FACULTEIT ECONOMIE
EN BEDRIJFSKUNDE

TWEEKERKENSTRAAT 2
B-9000 GENT
Tel. : 32 - (0)9 – 264.34.61
Fax. : 32 - (0)9 – 264.35.92

WORKING PAPER

Investment-Cash Flow Sensitivity and the Cost of External Finance

Klaas Mulier Koen Schoors Bruno Merlevede

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Abstract

We contribute to the investment-cash flow sensitivity debate by creating a new index to identify the supply of finance to firms. We find that firms that are considered constrained according to our index pay a higher interest rate on their debt, and display the highest investment-cash flow sensitivities. Moreover, these findings are not driven by the possible information content of cash flow regarding investment opportunities as we control for opportunities by augmenting our empirical model with firm-level employment growth. We thus provide new evidence consistent with Campbell et al. (2012) that the cost of capital is the driving force behind investment-cash flow sensitivity.

Keywords: Investment-cash flow sensitivity, cost of finance

JEL classification: D92; E22; G31

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†Corresponding author: Department of Accounting, Finance and Taxation, Ghent University, Belgium. e-mail: Klaas.Mulier@UGent.be

1 Introduction

In recent years there has been an intense academic debate on investment dynamics and financial constraints. A firm is financially constrained if its investment is limited by its generation of internal funds, because it cannot obtain sufficient external funds to finance its investment plans. The empirical literature has found financial constraints to be elusive, mainly because we lack a direct measure of financial constraints everyone can agree on. Financial constraints are therefore usually measured indirectly through variables that are assumed to be related to financial constraints, but these assumptions always leave room for reasonable doubt. The literature often resorts to interpreting investment-cash flow sensitivities as an indication of firm-level constraints to obtain external finance. The fundamental problem is that the only certain thing one can state about firms that exhibit high investment-cash flow sensitivities is that their cash flow relates to investment, either directly or indirectly. However, the equilibrium decision to finance investment with cash flow, observed by the econometrician, is by definition a mixed supply and demand effect. The question remains whether these high sensitivities reflect an unsatisfied demand for external funds by the firm (supply effect), the preference for internal funds over external funds for a variety of underlying reasons (demand effect), or simply the fact that cash flow is correlated with an omitted variable (e.g. opportunities) that is also positively associated with investment. The empirical challenge is to disentangle these effects in the face of the understanding that a perfect identification methodology may not exist. To this purpose we analyze a large sample of unquoted firms in Nordic countries, Western European countries and Eastern European transition countries.

The first contribution to the literature is that we construct a new index to identify the supply of external finance. We argue that it is mainly the supply side in the market for external finance that is binding and restricts the investment of firms. Investment reacts positively to cash flow because cash flow relaxes the constraints in the market for external finance, and this will be most prevalent for those that the constraint is most binding. Besides traditional variables proxying information asymmetries such as age and size, our index also incorporates the average profitability of the firm (cash flow).

Further, in order to validate our index we employ additional information supplied by implicit interest rates to disentangle supply and demand effects. Being financially constrained does not necessarily require that a firm is fully excluded from external funding, but merely that a firm cannot obtain external finance at a reasonably low cost. Hence, for a given demand for external finance, firms that face a more restricted supply, pay a higher equilibrium interest rate on their finance. We find that firms that are considered financially constrained according to our index pay a higher interest rate and show the highest investment-cash flow sensitivities. Moreover, other widely used financial constraints indices correlate much less or even negative with this implicit interest rate. Our findings are consistent with the recent evidence of Campbell et al. (2012) that the cost of capital is the driving force behind investment and its relation with internal funds and with the recent evidence of Farre-Mensa and Ljunqvist (2013) that the existing indices of financial constraints are inadequate.

A second contribution of this paper is that our findings are not driven by the possible correlation between cash flow and investment opportunities. If an increase in unobserved investment opportunities increases planned investment and implies elevated cash flows, then investment-cash flow sensitivities may arise in the absence of credit constraints. To avoid that our observed investment-cash flow sensititivities would merely reflect the presence of investment opportunities, we augment the empirical model with a firm level control variable for investment opportunities: employment growth. Firms will increase their workforce if they expect future growth opportunities. We show that employment growth is indeed positively related to both investment and cash flow and can thus be a good control variable.

Finally, unlike most studies investigating financial constraints, we investigate several countries characterised by different economic and financial systems, as financial constraints may be specific to a country or a financial system, and restrict our dataset to unquoted firms, which are much more likely to face financial constraints than quoted firms.

The paper is organized as follows: we start in section 2 with an overview of the related literature. We describe the dataset in section 3. We explain our identification strategy in section 4. Section 5 presents the empirical approach, estimations and robustness checks, and finally, section 6 concludes.

2 Related literature

In their pioneering paper, Fazzari, Hubbard and Petersen (1988) (hereinafter FHP) find that the investment of firms with low dividend pay-out ratios (i.e. firms that are more likely to face financial constraints) is highly sensitive to the availability of cash flow. A number of subsequent contributions (Whited, 1992; Hoshi et al., 1992; Carpenter et al., 1994; Kashyap et al., 1994; Bond and Meghir, 1994; Carpenter et al., 1998; Mizen and Vermeulen, 2005) find results in line with FHP. The FHP results were challenged in 1997 by Kaplan and Zingales (hereinafter KZ). KZ show theoretically that a firm's profit maximizing investment choices do not yield a simple monotonic relation between financial constraints and investment-cash flow sensitivities, which invalidates the empirical strategy of the FHP strand of literature. KZ's results were subsequently confirmed by a number of authors (Cleary, 1999, 2006; Cleary et al., 2007).

Several additional theoretical challenges to the FHP interpretation of investment-cash flow sensitivities were later developed. Alti (2003) assumes that young firms are uncertain about the quality of their projects and derive information about their projects from cash realizations. In this environment investment-cash flow sensitivities arise in the absence of any financial market imperfections, challenging the classical FHP interpretations. Erickson and Whited (2000) and Cummins et al. (2006) make similar comments that the significant role of cash flow for investment is related to investment opportunities, which are incorrectly measured by Q. However, Gilchrist and Himmelberg (1995) and later Carpenter and Guariglia (2008) still find that cash flow sensitivities are a reflection from underlying credit frictions since cash flow remains significant even when investment opportunities are controlled for.

The empirical literature has tried to realign the contradictory theoretical predictions and empirical findings with respect to investment-cash flow sensitivities. Allayannis and Mozumdar (2004) argue that some firms might be in such severe financial distress that investment cannot respond to cash flow, implying a lower sensitivity for financially more constrained firms. Their argument boils down to the proposition that the found sensitivity for firms in distress reflects a lower investment demand, rather than a credit supply constraint. The current literature appears to have reached a consensus about a U-shape form for the investment-cash flow relationship, as predicted by Cleary et al. (2007). A recent paper by Guariglia (2008) suggests that the opposite results found by FHP and KZ are due to different measures of financial constraints: while the FHP strand of the literature uses proxies for external financial constraints, such as firm size, age or dividend payout, the KZ strand of the literature uses proxies for firm liquidity that capture internal financial constraints. Guariglia (2008) shows that the Cleary et al. (2007) U-shape is present when considering a sample-split on the basis of internal funding (the KZ case), while the investment-cash flow sensitivity increases monotonically when splitting the sample according to external financial constraints (the FHP case). Becchetti et al. (2010) combine the traditional information on external financial constraints with qualitative information on self-declared credit rationing from a panel of Italian firms to assess the validity of the different points of view in the literature. They find that age and size are good predictors of the probability of being credit rationed. Also in support of the FHP results, Hadlock and Pierce (2010) show that an index based on firm size and age performs better in predicting financial constraints than the widely used KZ index, although they argue that investment-cash flow sensitivities are not a good setting to investigate financial constraints. Farre-Mensa and Ljunqvist (2013), finally, find that none of the existing indices (including the index of Hadlock and Pierce (2010)) adequatly measure financial constraints.

Further, Duchin et al. (2010) show that investment dropped significantly in the financial crisis due to the negative supply shock to external finance that characterized the recent crisis. They show that this drop is greatest for firms that are financially constrained, but do not relate this to excess cash flow sensitivity. Campbell et al. (2012) provide evidence that the cost of capital could be the intervening variable that explains the relation between decreasing internal funds and decreasing corporate investment. Contrary to what one would expect from the findings of Duchin et al. (2010) and Campbell et al. (2012), Chen and Chen (2012) show that investment-cash flow sensitivities have disappeared during the financial crisis and conclude that they do not measure the credit frictions that were widely present during that period.

3 Data

The data set used in this paper covers the period 1996-2008 and consists of the profit and loss account and balance sheet data for six European countries gathered by Bureau Van Dijk Electronic Publishing in the Amadeus database. One potential problem with this dataset is the survivorship bias. Bureau van Dijk releases updates of the Amadeus database on a monthly frequency and when a firm exits it will no longer be included in the database the following month. By compiling several releases (we use more than 10 versions with approximately one year interval) of the Amadeus database, our dataset comprises both entering and exiting firms over the sample period. Francis et al. (2013) have shown that country-level governance such as investor protection influences investment-cash flow sensitivities. To make sure that none of our possible results are driven by such country specific elements, we choose six countries with different backgrounds and sufficient data on the regression variables available. Belgium and France are two West European countries, Finland and Sweden represent the Scandinavian model and with the Czech Republic and Hungary, our sample also contains two transition countries. Following Cleary (1999), we exclude banks, insurance companies, other financial companies and utility firms from the dataset and retain firms from the following seven industries: agriculture and mining, manufacturing, construction, retail and wholesale trade, hotel and restaurants, services, and health and others (see Table 11 in the appendix for more details). Furthermore the sample consists of unquoted firms, which are more likely to face financial constraints than publicly quoted firms.

Table 1: Descriptive statistics: sample means and standard deviations

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
I_{it}/K_{it-1}	0.112	0.111	0.122	0.144	0.075	0.151
	(0.102)	(0.132)	(0.149)	(0.202)	(0.128)	(0.186)
$k_{it-2} - s_{it-2}$	-1.565	-1.860	-1.562	-1.848	-1.023	-1.360
	(0.912)	(0.690)	(0.894)	(1.316)	(1.063)	(0.975)
Δs_{it}	0.020	0.009	0.023	0.007	-0.020	0.007
	(0.122)	(0.106)	(0.179)	(0.338)	(0.210)	(0.271)
Δemp_{it}	0.011	0.018	0.032	0.007	-0.008	0.060
	(0.081)	(0.106)	(0.181)	(0.467)	(0.132)	(0.207)
CF_{it}/K_{it-1}	0.282	0.417	0.477	0.392	0.205	0.278
	(0.309)	(0.361)	(0.513)	(1.027)	(0.317)	(0.312)
$\#firms$	2,555	69,801	9,876	31,396	2,101	1,405
$\#obs$	17,117	404,366	58,097	141,475	13,697	7,443

Notes. The Table shows sample means and in parentheses the corresponding standard deviations. The subscript i indexes firms, and the subscript t, time, where t = 1996-2008. I is the firm's investment, K the replacement value of the firm's capital stock and k its logarithm, s is the logarithm of total sales, emp is logarithm of total costs of employees, and finally CF represents a firm's cash flow.

Table 1 shows descriptive statistics of the main variables of interest for our research.[1] Investment (I_{it}) is measured as the sum of depreciation in year t and the change in tangible fixed assets from year $t-1$ to year t. Using this measure of investment allows comparability with many other papers in the literature[2]. The replacement value of the capital stock is calculated with the perpetual inventory formula (Blundell et al., 1992). Using tangible fixed assets as the historic value of the capital stock and assuming that in the first period the historic value equals the replacement cost, we calculate the capital stock as $K_{it+1} = K_{it} * (1 - \delta) * (p_{t+1}/p_t) + I_{it+1}$. With

[1] See Table 8 for a definition of the variables used.

[2] See for instance Mizen and Vermeulen (2005); Bloom et al. (2007); Guariglia (2008).

δ representing the depreciation rate, which we assume to be constant at 5.5% and p_t is the price of investment goods, proxied by the gross total fixed capital formation deflator. Δs_{it} is the change in the log of real total sales, and measures sales growth. Δemp_{it} is the change in the log of real total costs of employees, and measures employment growth.[3] CF_{it}/K_{it-1} represents a firm's cash flow, scaled by its beginning of period capital.

Further, to control for outliers, large mergers or typing errors we drop observations in the 1% tails of the distribution of both the level and first difference of the regression variables. We also excluded firms with accounting periods that differ from the standard 12 months. Following Mizen and Vermeulen (2005) we also have a consecutive run of at least five observations for each firm. The descriptive statistics are relatively similar across the countries considered. The lower investment rate in the Czech Republic is partly due to the larger share of firms in the agricultural sector in the sample.

The descriptive statistics in Table 1 show that our data is similar to what is known from previous research. Investment levels are on average between 10 and 15 percent of the capital stock. Real sales growth is around 1 to 2 percent annually. Interestingly, this also appears to be the case for employment growth. Cash flow levels vary from 20 percent to 47 percent of the capital stock.

4 The identification of financial constraints

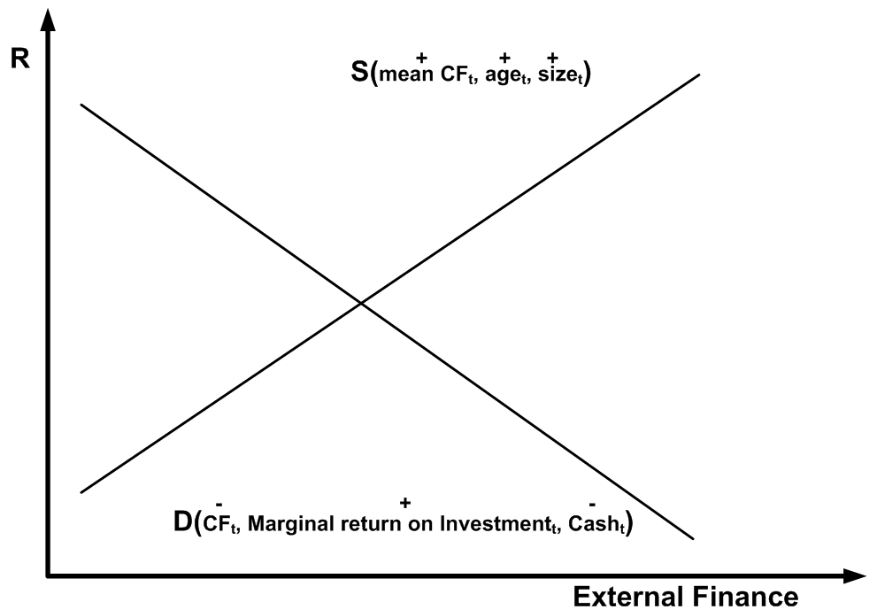
To get a better identification of possible financial constraints, we focus on categories of firms that we ex-ante believe to have different probabilities of suffering from financial constraints. To do this we identify the supply curve that firms face in the market for external finance and calculate the implicit interest rate that firms pay on their external finance. If our identification is correct we should observe that, for a

[3] real sales and real costs of employees are obtained by deflating the nominal values with the gdp deflator.

given demand for external finance, firms that are more constrained (i.e. face a more restricted supply) pay a higher interest rate on their debt.

4.1 Age-Size-Cash Flow (ASCF) Index

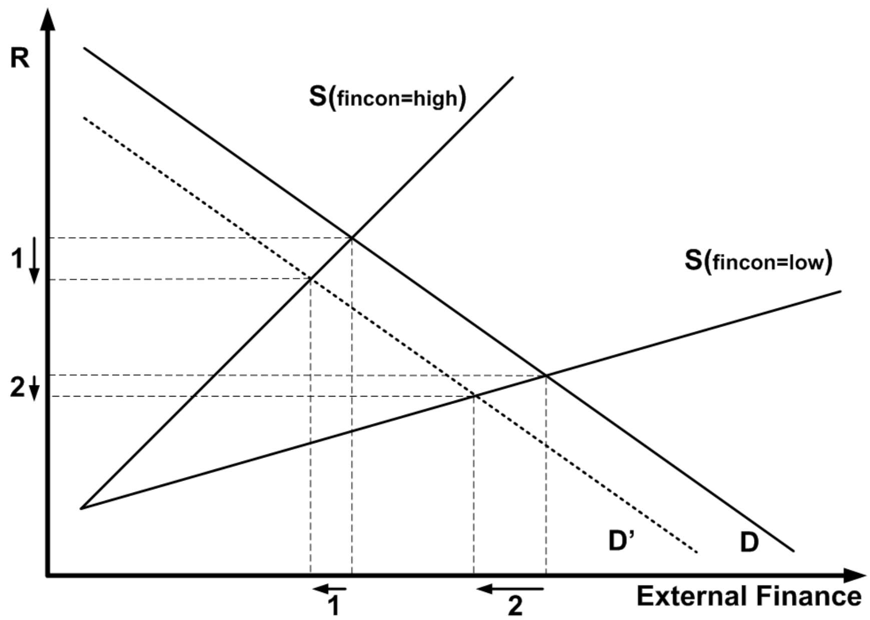
Figure 1: The market for external finance



As shown in Figure 1 we think of firm size, age and the average cash flow level as determinants of the supply curve. With respect to firm size and age, we believe that it is easier for financial institutions to gather sufficient information on larger firms (Bernanke et al., 1996) while older firms have better proven track records than young firms (Schiantarelli, 1995), which both decrease the degree of asymmetric information between lender and borrower. This, in turn, will increase the supply of external finance to larger and older firms (Rauh, 2006; Hadlock and Pierce, 2010). Further, since higher cash flows enable firms to repay their debt, external lenders (especially transaction lenders) will be less resilient in funding firms with higher cash flows. Firms with higher levels of cash flow will therefore be less likely to forgo net present value investments due to the lack of external finance available to them.

Figure 2 shows what we have in mind. If investment-cash flow sensitivities arise because cash flow relaxes constraints that firms face in the financial market, then this should be particularly important for firms that pay the highest interest rate for a given level of demand; or stated differently, for those firms that face the most inelastic supply of external funds. For such firms, a windfall gain in cash flow implies a greater drop in the cost of finance and hence a larger relaxation of the constraint.

Figure 2: The market for external finance: constrained vs unconstrained



In order to approximate the (elasticity of the) supply of finance to firms we measure for each of the above stated determinants whether a firm is scoring below or above its industry median in a given year. A firm gets a score of 2 for age if the firm is younger than the median firm in the same industry in our sample in a given year, and 1 otherwise. We then proceed in the same way for the size of the firm and the mean cash flow of the firm. We then sum the three scores and obtain for each firmyear a score between 3 (unconstrained supply of external finance) and 6 (constrained supply of external finance).

The main advantage of this approach is that it compiles multiple determinants of supply into one measure, that it is easy to compute, and applicable to almost any dataset available in economics. A scoring system like this is also flexible in the weight that is given to a certain discriminating variable. By using for instance the 75th percentile instead of the median, one can choose to put more or less weight on a variable. As we have no a priori assumptions on the importance that the four variables play in the supply of external finance, nor on the different role they might play across countries, we use the median as cut-off for each of them. A disadvantage of this approach is the interpretation of the index itself. While the interpretation of the scores 3 and 6 is still feasible (A score of 3 indicates that a firm is relatively old, relatively large and has relatively high levels of cash flow, and vice versa for a score of 6.), the scores in between are less straightforward to interpret.

Now, for the estimation purposes in the next section and to capture possible nonlinear effects of financial constraints, we generate a categorical variable $fincon = LOW_{it}$ which takes the value 1 if firm i gets a score of 3 or 4 in year t, and 0 otherwise, meaning unconstrained supply of external finance. Next, $fincon = HIGH_{it}$ takes the value 1 if firm i scores 5 or 6 in year t, and 0 otherwise, and implies that firm i faces a constrained supply of finance in year t. We will interact these categorical variables with cash flow and estimate model (5) to test whether the most constrained firms display the highest investment-cash flow sensitivities. Table 9 in the Appendix shows that this approach classifies around 60 percent of the sample as unconstrained and 40 percent as constrained. Table 10 in the Appendix learns that the probability that a firm stays within a certain category for several years is rather high, especially for unconstrained firms. On average, every year less than 5 percent of the firms switch to a different constraint-group. This can be explained by the fact that size and age do not change quickly over time. Nonetheless, a reasonable amount of firms in the sample do switch between groups over time.

We also relate our new index to three existing and widely used indexes: the Whited-Wu (WW) index, the Kaplan-Zingales (KZ) index and the Hadlock-Pierce (HP) index (note that all indexes are supposed to be increasing with financial constraints). Table 2 shows that the correlation is only moderate (with WW) or even

Table 2: Correlation between our index (ASCF) and existing indexes (WW, KZ, HP)

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
$Corr(ASCF, WW)$	0.45***	0.58***	0.52***	0.49***	0.26***	0.21***
$Corr(ASCF, KZ)$	-0.22***	-0.31***	-0.23***	-0.21***	-0.18***	-0.23***
$Corr(ASCF, HP)$	-0.12***	-0.16***	-0.16***	-0.34***	-0.06***	-0.34***

Notes. The table shows the correlation between our new index (ASCF) based on age, size and the mean cash flow with other financial constraints indices such as the Whited-Wu (WW), the Kaplan-Zingales (KZ) and the Hadlock-Pierce (HP) index.
WW $= -0.091 * \frac{CF}{TA} - 0.044 * ln(TA) + 0.021 * \frac{Longtermdebt}{TA} - 0.035 * salesgrowth + 0.102 * industrysalesgrowth$
KZ $= -1.001909 * \frac{CF}{TA} + 3.139193 * \frac{Longtermdebt}{TA} - 1.314759 * \frac{Cash}{TA} + 0.2826389 * q$
HP $= -0.737 * ln(TA) + 0.043 * (ln(TA))^2 - 0.04 * age$

negative (with KZ and HP). This should not necessarily be seen as surprising since the existing indices were built using data on listed companies while our data consists only of unlisted firms, nor should it necessarily be seen as an evil since recent research shows that the existing indices do not adequately measure financial constraints. (Farre-Mensa and Ljunqvist, 2013)

As can be seen in Figure 2, constrained firms are expected to pay a higher interest rate on their external finance, and hence the interest rate that firms pay on their financial debt could be an important confirmation of our identification strategy. Therefore, we will try to actually measure this interest rate, and relate it to our index to validate whether the ASCF index is a good proxy for the supply of finance in the next section.

4.2 Interest rates as an additional measure of financial constraints

Our measure of the interest rate is calculated as the ratio of the total interest paid (as reported in the profit and loss account) over the interest carrying liabilities, which are defined as the sum of the long term liabilities and the short term financial liabilities.

Petersen and Rajan (1997) argue that debt enforcement theories and the equity-stake theory of trade credit explain why suppliers are still willing to lend to financially constrained firms. Their evidence suggests that firms use more trade credit when credit from financial institutions or markets is limited or unavailable. In line with their suggestion that financially constrained firms use more trade credit, we find positive correlations between interest rates and net trade credit -defined as accounts payable minus accounts receivable- for all countries considered in our study (see Table 3, panel A). This is consistent with the interpretation that firms with more difficult access to external finance (higher interest rates) substitute external finance for net trade credit, while firms with easy access to external finance (low interest rates) also draw on external finance to invest in net trade credit. This indicates that it is mainly the supply of external finance and the associated cost of finance that is binding for firms.

Before analysing panel B of Table 3 it is important to note that the results are only designed to compare within countries. Several reasons come to mind. Cross country analysis might be hard to do since there are important institutional differences that we are (un)aware of and are hard to filter out (e.g. different central bank policy). The composition of the samples is not exactly the same in all countries, in terms of firm characteristics, sectoral presence, or even in terms of the years (boom/recession) that they are present. These reservations do however allow within country analysis as the construction of constraint-index is done for firms within the same year, within the same sector (and obviously within the same country).

Panel B of Table 3 shows that firms that are more constrained according to our index pay -on average- a higher interest rate on their financial debt. A t-test on the equality of the means shows that the mean interest rates are in each country statistical significantly different from each other for each constraint-group. Secondly, panel B of Table 3 documents that firms that face a constrained supply of external finance invest significantly less than unconstrained firms in all countries but Hungary. The evidence that firms for which external finance is more costly invest less should not be surprising

Table 3: Financial constraints and the interest rate

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
Panel A						
$Corr(R, \frac{netTC}{K})$	0.13***	0.20***	0.21***	0.20***	0.08***	0.15***
Panel B						
$R\ (fincon = LOW)$	2.79%	2.26%	2.99%	3.70%	4.93%	4.67%
t-test $H_0 : low - high = 0$	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
$R\ (fincon = HIGH)$	3.29%	2.68%	3.79%	5.08%	6.23%	5.45%
$I/K\ (fincon = LOW)$	0.12	0.12	0.13	0.16	0.08	0.15
t-test $H_0 : low - high = 0$	0.00***	0.00***	0.00***	0.00***	0.00***	0.49
$I/K\ (fincon = HIGH)$	0.11	0.10	0.11	0.12	0.06	0.15
Panel C						
$Corr(ASCF, R)$	0.17***	0.16***	0.21***	0.23***	0.10***	0.14***
$Corr(WW, R)$	0.06***	0.12***	0.15***	0.15***	-0.02***	0.01
$Corr(KZ, R)$	-0.16***	-0.18***	-0.16***	-0.14***	-0.18***	-0.26***
$Corr(HP, R)$	-0.02	-0.01***	-0.06***	-0.10***	0.16***	0.03***

Notes. Panel A reports correlations of the implicit interest rate (R) with net trade credit (accounts payable (TCP) minus accounts receivable (TCR)). Where the net trade credit is denoted by the capital stock, and R is the ratio of the total interest paid over the interest carrying debt. The interest carrying liabilities are the sum of the long term liabilities and the short term financial liabilities. Panel B shows the average R that firms pay on their debt and the average investment level (I/K) for all the firms classified in a given constraint group. Panel C shows the correlation between the respective indices and R. * indicates that the either the correlation or the conducted t-test is significantly different from zero at the 10% level; ** and ***, respectively at the 5% or 1% level.

as can be seen in Figure 2: a low supply of external finance is associated with a higher cost of finance and a lower amount of borrowed funds, which indirectly implies that constrained firms cannot invest as much as unconstrained firms. However, this can be seen as another indication that the index correctly measures the supply of finance. If the index would be positively correlated with the demand for finance, it could be possible to observe a demand driven higher interest rate for those firms that we consider financially constrained, but then they should also invest more instead of less. Table 3 thus shows that financial market frictions have real effects as firms that have a more costly access to finance invest significantly less. Also Minton and Schrand (1999) found this direct negative relation between capital costs and investment levels.

Finally, panel C of Table 3 displays the correlation of our index (and of other widely used indices) with the implicit interest rate. As argued above, if our identification of constrained supply of external finance is correct, we should observe that firms that are more constrained pay a higher interest rate on their debt. The Table reveals that our index has the strongest correlation with the implicit interest rate, while some of the existing indexes even have a negative correlation with the interest rate.

5 Empirical Approach and Estimation

5.1 The investment model

Our reduced form investment model is based on the error correction model (1) and follows the work of Bond et al. (2003), Mizen and Vermeulen (2005), Bloom et al. (2007) and Guariglia (2008). Changes in the capital stock are related to the optimal capital stock (k^*) and are dynamic, reflecting that capital adjustment is costly. As in the previous cited research, we use the approximation that $\Delta k_t \approx \frac{I_{it}}{K_{it-1}} - \delta_i$ and make the assumption that the optimal capital stock is related to output ($k^* \approx s$).

This gives model (2) which can now be estimated with our data. (See the Appendix for a full derivation of the model.) The widely used structural Q-model of investment is not applicable because the firms in our dataset are unquoted and hence it is not possible to construct a tobin's q with our data.

$$\Delta k_t = \alpha_1 \Delta k_{t-1} + \alpha_2 (k_{it-2} - k^*_{it-2}) + \alpha_3 \Delta k^*_{it} + \alpha_4 \Delta k^*_{it-1} + \upsilon_i + \upsilon_t + \upsilon_{jt} + \epsilon_{it} \quad (1)$$

$$\frac{I_{it}}{K_{it-1}} = \alpha_1 \frac{I_{it-1}}{K_{it-2}} + \alpha_2 (k_{it-2} - s_{it-2}) + \alpha_3 \Delta s_{it} + \alpha_4 \Delta s_{it-1} + \upsilon_i + \upsilon_t + \upsilon_{jt} + \epsilon_{it} \quad (2)$$

Where I is the firm's investment, K the replacement value of the firm's capital stock and k its logarithm, s is the logarithm of real total sales. The subscript i indexes firms, the subscript j industries and the subscript t, time, where $t =$ 1996-2008. The error term consists of four components: an unobserved firm specific component υ_i, a time component to filter out business cycle effects υ_t, a time component which varies over industries accounting for industry specific effects υ_{jt} and finally an idiosyncratic component ϵ_{it}. The error-correction term $(k_{it-2} - s_{it-2})$ captures the long run equilibrium between capital and its target, proxied by sales.

The reduced form investment model (2) (as well as the majority of structural models in the literature) makes the assumption of perfect capital markets. This implies that a firm's investment decision is independent of its financial decision, and therefore, financial variables should not play a role for investment. Fazzari et al. (1988) were the first to test this assumption by including cash flow in the empirical specification. Since then, including cash flow has become a common way in the literature to test for capital market frictions, so we augment model (2) with cash flow ($\frac{CF_{it}}{K_{it-1}}$) to obtain the baseline model (3).

$$\begin{aligned} \frac{I_{it}}{K_{it-1}} &= \alpha_1 \frac{I_{it-1}}{K_{it-2}} + \alpha_2 (k_{it-2} - s_{it-2}) + \alpha_3 \Delta s_{it} + \alpha_4 \Delta s_{it-1} \\ &\quad + \alpha_6 \frac{CF_{it}}{K_{it-1}} + \upsilon_i + \upsilon_t + \upsilon_{jt} + \epsilon_{it} \qquad (3) \end{aligned}$$

All specifications are estimated with the first difference General Method of Moments (GMM) estimator developed by Arellano and Bond (1991). The first difference GMM estimator is appropriate since it controls for biases due to unobserved firm-specific effects and the endogeneity of explanatory variables. Note that we are estimating a reduced form model and therefore we need to be careful in interpreting the results. Moreover, as the instruments used in the estimations sometimes differ between countries, we shall focus on the economic importance of the findings rather than on the cross country comparison. The measure of the interest rate introduced in section 4.2 will help us draw valid conclusions from the results. The instruments used for the endogenous variables are I_{it-2}/K_{it-3}, Δs_{it-2}, $k_{it-2} - s_{it-2}$, Δemp_{t-2}, CF_{it-2}/K_{it-3} and/or further lags. The exogenous time dummies and industry-time dummies are instrumented by themselves. Roodman (2009) warns for issues related to too many instruments used in the first difference GMM, but especially in the system GMM. Roodman (2009) points to efficiency problems that arise when the number of instruments is close to the number of crossections, which is likely not an issue in our case. Another issue relates to the weak power of the J-test when instruments are many, but note that few guidelines exist in the literature about how many instruments are too many to trust the J-statistic. In any case, we try to cap the number of instruments per period as much as possible.

Table 4 presents the estimates of specification (3). The lagged investment term is negative in some countries and zero in others. The error correction term always has a significant negative sign, indicating that when capital is lower than its desired level, investment increases, ensuring a return to the equilibrium level. Table 4 further indicates a significant positive relationship between sales growth and investment. The positive and significant value for cash flow implies that an increase in cash flow enables firms to invest more. Since all the firms in our sample are unquoted it is likely that this observed investment-cash flow sensitivity is an indication of financial constraints. A bit surprising, while the point estimate of cash flow in Hungary is very similar to that in other countries, it is not significant at the 10 percent level, but

Table 4: Baseline Estimation: model (3)

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
I_{it-1}/K_{it-2}	-0.085	-0.182***	-0.204***	-0.008	0.016	-0.094**
	(0.054)	(0.028)	(0.021)	(0.103)	(0.027)	(0.044)
$k_{it-2} - s_{it-2}$	-0.218***	-0.191***	-0.247***	-0.165***	-0.127***	-0.195***
	(0.045)	(0.020)	(0.023)	(0.026)	(0.022)	(0.063)
Δs_{it}	0.214***	-0.075	0.152***	0.183***	0.123***	0.082
	(0.063)	(0.101)	(0.036)	(0.028)	(0.035)	(0.063)
Δs_{it-1}	0.209***	0.153***	0.258***	0.173***	0.141***	0.216***
	(0.042)	(0.031)	(0.021)	(0.026)	(0.021)	(0.044)
CF_{it}/K_{it-1}	0.080***	0.057***	0.029***	0.042***	0.078***	0.073
	(0.023)	(0.014)	(0.011)	(0.008)	(0.025)	(0.049)
$sector/year\ dummies$	YES	YES	YES	YES	YES	YES
$\#instruments$	139	89	283	117	251	167
$m2$	0.94	0.07	0.51	0.44	0.25	0.31
J	0.53	0.13	0.09	0.13	0.37	0.87
$\#firms$	2,555	69,801	9,876	31,396	2,101	1,405
$\#obs$	17,117	404,366	58,097	141,475	13,697	7,443

Notes. The Table shows the output for the GMM first difference estimation of specification (3). The estimates are robust to heteroscedastic standard errors. All specifications were estimated with time dummies and time dummies interacted with industry dummies. m2 shows the p-value of the test of serial correlation in the error terms, under the null of no serial correlation. Values presented for the J-statistic are p-values of the test of overidentifying restrictions of the instruments, under the null of instrument validity. * indicates significance at, the 10% level; ** and ***, respectively at the 5% or 1% level.

we will come back to this when we do some robustness checks. Quantitatively, our results are similar across countries and consistent with previous research. Finally, $m2$ provides no indication that the instruments would be correlated with the error term. The null hypothesis of no second order serial correlation cannot be rejected in all our regressions. Also the null hypothesis of instrument validity, known as the Sargan test of overidentifying restrictions (J), cannot be rejected in all our specifications.

5.2 The investment opportunities bias

As Bond and Van Reenen (2005) point out, this approach is valid in a structural model because all information about investment opportunities is captured by q and thus any information content of cash flow can be expected to reflect capital market imperfections.[4] While our reduced form model (3) bypasses the known problems with measurement error in q, it does not control for the possible information content of cash flow regarding investment opportunities and the expectation about future marginal revenue. To control for the latter, model (3) is augmented with firm level employment growth (Δemp_{it-1}) under the assumption that firms will increase their workforce if they expect good investment opportunities.[5] Labour chosen at the beginning of the period thus controls for the unobserved opportunity shock. As labour is assumed to be more flexible than capital in the production process, employment reacts in period t and investment in period t+1 to expected opportunities $E_t[opportunities_{t+1}]$. When the opportunities hence realise in period t+1, they will affect cash flow in t+1 which might coincide with the augmented planned investment in t+1 due to the opportunity shock. Firms with better investment opportunities are thus likely to increase their workforce while firms with bad investment opportunities

[4]This approach is no longer valid if the structural model is not correctly specified or when marginal q does not fully capture the future marginal revenue of investing. See Erickson and Whited (2000) and Cummins et al. (2006) on the problems with measurement error in q.

[5]The literature on the identification of production functions uses a similar approach to control for shocks that are observed by the firm but not the econometrician. See for instance Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2006).

are likely to lay off some employees. If investment reacts to cash flow because it reveals investment opportunities, cash flow should not be significant anymore after the inclusion of beginning of period employment growth as shown in model (4).

One might argue that labour is not so flexible in Belgium and France, which would invalidate our approach. This is true when one considers the hiring and especially firing of employees. However, when business booms, firms in these countries ask their employees to work overtime rather than hiring new employees, and vice versa when business slows down. Such behaviour would indeed not be visible when employment growth is measured by the number of employees, but will be visible when employment growth is measured by the cost of the employees. So we can assume that the total costs are a better reflection of the total hours worked by the employees, than the number of employees itself. Another advantage of using the costs of employees is that the data on the actual number of employees has a lot more missing values in Amadeus.[6] In the remainder of the paper, we refer to growth in the real total costs of employees as employment growth, unless explicitly stated differently.

$$\begin{aligned}\frac{I_{it}}{K_{it-1}} &= \alpha_1\frac{I_{it-1}}{K_{it-2}} + \alpha_2(k_{it-2} - s_{it-2}) + \alpha_3\Delta s_{it} + \alpha_4\Delta s_{it-1} \\ &\quad +\alpha_5\Delta emp_{it-1} + \alpha_6\frac{CF_{it}}{K_{it-1}} + \upsilon_i + \upsilon_t + \upsilon_{jt} + \epsilon_{it} \qquad (4)\end{aligned}$$

Table 5 shows the correlation between employment growth on the one hand, and the investment level and cash flow on the other hand. Investment is positively related to employment growth in all the countries under investigation, showing that higher opportunities are indeed associated with higher levels of investment. It can also be seen that cash flow has a positive relation with employment growth, again in every country. This could be an indication that also cash flow is associated with higher opportunities. If this is what drives the sensitivity of investment to cash flow, then the sensitivity should disappear after including employment growth in the regression.

[6]We loose approximately 40 percent of the data when using the actual number of employees rather than the cost of employees. Nonetheless, later in the robustness section we will estimate one of the models with the actual number of employees as a sensitivity check.

Table 5: Investment opportunities proxied by employment growth: correlations

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
$Corr(\Delta emp_{t-1}, I_t/K_{t-1})$	0.12***	0.10***	0.09***	0.07***	0.17***	0.17***
$Corr(\Delta emp_{t-1}, CF_t/K_{t-1})$	0.08***	0.08***	0.06***	0.03***	0.17***	0.14***
$\#obs$	17,117	404,366	58,097	141,475	13.697	7,443

Notes. The Table shows correlations between employment growth and investment and between employment growth and cash flow. * indicates that the correlation is significantly different from zero at the 10% level; ** and ***, respectively at the 5% or 1% level.

However, it is clear from Table 6 that the investment opportunities bias does not drive the investment-cash flow sensitivity. In Belgium, France, Finland, Sweden and the Czech Republic investment still reacts significantly positive to a windfall in cash flow. In Hungary, the investment is not sensitive to the availability of cash flow, but that was already the case before the inclusion of employment growth. Given that our sample contains mostly small firms this finding is consistent with Carpenter and Guariglia (2008), who augmented a Q-model of investment with firm level opportunities and found that the cash flow sensitivity remains unchanged (or even increased) for small firms. In contrast to Carpenter and Guariglia (2008) our proxy for firm level opportunities is a measure of employment growth, which has the advantage of being available in many datasets.

Further, the estimates for the lagged investment, the error correction term and sales growth parameters of model (4) are very comparable to those in model (3). The evidence on the impact of employment growth is not entirely robust. It is significantly positive in 5 countries and positive but insignificant in Belgium. This is however not so important, since we only want to make sure that the investment-cash flow sensitivities are a true reflection of underlying financial constraints by controlling for the effect of investment opportunities on investment.

Table 6: Baseline Estimation: model (4)

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
I_{it-1}/K_{it-2}	-0.088**	-0.083	-0.218***	-0.121	0.007	-0.118**
	(0.044)	(0.085)	(0.020)	(0.079)	(0.039)	(0.048)
$k_{it-2} - s_{it-2}$	-0.220***	-0.157***	-0.260***	-0.198***	-0.130***	-0.208***
	(0.038)	(0.025)	(0.021)	(0.021)	(0.029)	(0.049)
Δs_{it}	0.204***	-0.027	0.180***	0.147***	0.120***	0.115**
	(0.059)	(0.079)	(0.034)	(0.023)	(0.039)	(0.052)
Δs_{it-1}	0.210***	0.148***	0.265***	0.201***	0.131***	0.224***
	(0.036)	(0.032)	(0.020)	(0.020)	(0.029)	(0.048)
CF_{it}/K_{it-1}	0.081***	0.123***	0.024**	0.033***	0.078**	0.074
	(0.023)	(0.017)	(0.011)	(0.007)	(0.032)	(0.047)
Δemp_{it-1}	0.005	0.197***	0.014***	0.003*	0.054***	0.052***
	(0.012)	(0.080)	(0.005)	(0.002)	(0.015)	(0.017)
q_{it}	4.101	7.157	6.587	5.876	2.756	2.876
	(3.888)	(6.254)	(6.820)	(10.67)	(3.920)	(3.273)
sector/year dummies	YES	YES	YES	YES	YES	YES
#instruments	158	119	356	181	296	201
m2	0.96	0.67	0.39	0.76	0.35	0.85
J	0.81	0.17	0.17	0.13	0.17	0.50
#firms	2,555	69,801	9,876	31,396	2,101	1,405
#obs	17,117	404,366	58,097	141,475	13,697	7,443

Notes. The Table shows the output for the GMM first difference estimation of specification (4). The estimates are robust to heteroscedastic standard errors. All specifications were estimated with time dummies and time dummies interacted with sector dummies. m2 shows the p-value of the test of serial correlation in the error terms, under the null of no serial correlation. Values presented for the J-statistic are p-values of the test of overidentifying restrictions of the instruments, under the null of instrument validity. * indicates significance at, the 10% level; ** and ***, respectively at the 5% or 1% level.

5.3 Main results

As a final test, we will interact cash flow with two categorical variables $fincon = LOW_{it}$ and $fincon = HIGH_{it}$ based on our financial constraints index and estimate model (5).

$$\begin{aligned} I_{it}/K_{it-1} &= \alpha_1 I_{it-1}/K_{it-2} + \alpha_2(k_{it-2} - s_{it-2}) + \alpha_3 \Delta s_{it} + \alpha_4 \Delta s_{it-1} + \alpha_5 \Delta emp_{it-1} \\ &\quad + \alpha_{6a}\left[CF_{it}/K_{it-1} * fincon = LOW_{it}\right] \\ &\quad + \alpha_{6b}\left[CF_{it}/K_{it-1} * fincon = HIGH_{it}\right] + \upsilon_i + \upsilon_t + \upsilon_{jt} + \epsilon_{it} \qquad (5) \end{aligned}$$

Table 7 presents the estimates of model (5) for all the countries under investigation. Again we find the negative sign for the lagged investment level and the error correction term. Sales growth is positively related to investment and so are opportunities, as proxied by beginning of period employment growth. As predicted, investment-cash flow sensitivities increase as the supply of external finance decreases. The impact of cash flow on investment for firms that are considered to be financially constrained is larger in every country and significantly larger in five out of six countries. Also note that in Hungary investment-cash flow sensitivities are present for the subsample of firms that face a restricted supply of external finance. This confirms our hypothesis. As shown in the previous section constrained firms pay the highest interest rate on their debt, indicative of the restricted, more inelastic supply curve of external finance. As a consequence, a windfall gain in cash flow for these firms implies a larger drop in the cost of finance, leading to significantly higher investment.

5.4 Robustness

As argued in the previous section, we believe that the growth in the cost of employees is better suited to measure investment opportunities than the growth in the actual

Table 7: Investment-cash flow sensitivities: constrained vs unconstrained firms (model (5))

	Belgium	France	Finland	Sweden*	Czech Rep	Hungary
I_{it-1}/K_{it-2}	-0.093*	-0.068	-0.209***	-0.116	-0.000	-0.143***
	(0.051)	(0.119)	(0.022)	(0.077)	(0.044)	(0.036)
$k_{it-2} - s_{it-2}$	-0.216***	-0.147***	-0.252***	-0.189***	-0.132***	-0.230***
	(0.042)	(0.028)	(0.024)	(0.021)	(0.030)	(0.040)
Δs_{it}	0.171***	0.024	0.231***	0.134***	0.121***	0.130***
	(0.045)	(0.075)	(0.050)	(0.023)	(0.045)	(0.041)
Δs_{it-1}	0.207***	0.133***	0.267***	0.193***	0.134***	0.242***
	(0.040)	(0.037)	(0.024)	(0.021)	(0.032)	(0.035)
Δemp_{it-1}	0.016	0.204***	0.008	0.004**	0.054***	0.049***
	(0.012)	(0.075)	(0.005)	(0.002)	(0.015)	(0.015)
CF_{it}/K_{it-1}*fincon=LOW	0.044**	0.127***	0.021*	0.021***	0.077***	0.053
	(0.021)	(0.026)	(0.012)	(0.006)	(0.030)	(0.045)
CF_{it}/K_{it-1}*fincon=HIGH	0.095***	0.167***	0.048***	0.064***	0.107**	0.153***
	(0.026)	(0.028)	(0.018)	(0.013)	(0.044)	(0.058)
sector/year dummies	YES	YES	YES	YES	YES	YES
#instruments	341	113	197	209	341	277
m2	0.57	0.71	0.78	0.74	0.44	0.68
J	0.14	0.17	0.09	0.20	0.11	0.80
#firms	2,555	69,801	9,876	31,396	2,101	1,405
#obs	17,117	404,366	58,097	141,475	13,697	7,443
Wald tests						
$H_0 : low - high = 0$	0.04**	0.00***	0.03**	0.00***	0.35	0.02**

Notes. The Table shows the output for the GMM first difference estimation of specification (5). The estimates are robust to heteroscedastic standard errors. All specifications were estimated with time dummies and time dummies interacted with industry dummies. m2 shows the p-value of the test of serial correlation in the error terms, under the null of no serial correlation. Values presented for the J-statistic are p-values of the test of overidentifying restrictions of the instruments, under the null of instrument validity. * indicates significance at, the 10% level; ** and ***, respectively at the 5% or 1% level.

number of employees. Nonetheless, we test how sensitive our results are to this. Table 12 in the appendix shows that investment-cash flow sensitivities are quite similar when we use employment growth calculated from the actual number of employees instead of the cost of employees to control for opportunities.

As an additional robustness check for the way we control for opportunities we borrow an alternative measure of marginal q from D'Espallier and Guariglia (2013).[7] Table 14 in the appendix shows that the main results broadly hold when we use an alternative measure of marginal q instead of the growth in the cost of employees to control for opportunities. D'Espallier and Guariglia (2013) also test two other proxies for investment opportunities, namely, sales growth and industry sales growth. Sales growth is already an important determinant in our investment model and note that the industry-time fixed effects υ_{jt} imply that any kind of investment opportunities that are industry-time specific (e.g. industry sales growth) are controlled for and thus should not bias our results.

In this paper we have argued that investment-cash flow sensitivities arise in the presence of financial market imperfections. In this case, the mechanism should not play any role for firms that do not have external funds. We try to falsify our hypothesis by estimating our simple model (4) for firms that do not make use of bank loans, which is the most important source of external finance for the firms in our sample. The results are shown Table 15 in the Appendix and support our hypothesis. Investment-cash flow sensitivities have disappeared in all countries. On average, around 17 percent of the firms in our data set do not have short and long term bank loans on their balance sheet. Remarkably, in Hungary more than half of the firms in the data set do not seem to have bank loans on their balance sheet, which could explain why we did not find significant investment-cash flow sensitivities for Hungary

[7] As there is no market data available for the unlisted firms in our sample, traditional variables such as Tobin's Q or Fundamental Q cannot be computed. Honda and Suzuki (2000) developed an accounting proxy for marginal q, which D'Espallier and Guariglia (2013) use to control for investment opportunities. The accounting proxy for marginal q is basically defined as the ratio of profit per unit of capital over the cost of capital.

in Table 4 and Table 6, while we did for the other countries. This provides further evidence that investment-cash flow sensitivities are related to the relaxation of credit constraints (i.e. a drop in the cost of finance), induced by a windfall gain in cash flow.

Moreover, our findings do not seem to be driven by country specific elements as we find that investment-cash flow sensitivities are highest for constrained firms in almost all countries investigated. As argued above, the instruments used in the regressions are not exactly the same in every country, nor is the composition of the sample exactly the same across countries; therefore, a cross-country comparison of the size of the mechanism should be avoided. Nonetheless, it is clear that -unrelated to the economic structure of a country- a windfall gain in cash flow instigates most investment to those firms that face the most restricted credit supply.

6 Conclusion

Consensus on what drives investment-cash flow sensitivities has yet to be reached. In this paper, we argue that investment-cash flow sensitivities are related to capital market imperfections and rise with the interest rate on external funds. Recent research of Farre-Mensa and Ljunqvist (2013) shows that existing, widely used indices do not adequatly measure financial constraints. Therefore, we first create a new index to identify the supply of external finance that firms face in six European countries with different economic systems and institutions between 1996 and 2008.

We find that firms classified as constrained according to our index, pay on average the highest interest rate on their financial debt. Additionally, firms facing a higher cost of finance resort significantly more to other sources (net trade credit) to finance their operations and have lower investment levels. We show that our financial constraints index correlates positive with the cost of finance, while existing indices correlate much less or even negatively with the cost of finance.

Finally, we argue that it is especially for these constrained firms, characterised by a higher cost of finance, that a windfall gain in cash flow results in a larger drop of the interest rate, thereby making new investment possible. Indeed, the investment-cash flow sensitivities are largest for the firms that face the most restricted credit supply according to our index.

Importantly, these findings are not related to the possible correlation between cash flow and investment opportunities (Erickson and Whited, 2000; Cummins et al., 2006), because we control for this relationship by augmenting the empirical model with a firm level control variable for opportunities: beginning of period employment growth. Firms will increase their workforce if they expect future growth opportunities. We show that employment growth is positively related to both investment and cash flow and can thus be a good control variable.

By providing new evidence consistent with the recent findings of Campbell et al. (2012) that the cost of capital is the driving force behind investment-cash flow sensitivities, this paper advocates the interpretation that investment-cash flow sensitivities reflect the role of cash flow in alleviating credit frictions, rather than differences in credit demand or investment opportunities. Our results also imply that credit market imperfections are still widely present and that policymakers may do well to ponder on the question how they could further alleviate these financial frictions and make investment and economic growth less dependent on internal cash flow generation.

We propose that future research on financial constraints complements the data on quantity outcomes with the information provided by implicit interest rates to ensure a better identification of financial constraints and more consistent tests of the underlying financial theories. Our results would be further reinforced if future studies affirm our findings with different measures of investment opportunities, possibly based on different data sources, such as firm surveys. Finally, this paper investigated the dynamics of investment in tangible fixed assets. Investigating investment-cash flow sensitivities in the context of other important types of investment such as for instance inventory investment is an interesting avenue for future research.

References

Ackerberg, D., Caves, K., Fraser, G., 2006. Structural identification of production functions. UCLA mimeo.

Allayannis, G., Mozumdar, A., May 2004. The impact of negative cash flow and influential observations on investment-cash flow sensitivity estimates. Journal Of Banking & Finance 28 (5), 901–930.

Alti, A., 2003. How sensitive is investment to cash flow when financing is frictionless? Journal of Finance 58, 707–722.

Arellano, M., Bond, S., Apr. 1991. Some tests of specification for panel data - monte-carlo evidence and an application to employment equations. Review Of Economic Studies 58 (2), 277–297.

Becchetti, L., Castelli, A., I., H., 2010. Investment-cash flow sensitivities, credit rationing and financing constraints in small and medium-sized firms. Small Business Economics 35, 467–497.

Bernanke, B., Gertler, M., Gilchrist, S., Feb. 1996. The financial accelerator and the flight to quality. Review Of Economics And Statistics 78 (1), 1–15.

Bloom, N., Bond, S., Van Reenen, J., Apr. 2007. Uncertainty and investment dynamics. Review Of Economic Studies 74 (2), 391–415.

Blundell, R., Bond, S., Devereux, M., Schiantarelli, F., Jan. 1992. Investment and tobins-q - evidence from company panel data. Journal Of Econometrics 51 (1-2), 233–257.

Bond, S., Elston, J. A., Mairesse, J., Mulkay, B., Feb. 2003. Financial factors and investment in Belgium, France, Germany, and the United Kingdom: A comparison using company panel data. Review Of Economics And Statistics 85 (1), 153–165.

Bond, S., Meghir, C., 1994. Dynamic investment models and the firm's financial policy. Review of Economic Studies 61(2), 197–222.

Bond, S., Van Reenen, J., 2005. Handbook of Econometrics. Elsevier, North Holland, Ch. Microeconometric models of investment and employment.

Campbell, J., Dhaliwal, D., Schwartz, W., 2012. Financing constraints and the cost of capital: Evidence from the funding of corporate pension plans. The Review of Financial Studies 25, 868–912.

Carpenter, R., Guariglia, A., 2008. Cash flow, investment, and investment opportunities: New tests using UK panel data. Journal Of Banking & Finance 32, 1894–1906.

Carpenter, R. E., Fazzari, S. M., Petersen, B. C., 1994. Inventory investment, internal-finance fluctuations, and the business-cycle. Brookings Papers On Economic Activity (2), 75–138.

Carpenter, R. E., Fazzari, S. M., Petersen, B. C., Nov. 1998. Financing constraints and inventory investment: A comparative study with high-frequency panel data. Review Of Economics And Statistics 80 (4), 513–519.

Chen, J., Chen, S., 2012. Investment-cash flow sensitivity cannot be a good measure of financial constraints: Evidence from the time series. Journal of Financial Economics 103, 393–410.

Cleary, S., Apr. 1999. The relationship between firm investment and financial status. Journal Of Finance 54 (2), 673–692.

Cleary, S., 2006. International corporate investment and the relationships between financial constraint measures. Journal of Banking & Finance 30(5), 1559–1580.

Cleary, S., Povel, P., Raith, M., Mar. 2007. The u-shaped investment curve: Theory and evidence. Journal Of Financial And Quantitative Analysis 42 (1), 1–39.

Cummins, J., Hasset, K., Oliner, S., 2006. Investment behavior, observable expectations, and internal funds. American Economic Review 96, 796–810.

D'Espallier, B., Guariglia, A., 2013. Does the investment opportunities bias affect the investment-cash flow sensitivities of unlisted SMEs? The European Journal of Finance.

Duchin, R., Ozbas, O., Sensoy, B., 2010. Costly external finance, corporate investment, and the subprime mortgage credit crisis. Journal of Financial Economics 97, 418–435.

Erickson, T., Whited, T., 2000. Measerment error and the relationship between investment and q. Journal of Political Economy 108, 1027–1057.

Farre-Mensa, J., Ljunqvist, A., 2013. Do measures of financial constraints measure financial constraints? NBER Working Paper 19551.

Fazzari, S., Hubbard, R., Petersen, B., 1988. Financing constraints and corporate investment. Brookings Papers on Economic Activity 1, 141–195.

Francis, B., Hasan, I., Song, L., Waisman, M., 2013. Corporate governance and investment-cash flow sensitivities: Evidence from emerging markets. Emerging Market Reveiw 15, 57–71.

Gilchrist, S., Himmelberg, C., 1995. Evidence on the role of cash flow for investment. Journal of Monetary Economics 36(3), 541–572.

Guariglia, A., Sep. 2008. Internal financial constraints, external financial constraints, and investment choice: Evidence from a panel of UK firms. Journal Of Banking & Finance 32 (9), 1795–1809.

Hadlock, C. J., Pierce, J., 2010. New evidence on measuring financial constraints: Moving beyond the KZ index. Review of Financial Studies 23(5), 1909–1940.

Honda, Y., Suzuki, K., 2000. Estimation of the investment treshold of large Japanese manufacturers. The Japanese Economic Review 51, 473–491.

Hoshi, G., Kashyap, A., Sharfstein, D., 1992. Corporate structure, liquidity and investment: Evidence from japanese industrial groups. Quarterly Journal of Economics 90, 33–61.

Kashyap, A. K., Lamont, O. A., Stein, J. C., Aug. 1994. Credit conditions and the cyclical behavior of inventories. Quarterly Journal Of Economics 109 (3), 565–592.

Levinsohn, J., Petrin, A., 2003. Estimating production functions using inputs to control for unobservables. Review Of Economic Studies 70, 317–341.

Minton, B. A., Schrand, C., Dec. 1999. The impact of cash flow volatility on discretionary investment and the costs of debt and equity financing. Journal Of Financial Economics 54 (3), 423–460.

Mizen, P., Vermeulen, P., 2005. Corporate investment and cash flow sensitivity: What drives the relationship? European Central Bank Working Paper 485.

Olley, S., Pakes, A., 1996. The dynamics of productivity in the telecommunications equipment industry. Econometrica 64, 1263–1297.

Petersen, M., Rajan, R., 1997. Trade credit: Theories and evidence. The Review of Financial Studies 10(3), 661–691.

Rauh, J., 2006. Investment and financing constraints: Evidence from the funding of corporate pension plans. Journal of Finance 61, 33–71.

Roodman, D., 2009. A note on the theme of too many intsruments. Oxford Bulletin of Economics and Statistics 71, 135–158.

Schiantarelli, F., 1995. Financial constraints and investment: Methodological issues and international evidence. Oxford Review of Economic Policy 12,2, 70–89.

Whited, T., 1992. Debt, liquidity constraints and corporate investment: Evidence from panel data. Journal of Finance 47, 1425–1460.

7 Appendix

Table 8: Definition of variables

p^f_t	gross fixed capital formation deflator$_t$
p^g_t	GDP deflator$_t$
I_{it+1}	$(tangible\ fixed\ assets_{it+1}/p^f_{t+1} - tangible\ fixed\ assets_{it}/p^f_t) + depreciation_{it+1}/p^f_{t+1}$
$K_{it=0}$	$tangible\ fixed\ assets_{it=0}$
$K_{it\neq 0}$	$K_{it} * (1-\delta) * (p^f_{t+1}/p^f_t) + I_{it+1}$
k_{it}	$\log(K_{it})$
$sales_{it}$	$nominal\ sales_{it}/p^g_t$
s_{it}	$log(sales_{it})$
CF_{it}	$cashflow_{it}/p^g_t$
$cost\ of\ employees_{it}$	$nominal\ cost\ of\ employees_{it}/p^g_t$
Δemp_{it}	$log(cost\ of\ employees)_{it} - log(cost\ of\ employees)_{it-1}$
$net\ TC_{it}$	$(accounts\ payable_{it} - accounts\ receivable_{it})/p^g_t$
R_{it}	$interest\ paid_{it}/(noncurrent\ liabilities_{it} + current\ liabilities_{it} - accounts\ payable_{it})$
bank loans	current liabilities loans + noncurrent liabilities long term debt

Model derivation

The error correction model for investment follows Bond et al. (2003), Mizen and Vermeulen (2005) and Guariglia (2008). This model starts from the assumption that the desired capital stock can be written as a log linear function of output (y_{it}) and the real user cost of capital[8] (j_{it}) and is shown by equation (6).

$$k_{it} = \upsilon_i + y_{it} + \sigma j_{it} \tag{6}$$

To account for adjustment costs, an autoregressive distributed lag specification with up to second-order dynamics of equation (6) is considered. Note that the long

[8]In the empirical model, variation in the real user cost of capital is controlled for by time dummies and further subsumed by the fixed effects.

run unit elasticity of capital with respect to output in equation (6) implies the restriction that $(1-\alpha_1-\alpha_2)/(\beta_0+\beta_1+\beta_2)$=1 in equation (7).

$$k_{it} = \alpha_1 k_{it-1} + \alpha_2 k_{it-2} + \beta_0 y_{it} + \beta_1 y_{it-1} + \beta_2 y_{it-2} \tag{7}$$

This model can be rewritten to obtain the regression model (1). First subtract k_{t-1} from the left and right hand side to obtain equation (8). In the next step, add and subtract $(\alpha_1-1)k_{t-2}$ from the right hand side to obtain equation (9). Next, add and subtract $\beta_0 y_{t-1}$ from the right hand side to obtain equation (10). Finally, add and subtract $(\beta_0+\beta_1)y_{it-2}$ from the right hand side to obtain equation (11). Using the restriction that $(1-\alpha_1-\alpha_2)/(\beta_0+\beta_1+\beta_2)$ is equal to 1, equation (11) can be rewritten to get equation (12).

$$\begin{aligned}
\Delta k_{it} &= (\alpha_1-1)k_{it-1} + \alpha_2 k_{it-2} + \beta_0 y_{it} + \beta_1 y_{it-1} + \beta_2 y_{it-2} && (8)\\
\Delta k_{it} &= (\alpha_1-1)\Delta k_{it-1} + (\alpha_1-1+\alpha_2)k_{it-2} + \beta_0 y_{it} + \beta_1 y_{it-1} + \beta_2 y_{it-2} && (9)\\
\Delta k_{it} &= (\alpha_1-1)\Delta k_{it-1} - (1-\alpha_1-\alpha_2)k_{it-2} + \beta_0 \Delta y_{it} + (\beta_0+\beta_1) y_{it-1} + \beta_2 y_{it-2} && (10)\\
\Delta k_{it} &= (\alpha_1-1)\Delta k_{it-1} - (1-\alpha_1-\alpha_2)k_{it-2} + \beta_0 \Delta y_{it} + (\beta_0+\beta_1)\Delta y_{it-1} \\
&\quad +(\beta_0+\beta_1+\beta_2) y_{it-2} && (11)\\
\Delta k_{it} &= (\alpha_1-1)\Delta k_{it-1} - (1-\alpha_1-\alpha_2)(k_{it-2}-y_{it-2}) + \beta_0 \Delta y_{it} + (\beta_0+\beta_1)\Delta y_{it-1} && (12)
\end{aligned}$$

Now equation (12) can easily be transformed into the empirical model (2) as shown below. It is assumed that the optimal capital stock is related to output ($y \approx s$), and that the percentage change in the capital stock is the investment rate: $\Delta k_t \approx \frac{I_{it}}{K_{it-1}} - \delta_i$, where δ_i is firm specific depreciation and is subsumed by the fixed effect.

$$\frac{I_{it}}{K_{it-1}} = \alpha_1 \frac{I_{it-1}}{K_{it-2}} + \alpha_2(k_{it-2} - s_{it-2}) + \alpha_3 \Delta s_{it} + \alpha_4 \Delta s_{it-1} + \upsilon_i + \upsilon_t + \upsilon_{jt} + \epsilon_{it}$$

Table 9: Descriptive statistics: identification of financial constraints

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
$fincon = LOW$	55%	56%	58%	53%	67%	64%
$fincon = HIGH$	45%	44%	42%	47%	33%	36%
age	29	18	18	25	12	10
$total\ assets$	1.34	0.68	0.94	0.58	0.62	1.22
$meanCF/K$	0.37	0.51	0.69	0.44	0.28	0.66
#*obs*	17,117	404,366	58,097	141,475	13.697	7,443

Notes. In the top part, the Table shows the share of firms in a country that are classified in a given constraint group. In the bottom part, the variable means are presented for the given variables that are used to calculated the position of the supply curve of external finance. Age is in number of year. Totalassets is in million euro. For non-euro countries the exchange rate used for conversion is that of januari 1999. In concreto: EXR swedish krona/euro = 9.0826, EXR Czech koruna/euro = 35.107, EXR Hungarian forint/euro = 250.79 . Mean CF/K is the average cash flow to capital ratio of all observations for a given firm. The coefficient of variation is the standard deviation of the firm's cash flow to capital ratio, scaled by the firm's mean cash flow to capital ratio.

Table 10: Transition probabilities: chance of being in the same constraint group next period

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
$fincon = LOW$	97%	98%	98%	97%	98%	96%
$fincon = HIGH$	95%	94%	93%	96%	84%	80%
#*obs*	17,117	404,366	58,168	141,475	13.697	7,443

Notes. In the top part, the Table shows the share of firms in a country that are classified in a given constraint group. In the bottom part, the variable means are presented for the given variables that are used to calculated the position of the supply curve of external finance. Age is in number of year. Totalassets is in million euro for Belgium, France and Finland; otherwise in million units local currency. Mean CF/K is the average cash flow to capital ratio of all observations for a given firm. The coefficient of variation is the standard deviation of the firm's average cash flow to capital ratio, scaled by the firm's mean cash flow to capital ratio.

Table 11: Descriptive statistics: industrial composition of the sample

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
agriculture and mining	1%	1%	4%	5%	12%	6%
manufacturing	38%	20%	24%	21%	50%	41%
construction	11%	18%	15%	15%	8%	12%
retail and wholesale	39%	32%	26%	27%	20%	36%
hotel and restaurant	1%	11%	4%	4%	1%	0%
services	9%	11%	19%	21%	7%	5%
health and other	1%	7%	8%	7%	2%	1%
#obs	17,117	404,366	58,097	141,475	13.697	7,443

Notes. The Table shows the share of firms in a country that belong to the given sector in our sample. The nace 2-digit level is used to compose the sectors.

Table 12: Baseline Estimation: number of employees

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
I_{it-1}/K_{it-2}	-0.141**	-0.137	-0.259***	-0.177**	0.014	-0.264
	(0.063)	(0.142)	(0.034)	(0.082)	(0.034)	(0.528)
$k_{it-2} - s_{it-2}$	-0.265***	-0.177***	-0.293***	-0.247***	-0.116***	-0.300
	(0.052)	(0.049)	(0.039)	(0.028)	(0.031)	(0.332)
Δs_{it}	0.225***	0.196	0.223***	0.134***	0.076*	0.092
	(0.060)	(0.126)	(0.039)	(0.027)	(0.042)	(0.163)
Δs_{it-1}	0.251***	0.181***	0.303***	0.231***	0.123***	0.206
	(0.046)	(0.080)	(0.036)	(0.026)	(0.030)	(0.290)
Δemp_{it-1}	0.005	0.089**	0.014***	0.005	0.016***	-0.001
	(0.014)	(0.040)	(0.005)	(0.003)	(0.005)	(0.069)
CF_{it}/K_{it-1}	0.053*	0.120***	0.015	0.053***	0.070**	-0.045
	(0.027)	(0.038)	(0.017)	(0.014)	(0.035)	(0.256
sector/year dummies	YES	YES	YES	YES	YES	YES
#instruments	145	104	334	164	187	117
m2	0.40	0.99	0.37	0.44	0.66	0.95
J	0.31	0.18	0.77	0.95	0.10	0.93
#obs	14,551	335,002	36,144	89,917	11,548	651

Notes. The Table shows the output for the GMM first difference estimation of specification (4), but uses the actual number of employees instead of the cost of employees to calculate Δemp_{it-1}. The estimates are robust to heteroscedastic standard errors. All specifications were estimated with time dummies and time dummies interacted with sector dummies. m2 shows the p-value of the test of serial correlation in the error terms, under the null of no serial correlation. Values presented for the J-statistic are p-values of the test of overidentifying restrictions of the instruments, under the null of instrument validity. * indicates significance at, the 10% level; ** and ***, respectively at the 5% or 1% level.

Table 13: Descriptive statistics: sample means and standard deviations

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
q_{it}	4.101	7.157	6.587	5.876	2.756	2.876
	(3.888)	(6.254)	(6.820)	(10.67)	(3.920)	(3.273)
$\#firms$	2,555	69,801	9,876	31,396	2,101	1,405
$\#obs$	17,117	404,366	58,097	141,475	13,697	7,443

Notes. The Table shows sample means and in parentheses the corresponding standard deviations. The subscript i indexes firms, and the subscript t, time, where t = 1996-2008. I is the firm's investment, K the replacement value of the firm's capital stock and k its logarithm, s is the logarithm of total sales, emp is logarithm of total costs of employees, and finally CF represents a firm's cash flow.

Table 14: Investment-cash flow sensitivities controlling for q: constrained vs unconstrained firms

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
I_{it-1}/K_{it-2}	-0.112***	-0.180	-0.209***	-0.311***	-0.045	-0.289***
	(0.041)	(0.142)	(0.031)	(0.059)	(0.068)	(0.084)
$k_{it-2} - s_{it-2}$	-0.234***	-0.205***	-0.258***	-0.232***	-0.186***	-0.350***
	(0.038)	(0.038)	(0.034)	(0.023)	(0.060)	(0.102)
Δs_{it}	0.190***	0.113	0.158***	0.145***	0.087*	0.167**
	(0.038)	(0.084)	(0.061)	(0.026)	(0.049)	(0.068)
Δs_{it-1}	0.230***	0.254***	0.264***	0.234***	0.182***	0.338***
	(0.031)	(0.046)	(0.033)	(0.022)	(0.057)	(0.092)
q_{it}	-0.001	-0.003	-0.004	0.002**	0.002	0.007
	(0.003)	(0.005)	(0.003)	(0.001)	(0.003)	(0.008)
CF_{it}/K_{it-1}*fincon=LOW	0.065*	0.135*	0.064*	0.008	0.076*	0.061
	(0.036)	(0.083)	(0.034)	(0.008)	(0.042)	(0.117)
CF_{it}/K_{it-1}*fincon=HIGH	0.110***	0.192**	0.135***	0.039***	0.053	0.161
	(0.040)	(0.082)	(0.044)	(0.014)	(0.056)	(0.147)
sector/year dummies	YES	YES	YES	YES	YES	YES
#instruments	341	113	196	209	341	242
m2	0.87	0.77	0.83	0.74	0.92	0.51
J	0.55	0.01	0.02	0.20	0.21	0.48
#firms	2,430	50,844	8,816	41,750	1,962	583
#obs	15,297	239,961	43,391	119,009	10,840	1,884
Wald tests						
$H_0 : low - high = 0$	0.09*	0.00***	0.03**	0.02**	0.64	0.30

Notes. The Table shows the output for the GMM first difference estimation of specification (5). The estimates are robust to heteroscedastic standard errors. All specifications were estimated with time dummies and time dummies interacted with industry dummies. m2 shows the p-value of the test of serial correlation in the error terms, under the null of no serial correlation. Values presented for the J-statistic are p-values of the test of overidentifying restrictions of the instruments, under the null of instrument validity. * indicates significance at, the 10% level; ** and ***, respectively at the 5% or 1% level.

Table 15: Baseline Estimation: no bank loans

	Belgium	France	Finland	Sweden	Czech Rep	Hungary
I_{it-1}/K_{it-2}	-0.303***	-0.166***	-0.241***	-0.178***	-0.116	-0.117**
	(0.079)	(0.044)	(0.055)	(0.034)	(0.079)	(0.056)
$k_{it-2} - s_{it-2}$	-0.365***	-0.180***	-0.252***	-0.235***	-0.214***	-0.187***
	(0.070)	(0.067)	(0.060)	(0.039)	(0.064)	(0.066)
Δs_{it}	0.140***	0.126	0.178***	0.208***	0.150***	0.055
	(0.055)	(0.143)	(0.042)	(0.034)	(0.043)	(0.070)
Δs_{it-1}	0.359***	0.180*	0.263***	0.236***	0.193***	0.202***
	(0.065)	(0.098)	(0.054)	(0.037)	(0.060)	(0.061)
Δemp_{it-1}	-0.041	0.038	0.002	0.003	0.040	0.054***
	(0.028)	(0.068)	(0.010)	(0.003)	(0.032)	(0.020)
CF_{it}/K_{it-1}	0.028	0.079	0.025	0.010	0.022	0.103
	(0.034)	(0.051)	(0.021)	(0.013)	(0.025)	(0.071)
sector/year dummies	YES	YES	YES	YES	YES	YES
#instruments	154	104	354	166	296	158
*m*2	0.18	0.52	0.58	0.50	0.52	0.41
J	0.50	0.36	0.53	0.29	0.39	0.83
#obs	2,505	91,436	10,779	22,736	2,381	4,764

Notes. The Table shows the output for the GMM first difference estimation of specification (4), but only for the subsample that has no bankloans on their balance sheet. Bank loans include both short term and long term bank debt. The estimates are robust to heteroscedastic standard errors. All specifications were estimated with time dummies and time dummies interacted with sector dummies. m2 shows the p-value of the test of serial correlation in the error terms, under the null of no serial correlation. Values presented for the J-statistic are p-values of the test of overidentifying restrictions of the instruments, under the null of instrument validity. * indicates significance at, the 10% level; ** and ***, respectively at the 5% or 1% level.