0.02**
		(0.02)	(0.17)	(0.83)	(0.74)	(0.05)

A7 Sample Development Including the KZ-Indez

Table A7.1: This table is a replication of Table 3.1 illustrating the sample development including the KZ-Index as a measure of financial constraints. The sample size is drastically reduced. The data set we use in the results has 252 unique firms, while this data set has 131. The inclusion of dividends is the most important driver of the data reductions, nearly halving the sample size. Including variables constructed with items from cash flow statements would reduce the sample size even further.

Panel A: Security data	Observations		Companies	Months
	Number	Diff	Number	Number
Compustat file	50951		415	287
Day > 25	48506	-2445	413	287
Return calculation	40231	-8275	406	286
Omit penny stocks	38064	-2167	403	286
Omit financial companies	30184	-7880	311	286
Merge with macrodata	29853	-331	311	279
Panel B: Accounting data	Observations		Companies	Years
	Number	Diff	Number	Number
Compustat file	4005		377	24
Omit financial companies	3993	-12	375	24
Omit at < 0	3971	-22	375	24
Omit BE < 0	3967	-4	375	24
Omit lt < 0	3850	-117	375	24
Omit div payout < 0	1220	-2630	190	24
Omit empty classification variables	1068	-152	183	23
Panel C: Merged file	Observations		Companies	Years
	Number	Diff	Number	Number
Merge files	1637		152	22
Allign ME at june with t - 1	735	-902	132	22
Match with return data	8142		131	257*

*Monthly

A8 Industry Characteristics

Table A8.1: Companies with directly reclassified SIC codes. The Standard Industrial Classification (SIC) are four-digit codes that indicate the company's type of business.

Company	SIC	Original Group	New Group
TELENOR ASA	4812	Transportation	Other
HAFSLUND ASA	4911	Transportation	Other
P4 RADIO HELE NORGE ASA	4832	Transportation	Other
NEXTGENTEL HOLDING ASA	4899	Transportation	Other
ARENDALS FOSSEKOMPANI ASA	4899	Transportation	Other
REACH SUBSEA ASA	4931	Transportation	Oil & Gas
DOF ASA	4400	Transportation	Oil & Gas
AKER FLOATING PRODUCTION ASA	4400	Transportation	Oil & Gas
EIDESVIK OFFSHORE ASA	4400	Transportation	Oil & Gas
HAVILA SHIPPING ASA	4400	Transportation	Oil & Gas
FARSTAD SHIPPING ASA	4400	Transportation	Oil & Gas
GC RIEBER SHIPPING ASA	1382	Mining	Transportation
HUNTER GROUP ASA	1382	Mining	Transportation
AMERICAN SHIPPING COMPANY ASA	3730	Manufacturing	Transportation
SCHIBSTED ASA	2711	Manufacturing	Other
POLARIS MEDIA ASA	2711	Manufacturing	Other
AKER MARITIME ASA	3533	Manufacturing	Oil & Gas
EQUINOR ASA	2911	Manufacturing	Oil & Gas
AKER RGI ASA	3533	Manufacturing	Oil & Gas
ADVANCED PROD & LOADING ASA	3533	Manufacturing	Oil & Gas
BJORGE GRUPPEN ASA	3533	Manufacturing	Oil & Gas
GRENLAND GROUP ASA	3533	Manufacturing	Oil & Gas

Table A8.2: This table gives an overview of the number of observations classified as constrained or unconstrained per industry group for each classification scheme. See section 3.4 for computation and explanation of the classification schemes.

		Accounting Data					**Security Data**				
		Total	**Oil**	**Transp**	**Manuf**	**Other**	**Total**	**Oil**	**Transp**	**Manuf**	**Other**
Size											
Constrained	C	554	97	57	223	177	5872	1058	618	2337	1859
Unconstrained	U	560	166	50	202	142	5932	1739	505	2169	1519
SA-Index											
Constrained	C	548	140	30	204	174	5852	1540	325	2163	1824
Unconstrained	U	560	113	91	185	171	5959	1156	983	1932	1888
Composite I											
Constrained	C	466	98	37	195	136	5135	1014	425	2048	1648
Unconstrained	U	505	131	31	185	158	5347	1340	339	1970	1698
Composite II											
Constrained	C	462	103	57	182	120	5135	1173	339	1999	1624
Unconstrained	U	400	86	23	165	126	3812	791	224	1545	1252

Table A8.3: This table provides descriptive statistics for each of the four industry groups. Market capitalization and total assets are denoted in MNOK.

	Oil Companies					Transport Companies				
	Mean	Stdv	Median	Min	Max	Mean	Stdv	Median	Min	Max
Earnings growth	-0.11	6.56	0.04	-43.78	64.26	0.25	3.72	0.00	-18.67	34.96
Investment growth	0.58	4.58	0.08	-1.00	92.16	0.09	0.54	0.01	-0.88	4.73
Market capitalization	39,300	191,221	1,833	14	1,875,589	2,889	4,074	1,236	52	22,813
Total assets	25,662	107,750	2,887	26	1,007,816	3,810	5,749	2,071	51	41,257
Debt-to-Assets	0.59	0.17	0.61	0.02	1.04	0.58	0.22	0.65	0.03	0.95
Book-to-Market	1.06	1.51	0.66	0.00	15.99	0.83	1.20	0.45	0.04	13.70
N	460					200				
	Manufacturing Companies					**Other Companies**				
	Mean	**Stdv**	**Median**	**Min**	**Max**	**Mean**	**Stdv**	**Median**	**Min**	**Max**
Earnings growth	-0.40	6.16	-0.03	-92.98	35.99	0.18	3.73	0.04	-24.26	53.94
Investment growth	0.23	1.91	0.04	-0.90	45.49	0.21	0.77	0.04	-0.83	8.01
Market capitalization	12,087	39,257	1,169	15	337,992	15,898	68,266	1,003	47	773,851
Total assets	11,125	33,473	1,416	13	277,901	11,126	31,743	1,079	6	212,736
Debt-to-Assets	0.51	0.19	0.53	0.08	1.02	0.54	0.19	0.57	0.02	0.95
Book-to-Market	0.97	1.45	0.66	0.01	27.76	0.71	0.81	0.52	0.01	11.68
N	683					503				

A9 Construction of the Fama-French Factor Mimicking Portfolios

The Fama-French factor mimicking portfolios are created by dividing the sample into three parts using 30% and 70% cutoffs at the end of June each year. We create all factors using both equal-weighted and value-weighted portfolio returns. Furthermore, all factors are one-way sorted, rather than double-sorted. For further details regarding the factors, see Fama and French (2015, 1993, 1992). For each month we calculate the difference in return between the portfolios, creating the factors as follows

1. Small-minus-big (SMB)

At the end of June each year we calculate the market capitalization of all firms, which we use to divide the sample. Firms in the bottom percentile are labelled small (S), while firms in the top percentile are labelled big (B). Subtracting the returns of the portfolio of small firms from the portfolio of big firms creates the SMB factor. The SMB factor captures the size-effect, which is the empirical observation that the returns of small firms outperforms those of large firms, after controlling for market risk. The SMB factor mimicking portfolios are the same as the financial constraint portfolios when using size as the classification scheme.

2. High-minus-low (HML)

Firms are sorted by their book-to-market values, as defined in section 4.1.2. The bottom percentile is labelled low (L), while the top percentile is labelled high (H). We subtract the monthly returns of the portfolio of high book-to-market firms from the portfolio of low book-to-market firms, creating the HML factor. The HML factor captures the value-effect, which is the empirical observation that the returns of high book-to-market firms, i.e. value-firms, outperform the returns of low book-to-market firms, i.e. growth firms, after controlling for market risk.

3. Conservative-minus-aggressive (CMA)

Firms are sorted by their growth in total assets, defined as investment in section 4.1.2. The bottom percentile is labelled conservative (C) and the top percentile is labelled aggressive (A). Subtracting the monthly returns of the portfolio of conservative firms from the portfolio of aggressive firms creates the CMA factor. The CMA factor, also known as the investment factor, captures the empirical observation that the returns of firms which invest conservatively outperform the returns of firms which invest aggressively, after controlling for market risk.

4. Robust-minus-weak (RMW)

Firms are sorted by their operating profitability, as defined in section 4.1.2. The bottom percentile is labelled weak (W), while the top percentile is labelled robust (R). Subtracting the returns of the robust portfolio from the weak portfolio creates the RMW factor. The RMW factor, also known as the profitability factor, captures the empirical observation that the returns of profitable firms are higher than those of less profitable firms, after controlling for market risk.