Estimating individual financial constraints

Bert D'Espallier[1], Ludo Peeters, Sigrid Vandemaele

KIZOK Research Institute, University of Hasselt, 3590 Diepenbeek, Belgium

Abstract

We estimate firm-specific *cash flow sensitivities of investment* for a panel of manufacturing SMEs, using the generalized maximum entropy-estimator (GME). Since this estimator easily allows for slope heterogeneity, we no longer have to rely on *ex-ante sample splitting,* which has been common practice in this literature. The results show a wide variation in individual sensitivities in every year, demonstrating the relevance of estimating firm-specific coefficients rather than an aggregate coefficient for assumed sub-samples. On the basis of the distribution of estimated sensitivities, differences in financial profile and financing behaviour between high sensitivity firms and the remainder of the sample were analysed . The results provide evidence for the existence of financial constraints for the high sensitivity sub-sample based on financial profile, but not on the actual use of various funding sources.

Keywords: corporate finance, small business finance, financial constraints, dynamic panel estimation, entropy econometrics, slope heterogeneity

I. Introduction

The literature on financial constraints studies the impact of financial policy on corporate investment. Both theoretical and empirical evidence point towards the existence of liquidity constraints, that potentially limit the capacity of the firm to develop over time. Theoretical arguments, referring to agency theory seem compelling and fully in line with the pecking order corporate finance paradigm (Jensen and Meckling, 1977; Myers and Majluf, 1984; inter alia.). In the empirical literature several tools have been developed that measure the extent to which constraints are present within firms. One technique frequently applied is the estimation

1

Corresponding author
Bert D'Espallier, Research Institute KIZOK, Hasselt University, Faculty of Applied Business Sciences.
Address: Universiteit Hasselt, Campus Diepenbeek, Agoralaan gebouw D, 3590 Diepenbeek
Tel: +32(0)11 26 86 39
Fax: +32(0)11 26 87 00
e-mail: bert.despallier@uhasselt.be

of *the cash flow sensitivity of investment* (Fazarri, Hubbard and Petersen, 1988; inter alia.). The idea is to extend the traditional neo-classical long-run investment model with variables capturing net worth (mostly cash flow). It has been found many times, that cash flow is indeed informative about the level of investment, and especially in firms that are *a priori* believed to be more cash constrained. Usually a sample is split up *ex-ante* using a single criterion that is likely to reflect differences in the level of constraints, such as *size, age, pay-out policy* or *access to financial markets*. A common finding is that firms, most likely to suffer from constraints, have a higher cash flow sensitivity of investment, when the investment equation is estimated using standard regression techniques.

Ever since its emergence by FHP, the cash flow sensitivity tool has been criticized on several grounds. The main critiques relate to 'investment opportunities bias', 'econometrical design' and 'ex-ante sample splitting'. Much attention has been devoted to the first and second problem. Time-series models, for instance, can be used to verify whether or not cash flow proxies for increased investment opportunities (Abel and Blanchard, 1986). Also the GMM-estimator can be used to account for the potential endogenous explanatory variables (Bond et al., 2003). The third problem however has received very little attention. The distinction between constrained and unconstrained firms, based upon an exogenous splitting criterion remains standard practice in the literature. The distinction is either implemented explicitly or by means of interaction dummies. Both approaches suffer from the same obvious drawback: Only one criterion can be tested at the same time, which results in rather limited conclusions. When the criterion *size* is used, for instance, one can only conclude that smaller firms are on average more constrained then larger firms. While this is probably true, it is not very accurate since is likely that heterogeneity exists within the sub-samples. In other words: *some* smaller firms might actually *not* be constrained and vice versa. Misclassification could occur, because of the variation within sub-samples.

In this study, we propose an approach that allows for a detailed examination of the cash flow sensitivity on the firm level. We use entropy econometrics to calculate the parameters of the investment equation for each individual firm (Golan et al., 1996; Léon et al., 1999; Peeters, 2004). As a result, we can extract the distribution of firm sensitivities and compare firm characteristics between high sensitivity firms and the remainder of the sample. Such a post-estimation analysis allows us to make explicit statements about the profile of high sensitivity firms. We perform our analysis on Belgian SMEs in the manufacturing sector over the period 2000 - 2004.

The remainder of this paper is organised as follows: the next section discusses both theoretical and empirical literature on financial constraints. Section 3 covers our methodological approach. Section 4 presents the main results of the study. Section 5 concludes and highlights contributions and implications of the study.

II. Conceptual framework

The cash constrained firm

Economic theory predicts that in a perfect market setting, investment decisions are not affected by financial decisions, since external financing can always be attracted at the true cost of capital (Modigliani and Miller, 1958). Consequently, all investment opportunities that yield a positive *net discounted value*, should be undertaken. In practice, market-frictions cause financing decisions to interfere with investment decisions. A major source of market-friction are *agency costs*. Myers and Majluf (1984) argue that asymmetric information between owner-managers and external investors leads to higher risk born by external investors. This results in an additional cost-component associated with external funding, since external investors demand a risk-premium to compensate for additional risk.

The existence of agency costs creates a wedge between the cost of internal funding and external funding (Carpenter and Petersen, 2002). The result is a hierarchy of preferred funding sources as in the traditional *pecking order* paradigm. However, when external funding sources become too expensive, due to excessively high risk premia, firms might be pushed into using internal funding sources only. At that point, pecking order behaviour is truncated and firms are 'constrained to internal finance'.

Asymmetric information problems might be particularly severe for smaller businesses. SMEs have only limited access to external financial markets, particularly in economies with relatively less developed stock markets. They usually also have a limited track-record and less collateral than their larger counterparts, which raises the risk for external financiers and results in higher risk-premia charged. Overall, smaller firms could be more constrained to internal finance then larger counterparts (Harhoff, 1997).

The cash flow sensitivity of investment

The standard approach for detecting constraints has been to look at the difference in *cash flow sensitivity of investment* between constrained and unconstrained firms. Traditionally, a sample is split-up in constrained versus unconstrained firms based upon prior beliefs. For each sub-group, an investment equation is estimated using standard regression techniques. The investment equation can take several forms, with several dependent variables, depending on the nature of the constraints under study.

As a starting point the neo-classical long run investment model described by Jorgenson (1963) is often used. In this model, the desired stock of capital $c_{i,t}$ is positively related to output $y_{i,t}$, and negatively related to the user cost of capital $j_{i,t}$:

$$c_{i,t} = a + y_{i,t} - \sigma \; j_{i,t} \tag{1}$$

Taking the first differences and applying an approximation for stock of capital: $\Delta c_{i,t} = \frac{I_{i,t}}{C_{i,t-1}} - \delta$ yields:

$$\frac{I_{i,t}}{C_{i,t-1}} = \delta + \Delta y_{i,t} - \sigma \; j_{i,t}$$

where:

$I_{i,t}$	investments in fixed assets during year t
$C_{i,t-1}$	the beginning of year capital stock
δ	the rate of depreciation
$I_{i,t} / C_{i,t-1}$	the investment-rate at year t.

This model is usually nested in a dynamic specification to capture long-term effects. Time and industry dummies are used to model the user cost of capital $j_{i,t}$. Implementing this into the specification yields:

$$\frac{I_{i,t}}{C_{i,t-1}} = \alpha \frac{I_{i,t-1}}{C_{i,t-2}} + \beta_1 \; \Delta y_{i,t} + \beta_2 \; \Delta y_{i,t-1} + d_t + a_i + \varepsilon_{i,t}$$

where d_t is a set of time dummies and a_i are the unobserved firm-specific effects.

In order to detect financial constraints, this empirical specification is extended by including variables capturing *net worth*, typically *cash flow*. All variables need to be scaled by *total assets* in order to remove size-effects. *Turnover* is often used to proxy for the output $y_{i,t}$. The empirical specification we use throughout this paper is very close to the one used by Bond et al. (2003) and Cincera (2002).

$$\frac{I_{i,t}}{TA_{i,t-1}} = \alpha + \beta \frac{CF_{i,t}}{TA_{i,t-1}} + \gamma \frac{CF_{i,t-1}}{TA_{i,t-2}} + \vartheta \frac{I_{i,t-1}}{TA_{t-2}} + \kappa \Delta turnover_{i,t} + \lambda \Delta turnover_{i,t-1} + d_t + a_i + \varepsilon_{i,t} \tag{2}$$

To measure potential liquidity constraints, the cash flow sensitivity of investment has to be analyzed. This is the *long term* response of investment with respect to cash flow and is given by:

$$LTS = long\ term\ sensitivity = \frac{\hat{\beta} + \hat{\gamma}}{1 - \hat{\vartheta}} \tag{3}$$

Ex-ante sample splitting

The sample split between constrained and unconstrained firms, is usually performed using a single criterion that is likely to be informative about the level of constraints (Schiantarelli, 1995). Common choices for the split include *size*, *pay-out policy*, *age* or *access to financial markets*. A common finding is that the sub-sample most likely to face financial constraints has a higher cash flow sensitivity of investment. The reason is that firms, constrained to internal finance, are dependent upon the availability of internally generated cash flows to finance their investments. Hence their investment-rate fluctuates with the availability of internal funds. The sample split might also be performed implicitly, by using interaction dummies for each splitting criterion as in Pawlina and Renneboog (2005), for instance. The result is the same: for each dummy-variable, a different cash flow sensitivity of investment is calculated. Again, the sub-samples constructed as the constrained ones, exhibit higher cash flow sensitivity of investment. Table 1 summarizes some studies using the results from the estimation based upon *ex-ante* sample splitting as evidence of financial constraints.

Table 1: Ex-ante sample splitting

Name	*Year*	*cash flow sensitivity constrained sample.*	*Unconstrained sample*	*Splitting criterion*	*dependent variable*
Fazzari, Hubbard and Petersen	*1988*	0.46	0.23	*Size*	*inv. fixed assets*
Harhoff	*1997*	0.42	0.26	*Size*	*inv. fixed assets*
		0.10	0.05	*Size*	*inv. R&D*
Hoshi, Kashyap and Scharfstein	*1991*	0.50	0.04	*Group dummy*	*inv. fixed assets*
Carpenter and Petersen	*2002*	0.46	0.23	*Size*	*total asset growth*
Bond, Harhoff and Van Reenen	*2003*	0.24	0.14	*Cross country*	*inv. fixed assets*
		0.75	0.45	*R&D dummy*	*inv. R&D*

Ever since the publication of the seminal paper by FHP (1988), the cash flow sensitivity tool has been criticized on several grounds. The main critiques formulated involve '*increased investment opportunities*', '*econometrical design*' and '*ex-ante sample splitting*'. Much attention has been devoted to the first and second problem. Time-series models for instance, can be used to verify whether or not cash flow proxies for increased investment opportunities (Abel and Blanchard, 1986). The GMM-estimator can be used to account for the potential endogenous explanatory variables (Bond et al. 2003).

More studies keep casting doubt on the ability of the cash flow sensitivity of investment to capture financial constraints (Kaplan and Zingales, 1997; Cleary, 1999; Alti, 2003; Almeida et al., 2004; Allayannis and Mozumdar, 2004). Other studies accept positive sensitivities as being evidence of cash constraints, and further develop the methodology (Cincera, 2002, Bond et al., 2003). In conclusion, the literature recognizes that corporate investment is sensitive to changes in net-worth. However, it remains unclear whether or not significant sensitivity is caused by the existence of liquidity constraints (Pawlina and Renneboog, 2005).

In the present study, we focus on the issue of *ex-ante sample* splitting, which has a number of limitations. Firstly, the chosen criterion has to be conceived beforehand. There has to be some theory indicating which groups of firms *could* exhibit constraints. The chosen criterion however might not necessarily be the most interesting one to focus on. Secondly, the conclusions remain rather limited, because the investigator can only say something about differences between assumed sub-samples. The splitting criteria to obtain these sub-samples are usually rather crude (*large vs. small, young vs. old*, …) and consequently, the conclusions remain rather limited. Finally, the regression analysis aggregates all sensitivities of the members of a sub-sample into one single number. Hence, any heterogeneity between sub-samples is ruled out and no variation in the level of constraints can be detected. When using the criterion *size* for instance, you can only conclude that smaller firms are *on average* more constrained then larger firms. While this is probably true, it is not very accurate since is very likely that heterogeneity might exist within the sub-samples. In other words: *some* smaller firms might actually *not* be constrained and vice versa. The obtained sensitivity of a sub-sample is an aggregate indicator, which can be very misleading, because we lack information about individual sensitivities within the sub-samples. Misclassification can occur, because of this heterogeneity in the sub-samples. Schiantarelli (1995) concludes that using only one indicator "may or may not be a sufficient statistic for the existence of liquidity constraints." Although these draw-back have been recognised by several authors, no attempts, of which we know, have been made to address the *ex-ante sample* splitting.

III. Estimating individual cash constraints

We propose an alternative approach that allows for a detailed examination of the cash flow sensitivity at the firm level, without relying on the ex-ante division into sub-samples. We use entropy econometrics to calculate the parameters of the investment equation for each individual firm (Golan et al., 1996; Léon et al., 1999; Peeters, 2004). By doing so we can extract the entire distribution of firm-specific sensitivities and compare firm characteristics between high sensitivity firms and the remainder of the sample, which serves as a control-sample. This allows us to compare the profile of high sensitivity firms with the profile of the control-sample.

We estimate the parameters of the investment equation (2) using the *generalized maximum entropy* (GME) - estimator (Golan et al., 1996). The implementation of GME requires that the parameters of the model be specified as linear combinations of some predetermined and discrete support values and associated probabilities. The estimation problem is converted into a constrained maximization problem, where the objective function consists of the entropy-information criterion, as originally formulated by Shannon (1948). Maximizing this entropy measure amounts to choosing the probability vector p that is closest to the uniform distribution, and yet consistent with the available data and the relevant constraints. The equation to be estimated appears as a *data-consistency constraint* in the model formulation.

Normalization constraints are added to ensure that the estimated probabilities add up to one. The general notation of the GME problem is as follows:

$$\max_p H(p) = -\sum_k p_k \ln p_k \qquad (4)$$

subject to:

Data-consistency: $y = Xp$ (5)

Normalization-constraint: $\sum_k p_k = 1$ (6)

with:

k	the number of parameters
p_k	the probability of each parameter to be estimated
$y = Xp$	the model you want to fit (data-consistency constraint)

The entropy-measure in (4) reaches a maximum when the probabilities are uniformly distributed ($p_1 = p_2 = ... = p_k = 1/K$). When the entropy in maximized, we obtain the set of probabilities that "can be realised in the greatest number of ways consistent with what we know" (Golan et al., 1996). These estimated probabilities can be recombined with the predetermined support values, in order to get parameter estimates.

The GME formulation of the model (2) is as follows:

$$\begin{aligned}\underset{p}{\text{Max}}\ H(.) = &-\sum_m p_{\alpha_m} \ln p_{\alpha_m} - \sum_i \sum_m p_{\beta_{i,m}} \ln p_{\beta_{i,n}} - \sum_i \sum_m p_{\gamma_{i,m}} \ln p_{\gamma_{i,m}} \\ &-\sum_m p_{\vartheta_m} \ln p_{\vartheta_m} - \sum_m p_{\kappa_m} \ln p_{\kappa_m} - \sum_m p_{\lambda_m} \ln p_{\lambda_m} - \sum_i \sum_m p_{\mu_{i,m}} \ln p_{\mu_{i,m}}\end{aligned}$$

(7)

subject to:

$$\frac{I_{i,t}}{TA_{i,t-1}} = \sum_m p_{\alpha_m} s_{\alpha_m} + \left(\sum_m p_{\beta_{i,m}} s_{\beta_{i,m}} \right) \frac{CF_{i,t}}{TA_{i,t-1}} +$$
$$\left(\sum_m p_{\gamma_{i,m}} s_{\gamma_{i,m}} \right) \frac{CF_{i,t-1}}{TA_{i,t-2}} +$$
$$\left(\sum_m p_{\vartheta_m} s_{\vartheta_m} \right) \frac{I_{i,t-1}}{TA_{i,t-2}} +$$
$$\left(\sum_m p_{\kappa_m} s_{\kappa_m} \right) \Delta turnover_{i,t} + \left(\sum_m p_{\lambda_m} s_{\lambda_m} \right) \Delta turnover_{i,t-1} +$$
$$\sum_m p_{\mu_{i,m}} s_{\mu_{i,m}}$$
$$($$

(8)

$$\sum_m p_{\alpha_m} = 1, \quad \sum_m p_{\beta_{i,m}} = 1, \quad \sum_m p_{\gamma_{i,m}} = 1,$$
$$\sum_m p_{\vartheta_m} = 1, \quad \sum_m p_{\kappa_m} = 1, \quad \sum_m p_{\lambda_m} = 1, \quad \sum_m p_{\mu_{i,m}} = 1$$

(9)

The objective function in (7) is the entropy criterion which has to be maximized. The first constraint in (8) is the data-consistency constraint which is the parametrical version of the cash flow sensitivity model (2). Each parameter is defined as a linear combination of predetermined support values and probabilities to be estimated. The second set of constraints in (9) are the normalization- constraints, which ensure that for each parameter, the estimated probabilities sum up to one. The probabilities estimated by the GME maximization problem are recombined with the predetermined support values in order to obtain parameter estimates as in (10).

$$\begin{aligned}
\hat{\alpha} &= \sum_m \hat{p}_{\alpha_m} s_{\alpha_m} \\
\hat{\beta}_i &= \sum_m \hat{p}_{\beta_{i,m}} s_{\beta_{i,m}} \\
\hat{\gamma}_i &= \sum_m \hat{p}_{\gamma_{i,m}} s_{\gamma_{i,m}} \\
& etc\ldots
\end{aligned} \tag{10}$$

We now have a model that estimates for each firm an individual cash-flow sensitivity:

$$\frac{I_{i,t}}{TA_{i,t-1}} = \hat{\alpha} + \hat{\beta}_i \frac{CF_{i,t}}{TA_{i,t-1}} + \hat{\gamma}_i \frac{CF_{i,t-1}}{TA_{i,t-2}} + \hat{\vartheta} \frac{I_{i,t-1}}{TA_{i,t-2}} + \hat{\kappa}\Delta turnover_{i,t} + \hat{\lambda}\Delta turnover_{i,t-1} + \hat{\mu}_{i,t} \tag{11}$$

with:

$\hat{\beta}_i$: The *short-run* cash flow sensitivity of investment. It measures, for firm *i*, the immediate investment response to a cash flow shock.

γ_i : The *lagged* cash flow sensitivity of investment. It measures, for firm *i*, the investment response to a cash flow shock of the previous period.

The equation (11) is equivalent with the equation (2) except for the *i*-indices who indicate the firm-specific character of the GME estimator. The firm-specific long-run cash flow sensitivity of investment (LTS_i) is given, equivalently with (3), by:

$$LTS_i = (\hat{\beta}_i + \hat{\gamma}_i)/(1-\hat{\vartheta}) \tag{12}$$

The use of GME does not require any assumption of random drawings from some particular distribution, as for example the random coefficient model (RCM) does (Peeters, 2004). In contrast with the RCM approach, GME allows to estimate a full parametric specification of the individual, unobserved firm effects, without running into a degree-of-freedom problem i.e., the problem of under-determinacy due to the fact that the number of parameters to be estimated is larger than the number of observations. As a result, the GME estimator estimates fixed or non-random parameters, whereas in conventional techniques the parameters are "predicted", based on the estimated second-order moment of the expectation vector (Léon et al., 1999; Peeters, 2004). Moreover, the GME estimator does not suffer from the potential endogeneity bias due to correlation between the varying parameters and the regressors (Peeters, 2004).

IV. Data and Results

Data and descriptive statistics

We perform our analysis on Belgian SMEs in the manufacturing sector over a 5 year time period (2000-2004). SMEs are defined following the standard OECD definition[2]. Since we are not interested in the very smallest of firms who have usually very limited asset base, we remove those SMEs with less then 5 full-time equivalent employees. 9707 firms remain in our sample. For the GME estimation we require that numbers for *investment in fixed assets* and *cash flow* be available in the observed period. We are left with 2974 firms, which means 14870 firm-years under study. In each analysis, we remove outliers by cutting off top- and low 1 percentile of every variable used[3].

Table 2 reports some important characteristics of the SME – population in the year 2003. The median firm has total assets of €1 669 000, has 15 employees and is 18 years in operation. Investments in fixed assets are relatively modest at 4% of total assets for the median firm. The cash flow of the median firm equals 10% of total assets. The debt-ratio of 66.27% indicates that the median firm has almost reached the traditional 70-30 proportion of full debt capacity.

Long-term debt is used to a much smaller extent, and the long term debt-ratio remains relatively small at 23.62%. Reserves and retained earnings constitute 17.36% of total assets, indicating that SME's tend to reserve their profits, rather then distributing them to shareholders.

Table 3 focuses on the use of various funding sources throughout the entire sample period. We see that the growth in total assets was high at 9.65% in 2000, rapidly declined in 2001 and 2000, and went back up to 9.07% in 2004. This growth was financed primarily with retained

[2] An SME has fewer then 250 employees measured in full-time equivalent; total assets are less then € 45000 000 and turnover is less then € 50 000 000.

[3] This is the standard procedure used in the financial constraints literature (Cincera, 2002)

earnings, since changes in retained earnings ($\Delta RE/TA$) exceeded changes in financial debt ($\Delta fin.debt/TA$) in every year except in the year 2000. External equity financing ($\Delta ex.equity/TA$) was the smallest funding source used and never exceeded 1 percent of total assets on average.

From the analysis in Tables 2 and 3, we conclude that growth in our SME-sample is financed primarily by internal funding, to a smaller extent with debt and to marginal extent with external equity. These results are in line with SME-financing behaviour described in other studies (Reid, 1996; Smallbone and North, 1995; Manigart and Struyf, 1997; Hughes, 1994; Freedman and Godwin, 1994; Audretsch and Elston, 1997).

Table 2: Firm characteristics of the SME-sample

firm characteristics	*Min*	*25*	*50*	*75*	*max*
total assets (x €1000)	148	764	1669	4382	28720
turnover (x€1000)	381	1291	3062	7755	42772
employees (FTE)	5	9	15	30	184
years in operation (#years)	5	13	18	29	75
investments in fixed assets (% of TA)	0	0.02	0.04	0.1	0.68
cash flow (% of TA)	0.02	0.06	0.1	0.16	0.46
Net working capital (x€1000)	-2611	23	221	791	9441
current-ratio	0.27	1.04	1.32	1.87	8.99
debt ratio	10.05%	48.55%	66.27%	78.99%	91.92%
Ltdebt ratio	0%	6.09%	23.62%	49.35%	91.83%
Reserves+retained earnings (% of TA)	-50.87%	5.70%	17.36%	35.81%	81.98%
profitability (% of TA)	-12.80%	2.63%	6.38%	12.82%	70.62%
sales margin	-6.22%	1.15%	3.00%	5.95%	23.96%

n = 2974

Only values of the year 2003 are mentioned.

Table 3: Financing behaviour throughout the sample period

Use of various funding sources throughout sample period			*all firms*
growth in total assets	*ΔTA/TA*	*2000*	9.65%
		2001	6.01%
		2002	2.82%
		2003	5.14%
		2004	9.07%
internal financing	*ΔRE/TA*	*2000*	2.45%
		2001	2.24%
		2002	2.23%
		2003	2.63%
		2004	2.50%
financial debt financing	*Δfin-debt/TA*	*2000*	2.80%
		2001	1.40%
		2002	-0.55%
		2003	0.12%
		2004	1.57%
external equity financing	*Δex. equity/TA*	*2000*	0.21%
		2001	0.46%
		2002	0.04%
		2003	0.06%
		2004	0.55%

n= 2974

Numbers are averages over all firms in the sample.

Estimation results

The model in (11) was estimated for each year in our sample period using the GAMS optimization software package. Table 4 summarizes the results from the optimization procedure. The results show that in every year investment is highly sensitive to cash flow for the vast majority of the sample. However there is a wide variety in individual sensitivities ranging from 0.17 to 2.00 in the most recent year. This wide range indicates the relevance of individual estimation rather then aggregate estimation of assumed sub-samples. The average sensitivity declines over the years from .66 in year 2000 to .51 in year 2004. Figure 1 plots the probability densities for the individual sensitivities in every year.

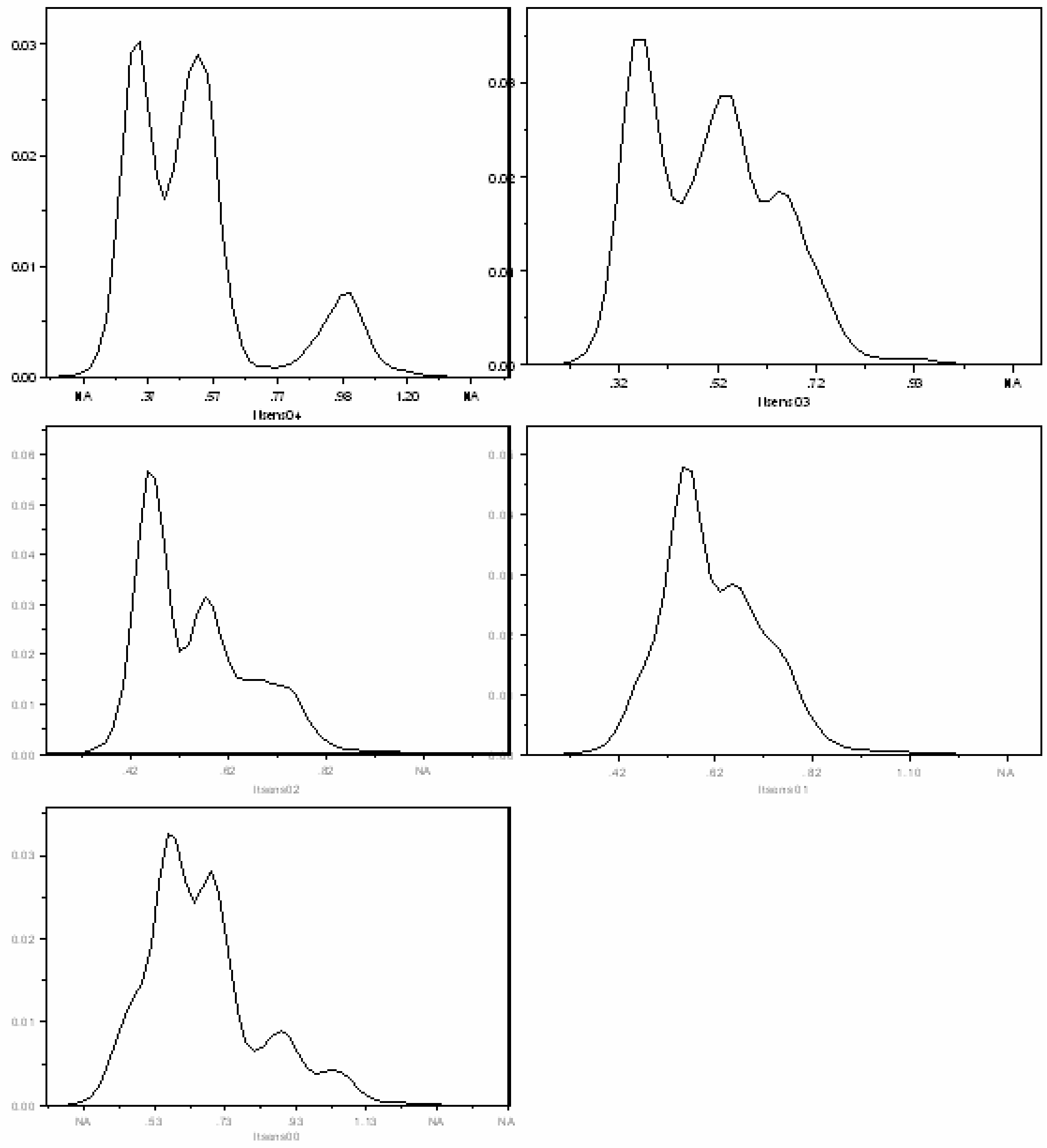
Table 4: Long-run cash flow sensitivity of investment from the GME optimization procedure

Long run sensitivity	*Mean*	*Min*	*Median*	*Max*
2004	0.51	0.17	0.47	2.00
2003	0.50	0.18	0.50	1.81
2002	0.55	0.33	0.53	1.96
2001	0.61	0.28	0.58	1.92
2000	0.66	-0.20	0.64	2.54

n=2974

Numbers are the results for long term sensitivity parameter given in (12) which come from the GME optimization procedure

figure 1: Density functions of the estimated long-term sensitivity in every year of the sample period



The financial profile of high sensitivity firms

Once we have estimated the distribution of firm-specific sensitivities, we compare firm characteristics between high sensitivity firms and a control-sample. This allows us to build up the profile of a high sensitivity firm and analyse whether we can find any evidence of financial constraints. We assign firms to the high sensitivity sub-sample if the firm has, in each year, a sensitivity higher then (*median sensitivity of that year + 0.05*). By doing this we make sure that firms are assigned to the high sensitivity sub-sample, only if they exhibit a high cash flow sensitivity *in every year* of the sample period. This way we capture firms who really invest at the pace of their cash flow, year after year. Table 5 gives information on the description of the sub-samples.

Table 5: description of sub-sample

	high sensitivity firms	*control-sample*	*all firms*
# firms	411	2563	2974
% of sample	13.80%	86.20%	100%
Average sensitivity	0.7904	0.5369	0.5704

n= 2974

We test differences in financial profile and financing behaviour between high sensitivity firms and the control-sample. We look at the financial profile both in the first and last year of the sample period, and to the funding behaviour throughout the sample period. The differences between the sub-samples are investigated using an independent samples t-test. This test uses a t-statistic to test whether the means of the sub-samples are equal (null-hypotheses) or not. Table 6 presents the summary statistics of the financial profile for the sub-samples. Table 7 summarizes the use of various funding sources for the sub-samples.

When looking at Table 6, we see two different financial profiles emerging for both sub-samples. The high sensitivity firms have a higher *financial debt ratio* and a higher *long term debt ratio*, which results in a higher *overall debt-ratio*. They also carry significantly less *liquidity* and are significantly less *profitable*. Finally they have less *reserves and retained earnings* to use as a cushion to finance future investments. Overall this profile does seem to confirm the financial constraints hypothesis. The high debt ratio of 71.92% indicates the difficulty in attracting more debt-financing in the future, unless the asset base would increase. The lower liquidity, profitability and solvency figures seem to suggest the lower attractiveness to external investors. It seems these firms do depend on internal sources to be able to finance future investment opportunities, which is implicit evidence of financial constraints.

Furthermore, this observed profile seems to be consistent over time, since we observe the same profile both in the beginning and at the end of the sample period.

When looking at the funding sources that were actually used throughout the sample period (Table 7) , we do not find any significant differences between the two sub-samples. The high sensitivity sub-sample did not use any less financial debt, nor external equity financing then the control-sample. Also the results for the use of internal funding sources and alternative funding sources (like *trade credit*) do not suggest much difference between the sub-samples. This result might be driven by the fact that many firms in the control sample have very low investment demands. These firms do not use external funding sources although they have the intrinsic balance sheet capacity to attract outside funding sources. This causes overall rates of external funding to be extremely low, blurring the distinguishing power of the cash flow sensitivity of investment.

In conclusion, the differences in financial profile do seem to suggest that the cash flow sensitivity of investment is a parameter that distinguishes between two different groups of firms. However, the observed difference is not translated into the differences in the use of various funding sources, possibly because the overall low use of external funding sources.

Table 6: differences in financial profile between high sensitivity firms and the control -sample

	variables	***definition***	***high sensitivity firms***	***control- sample***	***t-test: p-value***
financial profile in 2000	*size*	*TA*	3974	4386	0.206
	age	*years in operation*	24.52	24.01	0.541
	debt ratio	*debt / TA*	71.92%	65.75%	0.000***
	long term debt ratio	*long term debt / TA*	40.61%	31.12%	0.000***
	financial debt ratio	*financial debt / TA*	29.55%	26.43%	0.003***
	ratio of self financing	*(reserves + retained earnings) / TA*	15.12%	18.79%	0.008***
	ratio of interest expenses	*interest expenses / TA*	2.83%	2.68%	0.757
	profitability	*EBIT / TA*	5.89%	8.37%	0.000***
	current ratio	*current assets / current liabilities*	1.28	1.66	0.000***
financial profile in 2004	*size*	*TA*	4400	5068	0.138
	age	*years in operation*	24.52	24.01	0.541
	debt ratio	*debt / TA*	67.12%	61.14%	0.000***
	long term debt ratio	*long term debt / TA*	34.90%	26.33%	0.000***
	financial debt ratio	*financial debt / TA*	26.63%	24.33%	0.044**
	ratio of self financing	*(reserves + retained earnings) / TA*	18.65%	22.97%	0.021**
	ratio of interest expenses	*interest expenses / TA*	2.42%	2.38%	0.754
	profitability	*EBIT / TA*	5.77%	8.44%	0.000***
	current ratio	*current assets / current liabilities*	1.44	1.94	0.000***

p-value is the probability of the null-hypothesis of no difference

*** is the 5 percent significance level*

**** is the 1percent significance level*

Table 7: differences in financing behaviour between high sensitivity firms versus the control- sample

funding sources used	*definition*	*high sensitivity firms*	*control-sample*	*t-test: p-value*
internal sources	*ΔRE/TA 04*	2.20%	2.44%	0.665
	ΔRE/TA 03	2.34%	3.04%	0.082
	ΔRE/TA 02	1.72%	2.44%	0.074
	ΔRE/TA 01	1.75%	2.03%	0.550
	ΔRE/TA 00	1.88%	2.79%	0.067
financial debt financing	*Δfin.debt/TA 04*	2.51%	2.19%	0.824
	Δfin.debt/TA 03	0.86%	0.38%	0.501
	Δfin.debt/TA 02	-0.55%	-0.13%	0.565
	Δfin.debt/TA 01	1.87%	1.67%	0.821
	Δfin.debt/TA 00	3.41%	2.87%	0.601
external equity financing	*Δ ex. equity/ TA 04*	0.28%	0.36%	0.895
	Δ ex. equity/ TA 03	0.24%	0.22%	0.895
	Δ ex. equity/ TA 02	0.25%	0.54%	0.466
	Δ ex. equity/ TA 01	0.77%	0.63%	0.546
	Δ ex.equity/ TA 00	0.30%	0.48%	0.648
trade credit financing	*DPO-DRO 04*	13.56	5.64	0.006***
	DPO-DRO 03	9.91	6.86	0.296
	DPO-DRO 02	9.12	9.82	0.808
	DPO-DRO 01	11.62	11.62	0.498
	DPO-DRO 00	13.31	11.00	0.421

p-value is the probability of the null-hypothesis of no difference

*** is the 5 percent significance level*

**** is the 1percent significance level*

V. Conclusions and discussion

The financial constraints literature uses the *cash flow sensitivity of investment* to distinguish between constrained versus unconstrained firms. A major drawback of this approach is the *ex-ante sample splitting* using one assumed criterion such as *size, age, pay-out policy* or *access to financial markets*. Although this drawback has been recognised by several authors, the regression based analysis of sub-samples is still common practice in this literature.

In this paper, we propose an alternative approach, which allows for a detailed examination of the cash flow sensitivity at the firm level, without making any prior assumptions. We use the GME estimator to calculate the parameters of the investment equation and extract firm-specific sensitivities. Our results indicate a wide variety in individual sensitivities in every year, demonstrating the relevance of individual estimation rather then aggregate estimation of assumed sub-samples.

Once we estimated the individual sensitivities, we compared firm characteristics and financing behaviour between high sensitivity firms and the remainder of the sample, which serves as the control-sample. This allows us to make profiles of high sensitivity firms and analyse whether we can find any evidence of financial constraints. Our results show differences in financial profile between high sensitivity firms and the control-sample. In fact, we see that the profile of the high sensitivity firm does seem to match with the profile of a financially constrained firm. This conclusion, however, is not translated into differences in the actual use of the various funding sources. This is possibly because the overall low use of external funding sources because of low investment demands. We conclude that in the case of SMEs, the cash flow sensitivity of investment is, at least to some extent, able to capture differences in financial constraints.

We believe the preceding results have some interesting implications. Firstly, we address the limited capacity of a regression analysis to test for financial constraints. A regression analysis makes an aggregate sensitivity of the entire sub-sample without taking into account individual heterogeneity. This leads to limited conclusions in the best case, and serious misclassification in the worst case because of overlap between the sub-samples. Our approach does not suffer from aggregation and hence allows a more detailed analysis of the usefulness of the sensitivity parameter.

Secondly, we believe the cash flow sensitivity of investment is, to some extent, an interesting tool to determine the severity of constraints. However, the parameter does not a perfect job in distinguishing between constrained and unconstrained firms. For instance, we find that many firms in the control-sample use very little external funding sources, blurring the distinguishing power of the cash flow sensitivity of investment. Firms might be reluctant to use external equity and external debt funding because various reasons such as loss of control, pride, transaction costs, etc. (Freel 2000; Cressy and Olofsson, 1997; Hughes, 1994; Lopez-Garcia and Aybar-Arias, 2000). This causes low demand for outside funding sources and leads to *demand-constraints* rather then *supply-constraints* (Howorth, 2001). These demand-constraints might be especially severe in case of SME-financing.

Finally, we emphasize the difficulty of finding a quantitative measure that adequately captures the concept of financial constraints. A more integration of qualitative and quantitative research could help to develop a reliable tool that measures financial constraints.

VI. References

Abel A.B., Blanchard O.J., (1986), “The present value of profits and cyclical movements in investment”, *Econometrica*, Vol. 54, pp. 249-273

Allayannis G., Mozumdar A., (2004), “The impact of negative cash flow and influential observations on investment-cash flow sensitivity estimates”, *Journal of Banking and Finance,* Vol. 28, pp. 901-930

Almeida H., Campello M., Weisbach M.S., (2004), “The cash flow sensitivity of cash”, *Journal of Finance,* Vol. 59, pp. 1777-1804

Alti A., (2003), “How sensitive is investment to cash flow when financing is frictionless?”, *Journal of Finance,* Vol. 58, pp. 707-722

Audretsch D.B., Elston J.A., (1997), “Financing the German Mittelstand”, *Small Business Economics*, Vol. 9, pp. 97-110

Binks M.R., Ennew C.T., (1996), “Growing firms and the credit constraint”, *Small Business Economics*, Vol. 8, pp. 17-25

Bond S., Elston J.A., Mairesse J., Mulkay B., (2003), “Financial factors and investment in Belgium, France, Germany, and the United Kingdom: a comparison using company panel data”, *The Review of Economics and Statistics,* Vol. 85, pp. 153-165

Bond S., Harhoff D., Van Reenen J., (2003), “Investment, R&D and financial constraints in Britain and Germany”, *Centre for Economic Performance working paper,* London

Carpenter R.E., Petersen B.C., (2002), “Is the growth of small firms constrained by internal finance?”, *The Review of Economics and Statistics*, Vol. 84, pp. 298-309

Chittenden F., Hall G., Hutchinson P., (1996), “Small firm growth, access to capital markets, and financial structure: review of issues and empirical investigation”, *Small Business Economics*, Vol. 8, pp. 59-67

Cincera M., (2002), “Financing constraints, fixed capital and R&D-investment decisions of Belgian firms”, *NBB working papers*, Vol. 32

Cleary S., (1999), “The relationship between firm investment and financial status”, *Journal of Finance,* Vol. 54, pp. 673-691

Cosh A., Hughes A., (1994), “Acquisition activity in the small business sector”, in Hughes A., Storey D.J., (editors) *Finance and the small firm*, Routledge, London

Cressy R., Oloffson C., (1997), “The financial conditions for Swedish SME’s: survey and research agenda”, *Small Business Economics,* Vol. 9, pp. 179-194

Fazzari S.M., Hubbard R.G., Petersen B.C., (1988), “Financing constraints and corporate investment”, *Brookings paper on economic activity*, Vol. 1, pp. 141-195

Fama E.F., French K.R., (2004), “Financing decisions: who issues stock?”, *Journal of Financial Economics,* Vol. 76, pp. 549-582

Freedman J., Godwin M., (1994), “Incorporating the micro-business: perceptions and misperceptions”, in Hughes A., Storey D.J., (editors) *Finance and the small firm*, Routledge, London

Freel M.S., (2000), “Barriers to product innovation in small manufacturing firms”, *Interational Small Business Journal*, Vol. 18, pp. 60-80

Fu T.W., Ke M.C., Huang Y.S., (2002), “Capital growth, financing source and profitability of small businesses: evidence from Taiwan small enterprises”, *Small Business Economics,* Vol. 18, pp. 257-267

Golan A., Judge G.G., Miller D., (1996), *Maximum entropy econometrics: robust estimation with limited data*, Wiley, Indianapolis

Harhoff D., (1997), "Are there financing constraints for R&D and investment in German manufacturing firms?", *SSRC research paper,* Berlin

Howorth C.A., (2001), "Small firms demand for finance: a research note", *International Small Business Journal,* Vol. 19, pp. 78-88

Hughes A., (1994), "Introduction: financing small firms", in Hughes A., Storey D.J., (editors) *Finance and the small firm*, Routledge, London

Jensen M., (1986), "Agency cost of free cash flow, corporate finance and takeovers", *American Economic Review,* Vol. 76, pp. 297-317

Jensen M., Meckling W., (1976), "Theory of the firm: managerial behaviour, agency costs, and ownership structure", *Journal of Financial Economics,* Vol. 3, pp. 305-360

Jorgenson D.W., (1963), "Capital theory and investment behaviour", *American Economic Review,* Vol. 53, pp. 247-259

Kaplan S.N., Zingales L., (1997), "Investment-cash flow sensitivities are not valid measures of financing constraints", *Quarterly Journal of Economics,* Vol. 115, pp. 707-712

Kaplan S.N., Zingales L., (2000), "Do investment cash flow sensitivities provide useful measures of financing constraints?", *Quarterly Journal of Economics,* Vol. 112, pp. 169-215

Leon Y., Peeters L., Quinqu M. and Surry, Y., (1999), "The Use of Maximum Entropy to Estimate Input-Output Coefficients From Regional Farm Accounting Data", *Journal of Agricultural Economics*, Vol. 50, pp. 425-439

Lopez-Gracia J., Aybar-Arias C., (2000), "An empirical approach to the financing behaviour of small and medium-sized companies, *Small Business Economics,* Vol. 14, pp. 55-63

Manigart S., Struyf C., (1997), "Financing high-technology start-ups in Belgium: an explorative study", *Small Business Economics,* Vol. 9, pp. 125-135

McMahon R.G.P., (2001), “Growth and performance of manufacturing SME’s: the influence of financial management characteristics”, *International Small Business Journal,* Vol. 19, pp. 10-28

Modigliani F., Miller M.H., (1958), “The cost of capital, corporate finance and the theory of investment, *American Economic Review,* Vol. 48, pp. 261-297

Myers S., Majluf N., (1984), “Corporate financing and investment decisions when firms have information that investors do not have”, *Journal of Financial Economics,* Vol. 13, pp. 187-221

Pawlina G., Renneboog L., (2005), “Is investment cash flow sensitivity caused by the agency costs or asymmetric information? Evidence from the UK”, *ECGI working paper series in finance,* N° 69/2005

Peeters L., (2004), “Estimating a random-coefficients sample-selection model using generalized maximum entropy, *Economics Letters,* Vol. 84, pp. 87-92

Petersen M.A., Rajan R.G., (1994), “The benefits of lending relationships: evidence from small business data”, *Journal of Finance,* Vol. 49, pp. 3-37

Reid G., (1996), “Financial structure and the growing small firm: theoretical underpinning and current evidence”, *Small Business Economics*, Vol. 8, pp. 1-7

Schiantarelli F., (1995), “Financial constraints and investment: a critical review of methodological issues and international evidence”, *Boston College Working Papers in Economics.* Vol. 293

Smallbone D., North D., (1995), “Targeting established SME’s: does their age matter?”, *International Small Business Journal,* Vol. 13, pp. 47-64

Stiglitz J., Weiss A., (1981), “Credit rationing in markets with imperfect information”, *American Economic Review,* Vol. 71, pp. 393-410

Data-appendix

Data are taken from the BELFIRST DVD, published yearly by Bureau Van Dijk. This dataset consists of detailed balance sheets, as well as income statements for the entire population of Belgian companies. Following Table gives the extracted variables, definitions and number according to the MAR-account numbers classification (Minimaal Algemeen Rekenstelsel).

Variables	*definition*	*MAR-number*
total assets (x €1000)		20/58
turnover (x€1000)		70
employees (FTE)		9087
years in operation (#years)		
investments in fixed assets (% of TA)	*(investments in fixed assets/ total assets)*100*	(8029+8169+8365)/(20/58)
cash flow (% of TA)	*(cashflow / total assets)*100*	(70/67-67/70+630-8089-8289+8475-8485-694/6)/(20/58)
net working capital (x€1000)	*current assets-current liabilities*	(29/58-29-42/48-492/3)
current-ratio	*limited current assets/current liabilities*	(29/58-29)/(42/48+492/3)
debt ratio	*debt/total liabilities*	(16+17/49)/10/49
Ltdebt ratio	*Ltdebt/total liabilities*	(16+17)/10/49
Reserves+transferred profits (% of TA)	*(Reserves+ transferred profits)/total assets*	(13+140-141)/10/49
profitability (% of TA)	*net-profits after tax and depreciation / total assets*	(70/66-66/70-65+780-680-9126-656)/20/58
sales margin	*net-profits after depreciation before tax / turnover*	(70/64-64/70+9125)/70
RE	*retained earnings*	11+12+13+(140-141)+15
ex. Equity	*external equity*	10/15-(11+12+13+(140-141)+15))
fin. Debt	*financial debt*	170/4+178/9+43+47/48
DPO	*days payable outstanding*	44/((600/8+61+9145)/365)
DRO	*days recievable outstanding*	40+9150/((70+74-740+9146)/365)
interest expenses		65