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Financing Constraints Revisited - Is there a Role for Taxation and Internal Funds?

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Financing Constraints Revisited - Is there a Role for Taxation and Internal Funds?

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Abstract: The empirical investment literature provides evidence on financing constraints mostly by estimating investment cash-flow sensitivities for a priori (un-)constrained firms or develops rather ad-hoc indicators to explain firms' differential access to external capital. However, the sources and determinants of financing constraints often remain unclear. Moreover, none of the existing indicators provides a role for taxation in explaining firms' financial constraint status. I fill this gap using a theoretical approach that explains how profit taxes, internal funds and other firm characteristics impact firms' access to external capital and subsequent investment levels. Based on the theoretical findings, I provide empirical evidence from a unique micro dataset of merged survey and financial statement data that allows a direct measurement of firms' credit constraints status and contains a vast set of control variables. Preliminary results point to a significant role of pledgeable income and underline the importance of own funds and expected output for obtaining external finance. Furthermore, a firm´s size and age significantly impact its access to external funds. Taxation, by reducing pledgeable income, exerts a positive effect on the probability of being financially restricted.

Keywords: Capital Constraints; Taxation; Investment; Cash Flow; Firm-Level Data; Survey Data.
JEL Classification: D22, G32, H25, H32.

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1 Introduction

Recent theoretical and empirical research has emphasized the importance of financial constraints for firms' business activities and the economic process as a whole. Especially in the investment literature evidence has been provided that problems of asymmetric information may impede firms' access to credit and significantly impact firm investment (see, e.g., Fazzari, Hubbard, Petersen, 1988, 2000).[1] Research on the impact of corporate taxation on the investment behaviour of firms, however, mostly relies on models abstracting from these frictions although there might be an important link between a firm's tax burden and its access to external capital: In case of asymmetric information between borrowers and lenders, profit taxation might exert a negative impact on the ability of firms to obtain outside funds because it reduces pledgeable income. As a consequence, there might also be an impact on firm investment. While this relationship has been theoretically established only recently by Keuschnigg and Ribi (2010), an empirical validation on these grounds is still missing.

This article sheds light on this issue by providing empirical evidence on the impact of taxation and other firm characteristics on firms' access to external capital. By this means, it also enhances the existing evidence on the sources and determinants of financial constraints which is rather scarce. Indeed, the question of how to measure a firm's financial constraint status has not been treated in much detail: While a broad literature studies investment-cash-flow sensitivities for firms a priori classified as being financially (un-)constrained (see, e.g., Fazzari, Hubbard, Petersen, 1988; Whited, 1992; Bond and Meghir, 1994; or Hubbard, Kashyap and Whited, 1995), these a priori indicators used to split the firm sample are seldom derived from a thorough theoretical model.[2] Moreover, in most studies, the sample split is fix in the sense that it does not allow for a time-varying classification of firms into constrained and unconstrained ones.[3] Opposed to this approach are studies by, e.g.,

[1] Other strands of literature provide evidence on the impact of financial constraints on stock returns (e.g. Whited and Wu, 2006) or on R&D investment (e.g. Bond et al., 1999).

[2] Firms a priori classified as being financially constrained are expected to exhibit a stronger effect of internal funds on investment. If so, this is taken as evidence for financial restrictions. Estimation frameworks that have been used include Q models of investment, Euler equations or forecasting methods.

[3] This problem has been adressed, among others, by Hu and Schiantarelli (1998), who use switching regression techniques to allow for time-varying sample splits.

Kaplan and Zingales (1997, 2000), Whited and Wu (2006), or, more recently, Hadlock and Pierce (2010) that have produced indicators to capture the severity of financial constraints for different firms. While some common findings emerge from all of these studies indicating, e.g., that firms' size and age may be useful predictors of financial restrictions,[4] evidence remains inconclusive as concerns further determinants of external financing constraints. This may be due to both the lack of a thorough theoretical model and the availability of adequate empirical data to study this aspect of business financing.

Using a unique dataset of matched survey and balance-sheet data available at the Ifo Institute in Munich, this article fills this gap. The dataset, which consists of German, mainly unquoted firms from the manufacturing sector, offers a broad set of balance sheet and qualitative variables and allows for a direct measurement of firms' credit constraints. Therefore, in contrast to previous studies, I do not have to rely on management reports to capture the degree of financing constraints[5] but can use survey answers anonymously provided by firms to measure their credit constraint status. What makes this dataset even more attractive to study external financing constraints is the fact that banks play an important role in business financing in Germany (see Harhoff and Koerting, 1998) and that it contains small and medium-sized firms with minor opportunities of raising debt capital directly on the capital market. Furthermore, it provides information on often unobserved factors like firms' volumes of orders or business expectations that allow the researcher to proxy for expected future cash flows or control for other unobserved impact factors. Therefore, I cannot only examine the usefulness of the various a priori classifications used in the literature (like, e.g., firms' size or age) but also shed light on the impact of profit taxes, firms' equity and expected internal funds on firms' access to external borrowing.

Preliminary results confirm the pledgeable income hypothesis suggested by the theoretical model and underline the importance of own funds and (expected) cash flows for obtaining external finance. Using a vast set of controls along with firm and time fixed effects, I show that the average tax burden,

[4]These findings were emphasized, among others, by Hadlock and Pierce (2010), Whited and Wu (2006), Devereux and Schiantarelli (1990), or Oliner and Rudebusch (1992).

[5]Many studies like Hadlock and Pierce (2010), or Kaplan and Zingales (1997) draw on statements made by managers in SEC filings and separate financially constrained from unconstrained firms by hand. This procedure is not only impractical but may also result in a rather arbitrary selection of firms.

as measured by a backward-looking average tax rate, has a positive effect on the probability of being financially constrained. Other determinants found to be significant are in line with the a priori classifications employed in investment studies and confirm previous evidence on firms' size and age being useful indicators of credit constraints:[6] Various specifications suggest that smaller firms, ceteris paribus, are more constrained than larger ones and that access to credit seems to be easier for older firms. Furthermore, I find that beyond demand side factors, the supply of credit seems to be important. Descriptive statistics point to the fact that external financing restrictions vary considerably with the overall business climate in the economy. This result supports the approach of Hu and Schiantarelli (1998) who suggest to use time-varying firm characteristics to distinguish between those with limited access to external financial sources and firms facing no constraints.

The analysis proceeds as follows: Section 2 introduces the theoretical model and derives the factors that may impact a firm's access to external finance. While I do not consider investment behaviour in this paper, it will become evident that these factors are strongly connected to constrained firms' investment levels. Section 3 describes the empirical implementation and gives an overview on the dataset. In Section 4, the empirical strategy is described, section 5 derives first results and provides various robustness checks. Finally, section 6 concludes.

2 Theoretical Background

While a considerable amount of literature investigates the impact of profit taxation on the investment behaviour of firms, most studies rely on models abstracting from financial frictions due to asymmetric information and, in this sense, consider full-information capital markets. In this case, imperfections due to company taxation may result in investment decisions of firms being no longer independent of their financing decisions (see Modigliani and Miller, 1958, 1963; or Miller, 1977), but the full-information setting preserves the optimality condition that investment is expanded

[6]Some indicators which might also be relevant but cannot be considered in our analysis include dividend payouts (used by Fazzari, Hubbard and Petersen, 1988, or Bond and Meghir, 1994, to classify firms), group affiliation (used, e.g., by Hoshi, Kashyap and Scharfstein, 1991) or ownership structure (Schaller, 1993). While these factors may be captured indirectly when controlling for fixed firm effects, the panel used consists mainly of unquoted companies such that omission of these factors may be less severe anyway.

until marginal return equals marginal cost. Taxation influences investment via the cost of capital and, unless neutrality holds, favours or discriminates against different forms of financing. If, for example, interest expenses are deductible from the tax base while equity payments are not, debt could be used as a tax shelter and this benefit ought to be reflected in the respective costs of debt and capital structures of firms. Especially, as suggested by theory, one might expect that the marginal tax rate is positively related to debt financing.[7] Moreover, if there are no other frictions, firms are charged a risk-corrected interest rate but should be able to obtain credit equally well.

This is not the case, however, if there are financing frictions due to asymmetric information or agency problems. In this case, the costs of external financing may result disproportionately high or there may even be quantitative credit constraints for some borrowers (see, e.g., Jaffee and Russell, 1976; Stiglitz and Weiss, 1981; Greenwald, Stiglitz and Weiss, 1984; or Jensen, 1986; Bernanke and Gertler, 1989; respectively). Some firms will be able to raise external finance only up to a certain threshold and they will not obtain additional funds irrespective of how much they would be willing to pay (see Almeida and Campello, 2007). From the point of view of the lender, expected cash flows and the availability of risk-bearing equity serve as an indicator for the amount of loans a firm can tackle, i.e. credit rationing might be expected for those companies confronted with uncertain return flows or low internal funds. As a result, depending on their financial standing and the degree of asymmetric information, also firms' investment might become sensitive to available internal funds (see Hubbard, 1998, for a survey). Moreover, there might be an important link between a firm's tax burden and its access to external capital: By reducing pledgeable income, profit taxation might exert a negative impact on the ability of firms to obtain outside funds and influence subsequent investment levels.

A useful theoretical approach to think about these issues has recently been suggested by Keuschnigg and Ribi (2010) who draw on Holmstrom and Tirole (1997) and Tirole (2006). Consider a risk-neutral owner of a firm who is endowed with funds A.[8] He can use these funds to finance some investment project I or invest them in the capital market at the exogenous deposit rate r, yielding

[7] See, e.g. Jensen and Meckling (1976) or Myers (1977) for the trade-off theory of capital structure or Myers and Majluf (1984) as regards the pecking-order theory.

[8] For convenience, we apply a similar notation as in Keuschnigg and Ribi (2010).

opportunity cost of $AR = A(1+r)$. Desired investment I may exceed available own funds, but the firm can borrow the rest D from the bank, i.e. $D = I - A$, where a loan rate i has to be paid.[9] The bank's financing cost on the deposit market amount to R per unit of lending but $(1+i)D$ will be received if the firm successfully completes the investment project. Total capital I is transferred into real capital and used to produce the outcome $f(I)$ (with $f'(I) > 0$ and $f''(I) < 0$) which is, however, uncertain and depends on the effort of the firm owner. The key here is that, from the point of view of the bank, managerial effort is not observable. If the owner exerts high effort, with probability p the project will be successful and output will be produced. Otherwise, if he exerts only low effort, the success probability declines ($p_L < p$) but the owner can consume private benefits B which are assumed to increase linearly with the level of investment, i.e. $B = bI, b > 0$. If the investment is successful, output will be positive and the firm's end of period value will be $I + f(I)$. Moreover, corporate taxes will be paid, yielding expected tax revenue of T, and the loan will be fully repaid. In this case, the owner earns an expected surplus Π^e over residual assets of

$$\Pi^e = pv^e - RA, \qquad \text{with} \qquad v^e = I + f(I) - (1+i)D - T.$$

Thus, in case of success, the owner's compensation v^e includes income from sales and disinvestment, $f(I) + I$, but he has to repay debt and pay taxes. The bank pays interest r in the deposit market and receives interest i on loans, resulting in an expected profit Π^b of

$$\Pi^b = p(1+i)D - DR$$

with $R = (1+r)$. Assuming that there is perfect competition on the capital market, profits melt down to zero ($\Pi^b = 0$) to get the equality between deposit and loan interest rates of $p(1+i) = R$. Obviously, the borrowing interest rate contains a mark-up reflecting the possibility of credit losses or, in case of firm-specific borrowing interest rates, the individual project risk factored by the bank. Taking account of the break-even condition in the banking sector, expected revenues of the owner amount to total private surplus $\Pi^e = \Pi$ of

$$\Pi = p(I + f(I) - T) - IR \qquad \text{or} \qquad \Pi = p(f(I) - T - iI). \tag{1}$$

[9]The firm may also choose to issue new equity, but due to the tax advantage of debt over equity existing in most tax systems, one may assume that debt will be the preferred source of finance.

Given that the bank cannot directly verify managerial effort after the loan has been granted, there is a problem of moral hazard. Therefore, a level of external financing has to be chosen that keeps the manager incentivized and which ensures repayment of the loan. Exerting a high effort in the investment project and repaying debt, the owner's surplus still has to be large enough so that he is not inclined to consume private benefits instead and exert only low (or even zero) effort. More formally, incentive compatibility is given if

$$pv^e \geq p_L v^e + bI, \qquad \text{i.e., as long as} \qquad v^e \geq \frac{b}{p - p_L} I.$$

Thus, with tax liability $T = \tau f(I)$, the amount of credit offered to the firm is restricted to

$$(1+i)D \leq I + (1-\tau)f(I) - \frac{b}{p - p_L} I \qquad \text{or} \qquad iD \leq A + (1-\tau)f(I) - \beta I. \tag{2}$$

Therefore, the amount of debt the firm can raise will depend on the amount it can credibly assure to repay to the bank or, put it differently, there have to be enough funds to be able to serve the debt obligations, otherwise financing would not be sustainable. If this holds, condition (2) will be non-binding at the optimal investment level I^* and the firm will receive the desired amount of funds. Moreover, as mentioned at the beginning and shown in the Appendix, just like in the case of full information, the decision of how much to invest is determined by marginal return and marginal cost. The reverse is true, however, in case of a binding incentive constraint: if credit is restricted according to (2), the firm will not be able to realize the optimal investment level and there will be unexploited investment opportunities.[10] Moreover, reformulating equation (2) to

$$0 \leq [A + f(I) - \tau f(I)] - \beta I - iD, \tag{3}$$

or, accounting for interest payment deductibility and the tax shield from using debt finance, to

$$0 \leq A + f(I) - \tau f(I) - (1-\tau) iD - \frac{b}{p - p_L} I, \tag{4}$$

we can observe that the incentive constraint becomes tighter if the amount of own funds, A, or the level of (expected) project returns, $f(I)$, from the respective investment is lower. In contrast, lower

[10] Readers interested in this issue are referred to Keuschnigg and Ribi (2010).

tax payments, a lower level of βI or lower cost of borrowing will increase the right hand side and relax the constraint. Note that the success probability p, which is not only included in β but also in the interest rate i, may be considered as a measure for the risk of the specific project. The factor b, in contrast, may be interpreted as the propensity to consume private benefits, i.e. kind of risk that relates to individual borrower characteristics. Obviously, both measures are unobservable and the bank has to form expectations on them. External financial funds might, thus, be differentially available to firms with similar project opportunities. Given that the firm owner looses his equity when interest obligations exceed the level of pledgeable income it is further expected that the level of own funds or internal net worth is key to the bank. Moreover, equation (2) confirms that it is usually not only the risk-adjusted rate of borrowing but also the amount of credit that determines a firm's credit constraint status. This is in line with the observation by Stiglitz and Weiss (1981) that asymmetric information with regard to project risk leads to adverse selection and a credit-market equilibrium in which loan contracts specify both quantity and price of a loan.

3 Empirical Implementation

While equation (4) points to characteristics possibly relevant for a firm's credit constraint status, several issues need to be addressed when specifying the empirical model:
First, debt service usually involves several years and interest payments have to be made out of future income. For this reason, available and expected internal funds are expected to matter for credit supply decisions. Therefore, I expand the static incentive constraint condition and include measures for a firm's stock of equity, cash flow and tax payments at the time of credit negotiations in the empirical specification. Expected cash flows are captured by a firm's appraisal of its volume of orders (see below), yet this variable might also reflects a firm's investment opportunities.

Second, the question is how to adequately measure a firm's tax burden in case of financing constraints. Following (4) it is the amount of revenues devoted to taxes that matters,[11] hence an

[11]If one sticks to the view that the marginal tax rate is positively related to debt finance, one should incorporate the statutory tax rate to reflect that some firms may have a major incentive for debt financing and higher credit demand.

average tax rate on pledgeable income is calculated from a firm's profit tax payments relative to its sales. Technically, this revenue-based measure is a backward-looking average tax rate reflecting all relevant tax parameters like statutory tax rates, tax credits etc. but which also captures firms' tax-planning activities and evolution of losses (e.g. losses carried forward from previous periods). Obviously, such measure offers large variation in tax burdens among firms, however, backward-looking indicators may also suffer from endogeneity in some research contexts (e.g. in investment studies or studies on capital structure choice).[12] When observing credit supply decisions made by banks, however, endogeneity of the tax variable should be a minor problem.

A third issue when obtaining empirical estimates based on (4) is the difficulty to isolate the impact of taxation and internal funds from the many other factors affecting a firm's credit constraint status. Most obvious here are a firm's interest payments or depreciation allowances whose omission would introduce correlation between the residual and the tax variable. Neglecting, for example, interest payments in the regression, the probability of being constrained and the tax measure are negatively correlated, however, there is a positive partial effect when controlling for this covariate.[13] Moreover, the empirical specification should account for firm-specific characteristics like the branch of industry or firm size, and for the overall tightness of financial constraints given that the general business climate has an impact on banks' propensity to grant credit to firms.[14] Considering equation (4), it can be further concluded that previous studies' finding of a firm's size and age being useful predictors of financing constraints[15] is in line with the theoretical model. These variables may indeed be useful proxies for the degree of asymmetric information and are, therefore, also included

[12]Given the problem of endogeneity for backward-looking measures, empirical investment studies often apply so-called forward-looking marginal or average tax rates to assess the impact of taxation on (infra-)marginal firm investment. Assuming a model company as concerns investment and financing structures, relevant determinants of the tax code are incorporated into a neoclassical investment model to calculate the effective and, from an empirical point of view exogenous, tax burden falling on a hypothetical investment project. Therefore, assumptions have to be made about the underlying investment project and sources of financing and one cannot account for tax-planning strategies or loss-carryover provisions. These factors may, however, be of special relevance for credit constrained firms.

[13]The inclusion of interest payments is not only suggested by equation (4) but also by, e.g., Whited (1992); or Hu and Schiantarelli (1998), who use this factor as control variable.

[14]Bernanke, Gertler and Gilchrist (1996); or Hubbard, Kashyap and Whited (1995) account for the overall macroeconomic conditions by using the spread between the 6-months commercial paper interest rate and the corresponding 6-months government bond rate in each month in the regressions. In an alternative interpretation, this measure reflects the refinancing costs of banks. Another possibility is, of course, to include time dummies.

[15]Beck et al. (2005) provide evidence that size and age matter for access to debt finance but also that innovative firms face larger financial constraints.

in my regressions. Indeed, one may expect stronger borrower-lender relationships for older firms as these have already had time to build up reputation. Asymmetric information will be lower and it will be easier for the bank to form expectations on project risks and borrowers' attributes.[16] Finally, a firm's legal form or ownership structure might be relevant omitted variables in regressions based on (4)[17] because larger organizations or business groups should not only have better access to external financial sources or internal capital market funds but also be more closely linked to banks and tax planning experts. To capture this aspect, I include individual firm effects and time dummies in all regressions.

In conclusion, there are many conceivable and partly unobervable impact factors that jointly determine a firm's tax burden and the probability of being credit constrained. Therefore, one cannot rule out problems of endogeneity when there is no suitable variable at hand that may serve as an instrument. Yet, drawing on the conditional independence assumption and using a vast set of controls that capture both capital demand and supply side factors and including time and firm-specific effects is, in my view, a good approach for studies on financing constraints. By using lagged values of the variables of interest to explain current-period credit constraint status one can further avoid problems of reverse causality induced by contemporary variables. Moreover, robustness checks using various estimation strategies and control variables are provided to illuminate the problem of endogeneity and verify my results.

Data Sources and Empirical Model

To test the propositions, I use survey data provided by the Ifo Institute in Munich which was recently matched with balance sheet data from Amadeus and Hoppenstedt. Result of this merge is a unique panel dataset of German firms in the manufacturing sector that consists almost exclusively

[16]The older a firm, the longer at least theoretically its relationship to the bank and the lower the level of asymmetric information on a firm's project implementation efforts, risk characteristics, etc. (see, e.g., Berger and Udell, 1990; or Harhoff and Körting, 1998)

[17]Corporate status, ownership concentration or bond ratings have also been used to proxy for information asymmetries (Schaller, 1993; Calomiris et al., 1995). If ownership concentration is high, it may be more difficult to appropriate private benefits. This would lead to a decrease in b and, respectively, easier access to external funds. Nevertheless, I ignore this type of information because there are mainly unquoted companies included in the panel (see below). Moreover, it would be very complex to merge information on ownership structures to the combined survey-balance-sheet dataset.

of unquoted firms for which financial restrictions might be quite important.[18] Moreover, the dataset contains a rich set of interesting survey variables, e.g. on a firm´s business situation, its commercial expectations or appraisal of its volumes of orders.[19] Information on firms' access to external finance is obtained from a regular survey question in the Ifo Business Survey that asks firms to assess the current willingness of banks to extend credit to businesses. Survey participants can respond by choosing 'accomodating', 'normal' or 'restrictive'. If a firm reports that credit supply is restrictive, I interpret this as information from the point of view of the firm that access to credit is difficult, e.g. extremely costly, or has been denied. In this case, the incentive constraint derived in the theoretical model becomes binding at the optimal investment level I^* and the expression in equation (4), labelled "IC", becomes

$$IC \equiv A + f(I) - \tau f(I) - (1-\tau)iD - \frac{b}{p - p_L} I \quad < 0. \tag{5}$$

Let $I[\cdot]$ define an indicator function returning value 1 if the term in brackets is true and let y_{it} be an indicator measuring restrictive credit supply of firm $i = 1, ..., N$ at time $t = 1, ..., T$ with

$$y_{it} = I[IC_{it} < 0] \tag{6}$$

then a firm's credit constraint status can be described by the following probit model

$$IC_{it} = \alpha + \boldsymbol{\beta}\mathbf{x}_{it} + \psi_t + \mu_i + u_{it} \tag{7}$$

$$u_{it}|(\mathbf{x}_i, \mu_i); \sim \text{Normal}(0, 1) \tag{8}$$

where the impact parameters derived from the theoretical model are captured in the list of regressors $\mathbf{x}_{it}$ and α is a constant term. The parameter ψ_t captures time effects and the disturbance term reflects the usual pattern of panel data, i.e. it consists of μ_i, an unobserved, firm-specific component

[18] Although there are also partnerships contained in the dataset, due to liability and firm structure considerations, I only include corporations in the regression sample.

[19] The Ifo Institute regularly asks firms to give an assessment of their economic situation and business outlook (Ifo Business Survey) or on their innovation activities (Ifo Innovation Survey). These survey datasets were matched with balance-sheet data and are provided to researchers by the Economics & Business Data Center (EBDC). The EBDC is a combined platform for empirical research in business administration and economics of the Ludwig-Maximilian University of Munich (LMU) and the Ifo Institute for Economic Research. For further information on these datasets and on other data sources provided by the EBDC see Hoenig (2010) or Becker and Wohlrabe (2008).

as well as a remaining standard normally distributed error term u_{it}. In this context, $\mathbf{x}_i$ contains all right-hand side variables in all periods.

The impact of the various explanatory variables on the probability of being credit constrained is analyzed using different empirical models. First, I use simple pooled probit and logit models that do, however, not account for the panel information contained in the dataset. Assuming that μ_i is random, a random effects probit estimator (see Heckman, 1981a,b) is then applied to control for the correlation between firm observations. Still, however, this estimator assumes that the individual effects and possibly other omitted variables are independent of the covariates what is a tough assumption in our setting, given the discussion in the previous section. In fact, unobservable personal characteristics of the firm's manager, ownership structure or other factors will not change by much over time but are probably correlated with some elements of $\mathbf{x}_{it}$. For this reason, at least a fixed effects model should be applied that gets rid of time-invariant firm effects or other omitted variables, e.g. by demeaning or including dummy variables in the regression. However, this procedure does not work for nonlinear models.[20] For this reason, I draw my conclusions from two additional estimation strategies:

First, I apply the correlated random effects (CRE) approach proposed by Mundlak (1978) and Chamberlain (1980) which alleviates the assumption of independence and allows at least for a linear correlation of μ_i with the regressors:

$$\mu_i = a + \boldsymbol{\theta}\bar{\mathbf{x}}_i + \epsilon_i \tag{9}$$

Here, $\bar{\mathbf{x}}_i$ are the time averages of the variables contained in $\mathbf{x}_{it}$ and ϵ_i is a random component with $\epsilon_i|\mathbf{x}_i \sim \text{Normal}(0, \sigma_\epsilon^2)$. Technically, also the means of the firm-specific, time-varying x_{it} are included in the basic regression equation, reproducing, in a sense, a fixed effects approach (see also Hsiao, 2003) where the firm parameters may be related to unobserved heterogeneity. Unfortunately, however, one can only estimate the effect of time-varying variables as all factors from $\bar{\mathbf{x}}_i$ that do not vary across i are omitted from the regression. As concerns interpretation, including $\bar{\mathbf{x}}_i$ in the

[20] Demeaning does not remove the individual-specific effects in nonlinear models and including dummy variables for the N fixed effects result in the incidental parameters problem in short panels (Hsiao, 2003).

estimation implies that β displays the impact of the various firm parameters on the probability of being credit constrained keeping the time average fixed, respectively. θ, on the other hand, captures the relationship between the various firm characteristics and unobserved heterogeneity.[21] While this approach is a good compromise, there may still be correlation between regressors and unobservable factors that cannot be captured by including variables' means. Therefore, I apply a second estimator and provide results for a fixed-effects logit model which removes firm heterogeneity by conditioning the likelihood function on the total number of events where the outcome for firm i is equal to 1 (Chamberlain, 1980). This implies that only those observations in the panel can be used where the credit constraint status is changing at least once, i.e. those firms reporting (no) constraints during the whole time period are dropped from the analysis. Obviously, this procedure reduces not only the sample size but may also result in larger standard errors if there is few within-firm variation in the variables of interest. Morevoer, one can only estimate the effect of time-variable covariates.[22]

Descriptive Statistics

Containing both survey and balance-sheet data, the sample used is especially interesting for my research question. In this regard, it is important to note that the surveys are conducted on an anonymous basis with answers kept totally secret. Therefore, firms should have no incentive to give incorrect answers on the credit assessment question for strategic or other reasons.[23] As concerns survey frequency, the question of interest was posed twice a year (March and August), resulting in two waves per year for the regressions which cover the period from the beginning of 2003 to the end of 2007.[24] The chronology of the survey and the time structure of the dataset allows me to

[21] One can also check if the CRE approach is superior to the standard random effects probit model by testing $H_0 : \theta = 0$. If we cannot reject the Null, adding time-averages to the model to partly control for unobserved heterogeneity does not provide additional information.

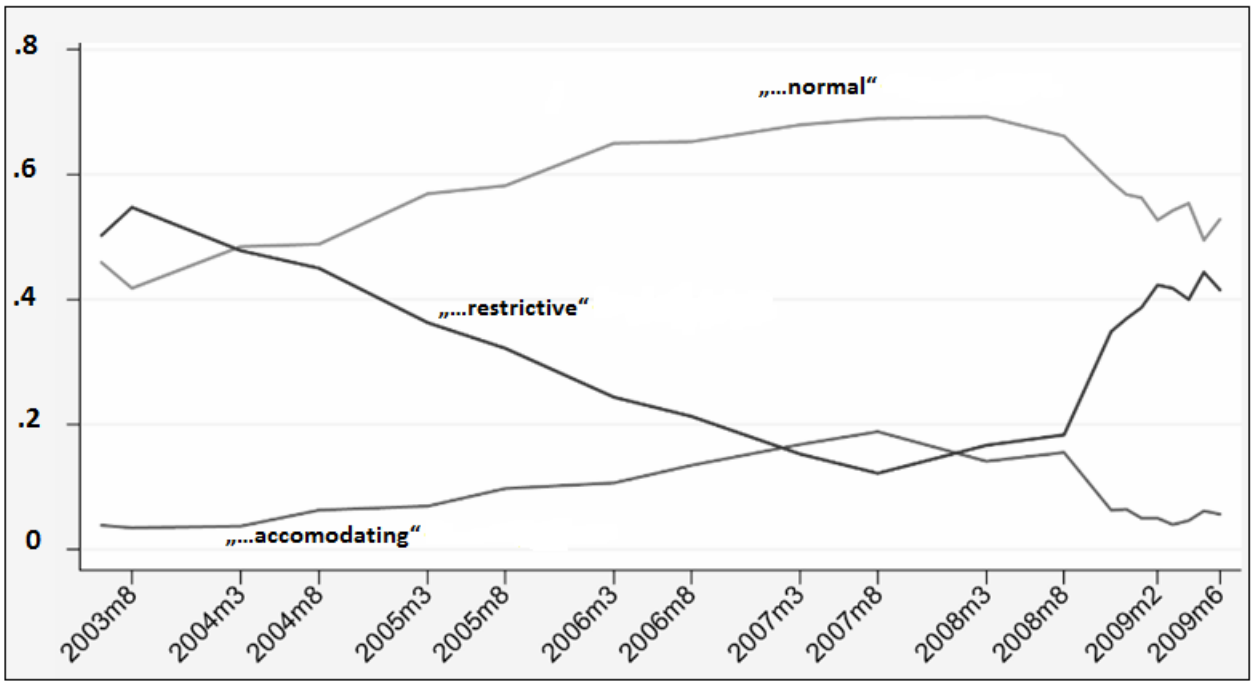
[22] All the models estimated are static models. A dynamic specification was not applied for two reasons: first, the time dimension of the sample is not very large and second, there is no evidence of persistence in firms' credit constraints (the correlation between the current and the lagged status is .53, indicating that firms are not very likely to remain in their status between two consecutive periods.)

[23] Moreover, firms' responses are combined in the monthly Ifo Business Climate Index which is a valuable information source on the evolution of the business situation in specific branches and the economy as a whole.

[24] For several reasons I only use data up to the year 2008: First of all, I expect the financial crisis to have a distinct impact on all the variables used in my estimations. Second, in 2008, Germany has seen a major tax reform where the corporate tax rate has been reduced from 25% to only 15%. Additionally, the business tax basis has been broadened by restricting the deduction of interest expenses. Third, since the end of 2008, the question on credit access is included

take full advantage of the yearly (unconsolidated) balance sheet and bi-annual or monthly survey informations and handle them appropriately. Especially, assuming that the survey participant had some meeting with his bank which took place around the time when the "*credit*" question was posed (March or August), the information that has been relevant for receiving or being denied credit should have been based on figures known (or expected) at that point of time. Therefore, in the regressions, I always use balance sheet figures, information on the volume of orders, etc. as of December of the previous year (i.e. lagged values of the major explanatory variables are used to explain contemporary credit constraint status). Moreover, as kind of refreshment, I include the information on the volume of orders in the month prior to the credit assessment question.

Figure 1: Percentage of firms assessing banks' credit supply as...



In total, there are almost 1500 observations for the dependent variable with quite substantial variation over time. This can be seen from Figure 1 which gives the fraction of firms assessing the lending situation restrictive or normal/accomodating. Descriptive statistics for the sample

in the regular questionnaire of the Ifo Business Survey and can thus be analyzed on a monthly basis. In my dataset, however, this would result in a mixture of biannual and monthly observed credit assessments that could distort the estimation setup.

used are provided in Tables (1) and (2), with Table (2) pointing out the differences according to firms' financial status.[25] As can be observed, firms reporting financing constraints display lower equity ratios than firms reporting normal/accomodating access to credit. Opposed to this, interest payments are higher for constrained firms. Restrictive access to credit may, therefore, also be due to a large amount of existing interest obligations resulting from high debt ratios in the past. The measure for tangibility ('$LTAN$') further suggests that it is the group of constrained firms that has slightly more depreciable assets, whereas '$Llog_sales$' indicates lower sales figures on average for financially constrained firms. This is in line with the figures on the variables '$LROS$' and '$LROA$' which suggest that internal funds or cash flows of unconstrained firms are larger than those of firms reporting restrictive access to external finance. In this regard it is important to note that the former measure is only used for robustness checks and captures a firm's profitability by its EBITDA in proportion to its sales. '$LROA$', in contrast, measures a firm's earnings before interest and taxes (EBIT) and relates it to its assets. Therefore, the latter measure indicates how effective firms are in using their assets to generate revenues - what should be quite important from the point of view of the bank.

As concerns the tax rate measures, the backward-looking indicator, '$LTRS$', suggests that unconstrained firms pay more taxes, while the measure on the average, firm-specific statutory tax rate, 'str', suggests similar tax burdens for both types of firms. This latter measure accounts for the corporate tax, the business tax and the solidarity surcharge and it provides variation among firms because different multipliers are applied for calculating the business tax burden (depending on a firm's location in Germany). In general, the statutory tax rate reflects an upper bound and it can be seen from Table 1 that there is a substantial difference to the mean and variance of the backward-looking tax rate measure. Obviously, this is due to the fact that loss-offset and other rules are quite important for calculating the tax burden. The divergence between both measures becomes even more pronounced when considering both groups of firms separately. Indeed, the figures in Table 2 indicate that loss-carry forwards or tax credits might reduce the tax base of constrained firms relatively more whereas the tax burden as reflected by the statutory tax rate is even larger for this

[25] To exclude effects of outliers, the upper and lower 1%-percentiles of the balance-sheet variables were dropped. Estimations on the sample including outliers were conducted to check for the robustness of the results (which could be confirmed).

group of firms. Note that "$LTRS$" does also take account of deductible interest payments which we found to be somewhat higher for firms with restrictive access to external financing.

As mentioned before, one speciality of the dataset is that it allows to proxy for a firm's future pledgeable income or expected output by using the survey variable "current volume of orders". This variable is ordinally scaled, where a value of 1 indicates 'relatively high' orders. A value of 0 means 'enough' orders and -1 reflects that the volume of orders is 'too small', respectively. For the analysis, I use the volume of orders from the month of December of the previous year ('$Lorders_Dec$'), from the month prior to the credit assessment ('$Lorders_pm$') and, to check for asymmetries, I split the information from this variable into two dummy variables: With the base category being a normal ('enough') volume of orders, the variable "$orders_high$" is 1 if the orders are 'relatively high' and 0 otherwise, while "$orders_low$" is 1 if the volume of orders is 'too small' and 0 otherwise. Obviously, all measures indicate that firms assessing themselves as being unconstrained on average report higher volumes of orders, while the share of firms indicating a lower than usual volume of orders is higher among financially restricted companies.

The importance of controlling for time effects in the analysis of credit constraints has already become evident from Figure 1 and is taken account for by including a full set of time dummies in the regressions. Beyond this, for the summary statistics, I calculate the overall business climate in the manufacturing sector ("$climate$") which is also captured in the Ifo Business Climate Index. This popular indicator is calculated from the firms' current business situation appraisals and their business expectations and is published monthly.[26] As can be verified from Table 2, the share of firms reporting credit constraints is significantly larger if the overall business climate in the economy is low. The '$climate$' indicator shows a pronounced difference for the group of constrained versus unconstrained firms suggesting that financing constraints are not equally binding at all times and making it crucial to control for business-cycle effects.[27]

[26] Technically, the difference between positive and negative answers is calculated for both variables to form a measure which captures the business climate in the manufacturing sector. For more information on the Ifo Business Climate Indicator or the Ifo Business Surveys, see Becker and Wohlrabe (2008).

[27] A full set of time dummies is in the regressions as the impact of time effects may also be nonlinear in nature. This, however, will not be captured when including only the monthly indicator for refinancing costs of banks or the indicator for the business climate.

In Tables (1) and (2) several indicators for a firm's size are displayed. '*Dbigcomp*' is a dummy variable where a value of 1 indicates firms with more than 300 employees, whereas detailed information can be obtained from the dummy variables covering specific size categories ('*size*1' to '*size*5'). In general, all size measures indicate that firms reporting normal or accomodating access to credit are, on average, larger than financially constrained ones.[28]

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
credit_diff	0.276	0.447	0	1	1482
Lequity_ratio	.376	.200	-.625	.883	1482
Llog_sales	.181	.017	.126	.240	1482
LROS	.104	.154	-.108	2.079	1482
LROA	.071	.082	-.174	.422	1482
LIntpay	.015	.038	0	.680	1482
LTAN_TA	.272	.189	0	.908	1482
LTRS	.017	.042	-.179	.777	1482
str	.383	.014	.331	.421	1468
Lorders_Dec	-0.175	0.658	-1	1	1482
Lorders_pm	-0.145	0.658	-1	1	1482
Lorders_high	0.155	0.362	0	1	1482
Lorders_low	0.3	0.458	0	1	1482
climate	-1.373	11.624	-18.5	16.4	1482
Dummy > 300 empl.	0.601	0.49	0	1	1482
size1 (1-49 empl.)	0.059	0.235	0	1	1482
size2 (50-199 empl.)	0.244	0.429	0	1	1482
size3 (200-499 empl.)	0.304	0.46	0	1	1482
size4 (500-999 empl.)	0.138	0.345	0	1	1482
size5 (>1000 empl.)	0.256	0.437	0	1	1482

The figures represent unweighted averages for the respective variables and the sample employed in the estimations. The "L" in front of the variable name indicates the use of lagged values. Variables are defined as follows: "Lequity_ratio" is total equity divided by total capital. "Llog_sales" is the log of sales. "LROS" is the return on sales defined as EBITDA over sales. "LROA" is return on assets defined as EBIT over total assets. "LIntpay" measures interest expenses in proportion to sales. "LTAN_TA" are tangible assets divided by total assets. "LTRS" are tax payments as a percentage of sales. "str" measures the firm-specific statutory tax rate accounting for corporate and business tax rates and the solidarity surcharge in the respective years. "Lorders_Dec" measures the volume of orders as of December of the previous year. "Lorders_pm" measures the volume of orders in the month prior to the assessment of credit supply. "Lorders_high" and "Lorders_low" are two dummy variables indicating if "Lorders_pm" takes on the value 1 or -1. *climate* is a measure for the overall business climate in the manufacturing sector measured by the Ifo Business Climate Indicator as explained in the text. "Dummy > 300 empl." is a dummy variable indicating the share of firms with more than 300 employees and "size1" to "size5" are dummy variables which separate small, medium and large firms according to the number of employees.

Beyond these variables, I have also experimented with other controls like the log of total assets as a measure of firm size, a firm's legal form or its export status. Moreover, various survey variables were investigated like, e.g. a firm's assessment of its business situation, its commercial expectations

[28]While firm size is included in all regressions, due to lack of data, a firm's age can only be considered in the regressions where other explanatory variables are excluded. For this reason, $'age'$ is not depicted in the summary statistics. However, financially constrained firms are, on overage, younger than unconstrained firms. In general, this impact factor is captured in the main regressions by including firm-fixed effects.

Table 2: Summary statistics according to credit status

Variable	Mean	Std. Dev.	Min.	Max.	N
credit_diff =0					
Lequity_ratio	.408	.195	-.625	.883	1073
Llog_sales	.183	.016	.126	.240	1073
LROS	.115	.174	-.108	2.079	1073
LROA	.083	.083	-.174	.422	1073
LIntpay	.014	.043	0	.680	1073
LTAN_TA	.263	.183	0	.908	1073
LTRS	.020	.047	-.179	.777	1073
str	.383	.015	.331	.421	1067
Lorders_Dec	-0.063	0.635	-1	1	1073
Lorders_pm	-0.044	0.633	-1	1	1073
Lorders_high	0.179	0.383	0	1	1073
Lorders_low	0.223	0.416	0	1	1073
climate	0.415	11.683	-18.5	16.4	1073
Dummy > 300 empl.	0.651	0.477	0	1	1073
size1 (1-49 empl.)	0.045	0.207	0	1	1073
size2 (50-199 empl.)	0.208	0.406	0	1	1073
size3 (200-499 empl.)	0.319	0.466	0	1	1073
size4 (500-999 empl.)	0.152	0.359	0	1	1073
size5 (>1000 empl.)	0.277	0.448	0	1	1073
credit_diff =1					
Lequity_ratio	.292	.190	-.580	.791	409
Llog_sales	.177	.018	.139	.238	409
LROS	.074	.075	-.065	.478	409
LROA	.042	.072	-.153	.274	409
LIntpay	.017	.022	0	.305	409
LTAN_TA	.298	.200	0	.810	409
LTRS	.010	.021	-.013	.170	409
str	.384	.013	.357	.421	401
Lorders_Dec	-0.467	0.63	-1	1	409
Lorders_pm	-0.411	0.651	-1	1	409
Lorders_high	0.09	0.287	0	1	409
Lorders_low	0.501	0.501	0	1	409
climate	-6.064	10.069	-18.5	16.4	409
Dummy > 300 empl.	0.469	0.5	0	1	409
size1 (1-49 empl.)	0.095	0.294	0	1	409
size2 (50-199 empl.)	0.337	0.473	0	1	409
size3 (200-499 empl.)	0.264	0.441	0	1	409
size4 (500-999 empl.)	0.1	0.301	0	1	409
size5 (>1000 empl.)	0.203	0.403	0	1	409

The figures represent unweighted averages for the respective variables and the sample employed in the estimations. The "L" in front of the variable name indicates the use of lagged values. For variables' definitions, see Table 1.

or demand situation. However, as none of these variables never obtained significance and seemed to provide no additional explanatory power, they were not included in the section of results.[29]

4 The Role of Internal Funds and Taxation

Given that this paper is one of the first to investigate the role of internal funds and taxation for firms' access to external credit finance, in a first step I restrict my focus on firm characteristics recently proposed to be useful indicators for financing constraints, namely firms' size and age (see Hadlock and Pierce, 2010). To this end, I apply a simple pooled probit model (see Table 3) and account for a firm's size via its log of sales or, alternatively, via four size dummies. In the latter specification, '$size4$' is the base case, and I also include a firm's age 'ln_age' to test the impact of this covariate. Unfortunately, accounting for a firm's age is not possible when adding the rest of the controls and, especially, the balance-sheet variables (the sample gets very small in this case with only 226 observations left). Therefore, I confine myself to draw conclusions on the impact of size *and* age from the larger sample in column (3).[30] Note that all specifications include time and industry dummies and use cluster-robust standard errors. Furthermore, the figures reported display raw coefficients and no marginal effects as I am, initially, only interested in the sign and significance of potential impact factors.

Consistent with Hadlock and Pierce (2010), the results of the first three columns in Table 3 point to a significant impact of a firm's size and age on the probability of being financially constrained. Using a firm's sales as an indicator of firm size or four dummy variables (see columns (1) and (2)), the results suggest that access to credit is easier for larger firms or that small firms with up to 200 employees are more probable of facing credit constraints, respectively. Including firms' age as control does not change this conclusion but reveals that older firms, which are likely to have a stronger relationship with their bank, have less difficulties to obtain external credit financing. Controlling for further

[29]Due to the fact that the panel dataset consists almost exclusively of unquoted companies and that there is only few information available, I do not analyze the impact of ownership, group structures or dividend payouts.

[30]With the exception of column (3), all results in Table 3 are obtained from the sample with 1482 observations, where information on all variables is available. Column (3) contains far more observations as there are no limitations on sample size due to missing balance-sheet figures.

company characteristics suggested by theory and using the pooled probit (column 4) or a random-effects probit approach (column 5), the dummy variables for small companies still enter significantly and keep their sign. Note that the additional covariates enter in lagged form to avoid simultaneity bias.

Table 3: Comparison Pooled, Random Effects and Correlated Random Effects Probit Models

	(1) Pooled_P	(2) Pooled_P	(3) Pooled_P	(4) Pooled_P	(5) Prob_RE	(6) Prob_CRE
Llog_sales	-0.164***					
	(0.043)					
size1		0.717***	0.592***	0.789***	1.163**	1.215**
		(0.277)	(0.200)	(0.305)	(0.492)	(0.522)
size2		0.634***	0.378*	0.630***	1.051***	1.005***
		(0.204)	(0.199)	(0.225)	(0.344)	(0.354)
size3		0.191	-0.058	0.244	0.449	0.466
		(0.183)	(0.213)	(0.214)	(0.322)	(0.333)
size5		-0.007	-0.212	0.029	0.002	0.052
		(0.199)	(0.250)	(0.229)	(0.343)	(0.357)
ln_age			-0.090**			
			(0.040)			
Lequity_ratio				-0.017***	-0.031***	-0.026**
				(0.004)	(0.006)	(0.013)
LROA				-0.031***	-0.047***	-0.028*
				(0.008)	(0.012)	(0.015)
LIntpay				0.003	-0.012	-0.022
				(0.014)	(0.032)	(0.051)
LTAN_TA				0.005	0.008	-0.004
				(0.003)	(0.006)	(0.017)
Lorders_Dec				-0.385***	-0.614***	-0.557***
				(0.091)	(0.133)	(0.155)
Lorders_pm				-0.192**	-0.310***	-0.254**
				(0.082)	(0.113)	(0.121)
LTRS				0.001	0.021	0.032
				(0.014)	(0.025)	(0.032)
_cons	2.094**	-1.314***	-0.996***	-1.045**	-1.466*	-1.209***
	(0.876)	(0.496)	(0.225)	(0.417)	(0.783)	(0.464)
Industry dummies	yes	yes	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes	yes	yes
Mean time-varying vars	-	-	-	-	-	ROA**(-)
N	1482	1482	3639	1482	1482	1482
AIC	1569.342	1574.620	4345.263	1377.537	1169.968	1165.248
R2_p	0.122	0.122	0.104	0.243		
LogL	-766.671	-766.310	-2.1e+03	-660.768	-555.984	-553.624

Dependent variable is "credit_diff" in all specifications. Robust standard errors in parentheses.
Stars indicate significance as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

As concerns the coefficient estimates, both the pooled and random-effects probit regression point to a significant impact of a firm's equity and available internal funds as measured by return on assets,

'*LROA*'. Reported financing restrictions decrease in the level of equity a firm can provide and the coefficient on before-tax cash flows is negative and significant as predicted by the theoretical model.[31] Other robust predictors of credit constraints are the proxies for expected cash flows measured by the volume of orders ('*Lorders_Dec*'; '*Lorders_pm*') which prove significant in both specifications. Specifically, access to credit is indicated to be more difficult if a firm's volume of orders is below normal at the time of credit negotiations suggesting that expected deviations from past cash flow measures are important for obtaining external finance. For the taxation parameter I find a positive, though insignificant impact on the probability of being constrained. Moreover, there seems to be no significant role for existing interest payments or the stock of tangible assets. It should be noted, however, that all specifications discussed so far ignore possible correlations between the regressors and unobserved individual-specific effects which might bias the results. For this reason, column (6) of Table 3 applies the correlated random-effects approach outlined in the previous section. Here, also the means of the firm-specific time-varying variables are included to account, in part, for unobserved heterogeneity among firms.[32] Having a look at the results, it is revealed that all impact factors mentioned so far keep their sign and significance. Moreover, there is a significant negative impact of the average level of cash flows or profitability (see lower part in column (6) of Table 3). This finding is not unexpected given that company performance figures may be particularly related to unobserved, rather time-invariant firm-specific components (like, e.g., manager's ability or effort, the company's product program, personal resources, legal form, etc.).

To explore this issue further and allow for correlations between the regressors and time-invariant individual effects, the regression results are complemented by various logit fixed effects specifications (outlined in Table 4). While this estimation approach also facilitates an interpretation of the size of the effects, it has the handicap of considerably reducing sample sizes as can be seen in the number of observations (see, e.g., column (2) in Table 4). Moreover, sufficient within-subject variation in the explanatory variables is needed, otherwise standard errors will be large.

[31] Leland and Pyle (1977) offer another interpreation on this issue: for firms with larger internal funds access to external finance might be easier as high cash flow measures might reflect managers' high effort for their investment projects.

[32] As I am not interested in the firm-specific mean values, results on these variables are not included in the output tables. However, if one of the factors obtains significance, it is indicated in the lower part of the table.

Table 4: Comparison Correlated Random Effects and Fixed Effects Logit Models

	(1) Log_CRE	(2) Log_FE	(3) Log_FE	(4) Log_FE	(5) Log_FE	(6) Log_FE
size1	2.184**					
	(0.929)					
size2	1.840***					
	(0.631)					
size3	0.811					
	(0.593)					
size5	0.013					
	(0.631)					
Lequity_ratio	-0.049**	-0.125***	-0.119***	-0.115***	-0.097***	-0.089***
	(0.024)	(0.034)	(0.035)	(0.035)	(0.032)	(0.031)
LROA	-0.046*	-0.056*	-0.060*	-0.057*	-0.070**	
	(0.027)	(0.033)	(0.034)	(0.033)	(0.034)	
LIntpay	-0.040	-1.315***	-1.260***	-1.188***	-1.255***	-0.918***
	(0.092)	(0.367)	(0.372)	(0.376)	(0.363)	(0.340)
LTAN_TA	-0.004	-0.006	-0.002	0.014	-0.009	0.008
	(0.031)	(0.036)	(0.036)	(0.039)	(0.035)	(0.033)
Lorders_Dec	-0.955***	-1.059***	-1.024***	-1.051***		-0.803**
	(0.278)	(0.346)	(0.348)	(0.350)		(0.319)
Lorders_pm	-0.479**	-0.415*	-0.423*	-0.463*		-0.558**
	(0.218)	(0.236)	(0.237)	(0.240)		(0.230)
LTRS	0.054	0.211	0.219	0.200	0.226*	0.173
	(0.058)	(0.137)	(0.139)	(0.138)	(0.130)	(0.137)
Llog_sales			0.450			
			(0.637)			
str				-0.054		
				(1.323)		
Lorders_high					-0.642	
					(0.394)	
Lorders_low					0.584*	
					(0.329)	
LROS						-0.062
						(0.048)
_cons	-2.661*					
	(1.482)					
Industry dummies	yes	-	-	-	-	-
Time dummies	yes	yes	yes	yes	yes	yes
Mean time-varying vars	ROA**(-)	-	-	-	-	-
N	1482	629	629	619	629	635
AIC	1171.138	334.850	336.357	332.107	345.268	354.335
R2_p		0.390	0.391	0.392	0.369	0.358
LogL	-549.569	-151.425	-151.178	-149.053	-156.634	-161.168

Dependent variable is "credit_diff" in all specifications. Robust standard errors in parentheses. Stars indicate significance as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

For comparison, in Table 4 the results for the various logit fixed effects specifications are presented along with the results for the CRE approach in case of a logit model (column (1)). As can be observed, there is not much difference in the coefficient estimates between columns (1) and (2), suggesting that the CRE model captures possible correlations between the regressors and time-invariant individual effects quite well. This is especially true for the impacts of the equity ratio, of the return on assets as a measure for cash flow and of the volume of orders as a measure for expected future cash flows. Indeed, all coefficient estimates remain negative and significant and do not change by much (see column (2)). The same is true for the coefficient on tangibility which remains negative and insignificant.[33] The coefficient on lagged interest payments, however, becomes negative and significant. In general, one would expect that higher interest burdens in the past, which are related to higher leverage and possibly more debt claimants, lead to banks being more reluctant in providing credit. Yet, there seems to be a negative relationship between the amount of existing interest payments and the probability of being constrained when accounting for firm fixed-effects. While this finding is contrary to the intuition, it may also point to the importance of controlling for individual-specific time-invariant components. If we believe that each firm is, as least in the short run, attributed a general level of risk or creditworthiness, then we might capture this level effect by including firm-fixed effects. Ignoring this information, however, induces an upward bias in the coefficient on interest payments because higher-risk firms do not only face higher borrowing rates but are also more likely to be credit constrained. Alternatively, one might argue that a closer bank-firm relationship (unobserved), c.p., facilitates access to debt (direct impact) but also implies lower borrowing rates (indirect impact via interest payments). Ignoring individual-specific effects will, thus, again induce an upward bias in the coefficient of interest.

As can be verified from columns (1) and (2) in Table 4, there is also a change in the impact of the average tax burden. Though still not significant at conventional levels (the p-value is about .11), the coefficient of $'LTRS'$ increases quite substantially and becomes even more positive in the logit fixed effects model. Obviously, this result may also be contributed to omitted firm-fixed effects in column

[33] In general, one would expect that higher tangibility supports higher borrowing capacities (see, e.g. Berger and Udell, 1990; or, more recently, Almeida and Campello, 2007), thus reducing the probability of being credit constrained. If tangible assets proxy for the amount of depreciation allowances, however, higher depreciations may also increase the probability of facing financing restrictions. In either case, the coefficient estimates are always insignificant what may be ascribed to the inclusion of equity as a measure for a firm's securities.

(1) and prior regressions: if firms that are more inclined to realize risky investment projects (high-risk borrowers) are also more keen in applying tax-optimizing strategies, there will be a downward bias in the tax coefficient when ignoring individual-specific effects. Therefore, I conclude from the logit fixed effects results that it is important to control for unobserved heterogeneity. Furthermore, consistent with the theoretical model, the results suggest that a firm's tax burden, by reducing pledgeable income or cash flows, has a positive impact on the probability of being constrained.

To check for the robustness of the results, I provide several specifications where I include sales as a measure for firm size (column (3)) or the firm-specific statutory tax rate (column (4)) to account for the fact that firms with higher marginal tax rates might have greater incentives for using debt finance. If this is the case, there may be sort of selection in the demand for credit. Furthermore, inclusion of the statutory tax rate might also account for differences in the infrastructure provided at different locations in Germany. Additionally, in column (5) I split the proxy for expected cash flows and allow for an asymmetric impact of deviations from a normal volume of orders. Finally, in column (6), a firm's return on sales is used as alternative measure for cash flows.[34] All in all, the findings confirm the coefficient estimates obtained from the basic specification in column (2), and endogenous selection does not seem to be a problem (see column (4)). One interesting aspect, however, emerges from column (5): Allowing for an asymmetric effect of above or below normal volumes of orders, I find that the probability of being constrained increases significantly if cash flows are expected to decrease in the future. Intuitively, if the volume of orders is normal or above average, past cash flow figures may be good, and rather conservative, proxies for future pledgeable income. In contrast, if the volume of orders is observed to be too small, this early indicator for low future revenues may negatively influence loan negotiations. Therefore, it seems plausible that a lower than usual volume of orders makes access to credit more difficult. Note that in column (5), the positive effect of a firm's average tax burden becomes significant at the 10% level thus strengthening the argument that taxation, by reducing firms' pledgeable income, impedes firms' access to external financial sources.

[34]Further robustness checks are provided in Table 3 in the Appendix, where I estimate a linear probability model with/without fixed effects (columns (4) and (6)). Moreover, as a compromise to few intertemporal variation in some of the firm variables, I also apply the CRE approach (column (5)). While the results derived so far are mainly unchanged, the cash flow and equity variables in the fixed effects model loose significance. It should be noted, however, that the fixed effects model does not remove firm heterogeneity in a nonlinear setting.

One issue that emerges from the discussion of the direction and significance of potential impact factors is, of course, the magnitude of the effects implied by the coefficient estimates. In this regard, the logit fixed effects approach allows for a useful interpretation. Specifically, if we exponentiate the regression coefficients the odds ratios can be calculated which relate the probability of being credit constrained to the probability of facing no restrictions. Taking, for instance, the negative coefficient estimate on the equity ratio, it can be concluded that if there is a 50% chance of being credit constrained (i.e. the odds are 1:1), then an increase in the equity ratio by 1 percentage point reduces the odds that $y = 1$ by about $(0.89 - 1) * 100$, i.e. 11%. Likewise, if the return on assets ratio increases by 1 percentage point, the odds of being credit constrained are reduced by 6%. For taxation, the coefficient estimate indicates that an increase in the average tax rate by 1 percentage point increases the odds of facing external financial restrictions by some 24%, what is a substantial effect. However, due to the large standard errors we fail to clearly reject the null hypothesis.

5 Conclusions

This paper provides theoretical and empirical evidence on the impact of various firm characteristics on firms' access to external financial sources. Drawing on an intuitive theoretical model suggested by Keuschnigg and Ribi (2010), I show that the amount of debt capital a firm can raise depends on the amount of money it can credibly repay to the bank and thus, on its capability to generate positive internal funds. In this regard, equity capital, available and expected cash flows are of special importance. Profit taxation is shown to reduce a firm's pledgeable income thus impeding its ability to obtain outside funds. The empirical analysis is based on a unique firm-level panel dataset of matched survey and balance-sheet data that allows a direct measurement of firms' differential access to external capital. The panel consists of German, mainly stand-alone firms from the manufacturing sector and contains a broad set of financial and rather qualitative parameters, thus making it possible to control for factors that are generally unobserved.

In accordance with the theoretical findings, the empirical evidence indicates that lower equity or cash flows positions, lower volumes of orders and a higher average tax burden increase firms' probability of facing external financial restrictions. Moreover, I can confirm previous evidence of, e.g.,

Hadlock and Pierce (2010) that firms' size and age may be useful indicators of financial restrictions. Various specifications indicate that older firms, ceteris paribus, seem to be less constrained than younger ones and for larger companies access to credit seems to be easier. Controlling for time effects and unobserved firm characteristics is found to be crucial in obtaining reliable estimates. Therefore, besides simple pooled probit (logit) and random effects probit (logit) models, I apply the correlated random effects approach proposed by Mundlak (1987) and Chamberlain (1980) and estimate various logit fixed effects specifications. With regard to the magnitude of the effects, relating the probability of being credit constrained to the probability of facing no restrictions, i.e. calculating odds ratios, it can be concluded that an increase in the equity ratio (return on assets) by 1 percentage point, c.p., reduces the odds of being constrained by about 11% (6%). An increase in the firm's average tax rate by 1 percentage point, in contrast, increases the odds of facing external financial restrictions by about 24%. Yet, given the small sample size in the logit fixed effects specifications and the hardly significant coefficient estimate of the tax variable, this effect should be interpreted with some caution.

While the findings from this article make several contributions to the current literature on credit constraints, two issues come to mind for future research. First, the results point to a significant role of internal funds for obtaining external finance, leading to the conclusion that internal and external financial restrictions might be interrelated. Previous research, however, mostly analyses both types of restrictions separately. Second, the results suggest that taxes along with rules on loss offsets play an important role for firms' access to external financial sources. To separate the impact of taxation from the many other factors affecting firms' credit constraint status, however, one has to use empirical models that reduce sample sizes quite substantially. Therefore, obtaining larger sample sizes in panel datasets with sufficient variation in tax parameters will be a major aim to get a better understanding of the relationship between profit taxation and external financing conditions.

Appendix

Optimal Investment Level in case of non-binding Incentive Constraint

As Keuschnigg and Ribi (2010) show, if the incentive constraint (2) from above is not binding, despite the problem of moral hazard, the optimal investment level is then given by maximizing (1) with respect to I, resulting in the well-known first-order condition

$$f'(I^*) = \frac{i}{1-\tau} \equiv u. \tag{A.10}$$

Thus, just like in the case of full information, the decision of how much to invest is determined by the (expected) pre-tax rate of return and the marginal cost u with the latter including the marginal corporate tax rate τ as well as the interest rate.[35] Thus, conditional on obtaining credit, all profitable investment opportunities will be exploited according to the marginal tax burden on investment[36] and the non-binding character of the incentive constraint implies that there is no further impact of taxation, internal funds or alike. It may well be, however, that firms with low success probability p face a higher rate of borrowing, i.e. risk-adjusted interest rate i, experiencing, in this sense, financial obstacles due to higher cost.

A.1 Robustness Checks

In this section, robustness checks for the results reported in Table 4 are provided. Columns (1) and (4) apply simple pooled logit and linear models, respectively. The correlated random effects approach is used for a logit model (column (2)) and a linear model (column (5)) while columns (3) and (6) show the results for the logit and linear fixed effects models.

[35] Surveys on the impact of taxation on investment are provided by Chirinko (2002) or Hassett and Hubbard (2002).

[36] For a thorough analysis, including assumptions for equilibria, graphical illustrations and further applications, see Keuschnigg and Ribi (2010).

Table A.1: TableFINAL

	(1) Pooled_Log	(2) CRE_Log	(3) Log_FE	(4) LIN	(5) LIN RE_means	(6) LIN FE
size1	1.359***	2.184**		0.206**	0.184**	
	(0.510)	(0.929)		(0.082)	(0.073)	
size2	1.077***	1.840***		0.163***	0.153***	
	(0.367)	(0.631)		(0.055)	(0.049)	
size3	0.411	0.811		0.050	0.055	
	(0.351)	(0.593)		(0.050)	(0.045)	
size5	0.056	0.013		-0.014	-0.014	
	(0.377)	(0.631)		(0.053)	(0.048)	
Lequity_ratio	-0.030***	-0.049**	-0.125***	-0.005***	-0.002	-0.004
	(0.007)	(0.024)	(0.034)	(0.001)	(0.002)	(0.002)
LROA	-0.054***	-0.046*	-0.056*	-0.007***	-0.004**	-0.004
	(0.015)	(0.027)	(0.033)	(0.002)	(0.002)	(0.003)
LIntpay	0.007	-0.040	-1.315***	-0.000	-0.007	-0.036
	(0.022)	(0.092)	(0.367)	(0.003)	(0.008)	(0.027)
LTAN_TA	0.009	-0.004	-0.006	0.001	-0.000	-0.001
	(0.006)	(0.031)	(0.036)	(0.001)	(0.002)	(0.003)
Lorders_Dec	-0.663***	-0.955***	-1.059***	-0.106***	-0.076***	-0.074***
	(0.162)	(0.278)	(0.346)	(0.025)	(0.022)	(0.028)
Lorders_pm	-0.337**	-0.479**	-0.415*	-0.057**	-0.046**	-0.042*
	(0.144)	(0.218)	(0.236)	(0.023)	(0.019)	(0.023)
LTRS	-0.000	0.054	0.211	0.001	0.003	0.002
	(0.023)	(0.058)	(0.137)	(0.003)	(0.004)	(0.007)
_cons	-1.751**	-2.661*		0.184	0.262**	0.384***
	(0.728)	(1.482)		(0.182)	(0.123)	(0.143)
Industry dummies	yes	yes		yes	yes	
Time dummies	yes	yes	yes	yes	yes	yes
Mean time-varying vars		ROA**(-)			ROA**(-) Equity_ratio **(-)	
N	1482	1482	629	1482	1482	1482
AIC	1375.158	1171.138	334.850	1436.042	.	306.656
R2	0.245		0.390	0.256		0.647
Log_L	-659.579	-549.569	-151.425	-690.021		-137.328

Dependent variable is "credit_diff" in all specifications. Robust standard errors in parentheses.
Stars indicate significance as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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