Small and Vulnerable? SME versus Large Firms' Financing Constraints during the Financial Crisis*

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Abstract

This study investigates firms' financing conditions over the course of the Financial Crisis in the late 2000s on both SMEs' and large firms. By exploiting high quality, proprietary data from official sources on German firms, we quantify financing constraints based on observable firm characteristics. This way, we are able to study differential effects between small and large firms without depending on size as a measure of restrictiveness itself. We show that SME are on average more likely to face excess demand for bank loans as compared to large firms. Contrasting theoretical predictions, however, we further find that the crisis did not affect SME in a disproportionate manner. It is rather the availability of non-bank sources and firms' riskiness determining the degree of financing constraints. Our results suggest that it is more efficient to address the underlying causes of (small) firms' vulnerability during economic slowdowns instead enhancing access to funding for SME in general.

JEL Classification: D22, D53, G01

Keywords: Financial constraints, Disequilibrium, SME lending, Firm-level data

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"*It is the combination of small, medium and large firms that gives the German industry its uniqueness and resilience. This has been rewarded in recent years through strong growth and high employment.*" (Draghi, 2012)

1 Introduction

A rich body of research investigates the impact of the Great Financial Crisis starting in late 2008 on firms' borrowing conditions and subsequent changes in real economic activities, i.e. lower rates of investment, R&D, and employment (**?**, **?**, **?**). Theory predicts that these adverse effects are particularly severe for ex ante financially constrained firms (see e.g. **?**). Because of their inherent difficulty in accessing funding, small firms are commonly expected to have a higher probability being constrained leaving them more often vulnerable in times of economic distress as compared to larger firms (**?**). Policymakers and academics have therefore increasingly shifted their attention towards financing condititons of small and medium-sized enterprises (SME).[1]

However, there are doubts about the conventional perception that the crisis actually harmed SME disproportionally as compared to large firms (**?**, **?**, **?**). Evidence suggests that both large *and* small firms adjusted their use of external funding towards an increased use of trade credit (**?**), the accumulation of cash holdings (**?**), or a lowering of capital expenditures (**?**). For instance, a representative survey among German manufacturing firms shows that firms' perceived restrictiveness to obtain bank credits at the outbreak of the crisis was even stronger for large than for medium-sized or small firms (**?**).

In this paper, we provide new evidence on the debate about whether and how financing conditions tightened during times of the Financial Crisis. We therefore examine the firm-level determinants of bank loans over the course of the crisis in order to estimate the degree of financing constraints differentiating among small and large firms. Quantifying these constraints without having to rely on direct measures of firm-size imposes an empirical challenge, because the most common measures either assume that size is a key determinant for constraints in itself (e.g. **?**) or they are only applicable for listed and, hence, relatively large firms (e.g. **?**). We overcome this issue by using a disequilibrium model based on observable firm characteristics that enables us to estimate firms' excess demand as a proxy for their degree to be financially constrained. We can thus address several specific research questions. First, we determine what are firm-level characteristics that explain the decline in firm-level loans in 2009. Second, we ask whether the crisis indeed affected SME more strongly than larger firms. Third, we answer what are alternative sources of funding that firms potentially choose to substitute for bank debt.

We find that it is not the size of a firm that determines the effect of the crisis on borrowing activities, *per se*. Across multiple tests, we do not find robust evidence that SME account for a

[1] Figure **??** (Appendix B) graphically illustrates policymakers' increased focus on SMEs' access to credit.

disproportional decline in lending and subsequent economic activity, everything else being equal. However, we find that SME are indeed more dependent on bank debt, carry a higher risk, and have a lower ability of providing collateral. These factors are important in determining the degree to which firms are affected by the crisis, independent from respective firms' size. Finally, we find that firms respond to the crisis by cutting investment and accumulating cash holdings, which appears to insulate firms to a certain degree.

Our analyses are based on high detail, proprietary financial data from *Deutsche Bundesbank* (**?**) covering a wide range of mostly small and medium-sized firms located in Germany. The German economy provides an ideal setup for the research questions at hand, because its is traditionally bank-based with close bank-industry relationships (**?**, **?**) while having a distinctively strong SME sector (**?**, **?**).[2] As such, bank loans are a prominent source of funding for German firms, particularly SME, for instance for fixed investment. According to the **?**, 53% of German SMEs' bank debt was used for fixed investment in 2015, which was a much higher share compared to other large European countries such as Spain (30%), Italy (31%), or France (40%). The combination of these two aspects - dependence on bank financing and its direct use for investment - suggests that changes in underlying financing conditions should have measurable effects on German SME in terms of borrowing activities. Furthermore, as the largest economy in the EU, implications of adverse shocks to economic activity in Germany indirectly affect other member states, too. Hence, adjustments in both firms' borrowing activities as well as bank lending potentially transmit across national borders.

Our analysis provides new evidence along several dimensions. First, we document new, particular findings on the impact of the Financial Crisis on the larges European economy by utilizing highly granular data from official sources on a broad set of firms. Second, we extend the literature on SME finance, by not only providing a detailed application but also comparing the results of a major economic event across both small and large firms. This way, we are able to explain the underlying problems of small firms without making the simplified claim that being small is a decisive characteristic by itself. Third, our analysis contributes to important policy debates. On the one hand, European policymakers point out that SME play a key role for the European economy. On the other hand, they stress the need to improve access to financing primarily for small firms in order to stimulate investment and employment. In this context, our results suggest that a more differentiated view on the topic would be appropriate to address the issue of financing constraints effectively. While it is indeed the case that SME are more bank dependent and have a higher default risk, the size of the firm is not equally important in determining its vulnerability

[2]The country's post-war economic strength is oftentimes attributed to its strong SME sector, the so-called '*Mittelstand*' (**?**). As opposed to other nations, Germany did not historically favor the development of national champions, i.e. large firms (**?**), resulting in a structurally different business landscape with a far developed SME sector in Germany, today.

to the crisis after controlling for other factors, like the ability to provide collateral. According to this, policymakers should rather be concerned with the underlying causes of what is commonly perceived as small firms' vulnerability.

The paper is organized as follows. Section 2 provides a short literature review. Section 3 outlines the institutional setting by describing the impact of the Financial Crisis on the German economy. Section 4 presents our data and descriptive statistics. Section 5 describes our methodological approach in detail and specifies out disequilibrium model. In section 6, we present the main results, including model extensions. Section 7 concludes.

2 Related literature

We mainly relate to two strands of the literature, which assess financing constraints as well as the impact of financial crises with a distinct focus on small firms. Since **?** and **?** first showed that credit rationing can be an equilibrium outcome in the presence of informational asymmetries, a large body of literature focuses on the determinants and implications of financial constraints. Financing constraints have strong negative effects on firm-level behavior by lowering real economic activity, especially capital investment (**?**, **?**). Because lending typically follows a cyclical pattern (**?**), multiple studies exploit exogenous variation arising from economic crises to make causal inferences on the implications of financing constraints. Against this background, a series of studies investigates the effects of the Financial Crisis and find that rationed firms strongly cut planned R&D, employment, and investment (see e.g. **?**, **?**, **?**). Thereby, most studies focus on large, mostly publicly-owned companies.

Central to this paper, however, is research on financing of small and medium-sized firms. By nature SME are not only associated with high growth rates but also with certain characteristics exposing them to developments in market conditions. As such, economic literature agrees that information asymmetries and agency problems are negatively correlated with firm size (**?**, **?**), which significantly alleviates small firms' ability to raise funding (**?**, **?**). For instance, external funding through stock or bond markets is commonly limited to informationally transparent large businesses making bank credit the most prominent external funding source for smaller firms (**?**, **?**, **?**). The combination of opacity and bank dependence is a distinct problem, exposing SME to the threat of credit rationing and, eventually, bankruptcy (**?**, **?**, **?**).[3]

Combining the implications of financial constraints with the particularities about small firms'

[3]Recent aggregate statistics support this notion. As such, the **?** shows that the majority of EU SME considered bank loans as relevant (i.e. 54% in 2015). At the same time, they identify access to finance as one of the most pressing problems faced by SME across all EU member states. While even in economic upswings, e.g. in 2015, overall 10% of SME declared access to finance as their most pressing problem, this number is much higher in recessions, e.g. 17% in 2009. In comparison, on an EU-wide average only the search for customers is perceived as a more relevant issue.

financing, a distinct strand of the literature examines how the economic crises affect SMEs' financing behavior and subsequent real economic activities. **?** is an early example on firm-level studies regarding SME that face credit rationing in the course of such an event. Consistent with theoretical predictions, the authors find the share of borrowing constrained small firms to increase significantly during the recession of 1990-1992 in the UK. Similarly, some evidence on the Financial Crisis in 2009 suggests that small firms have a higher propensity to face credit rationing inducing them to cut investment disproportionally (**?**, **?**, **?**). **?** find a reduction in SMEs' access to credit in form of more rigid collateral requirements during the crisis.

Closest to our paper is a group of studies that examines financing constraints of SME by means of utilizing disequilibrium model estimations (**?**, **?**, **?**), which assess the impact of adverse events on the availability of bank loans. Unlike these analyses, we propose a novel measure that assesses the degree of being financially constrained in a continuous space. Our results are thus not dependent on potentially ambiguous ex ante definitions. This is a promising approach, because we do not rely on an equivocal threshold that defines whether a firm is "constrained" (or not). Further, in contrast to these studies we include firms of all sizes in our estimations and therefore do not restrict ourselves to the perspective of small firms but evaluate the relative impact. Additionally, we investigate the impact on firms located in Germany, which is not only known for its strong firm-bank ties but also the largest economy in Europe.

3 The Financial Crisis in Germany

Figure **??** illustrates the impact of the Financial Crisis on German firms by plotting the monthly values for the period 2005-2012 of the Ifo Business Climate Index (**?**). The values correspond to survey questionnaire responses, indexed at 100 for the base values of January 1^{st} 2005. The graph plots values regarding the current business situation and the business outlook indicating a period of rapid economic expansion between 2005 and mid 2007. While business expectations tend to be more conservative from the beginning of 2006, values are constantly above 100 until late 2008. Using the taxonomy that a cyclical turning point takes place once a certain movement occurs three consecutive times, June 2008 marks this negative turning point in the German economy. Moreover, the index on the current business situation turned below the reference threshold of 100 by November 2008. Whereas business expectation recovered from the all-time low in December 2008, the index on the current business situation surpassed the threshold of 100 only by March 2010. Thus, the index clearly depicts the cyclical movement of the German economy throughout the years 2005 until 2010.

- Insert Figure **??** *here -*

To specifically assess how the Financial Crisis affected bank lending in Germany, Figure **??** illustrates perceived lending conditions in Germany during the period 2006-2012 by plotting the firm size-specific Ifo Credit Constraint Indicator (**?**). The lines indicate the fraction of respondents perceiving the current willingness of banks to extend credit as restrictive. During the periods of 2005 until 2008 and 2011 until 2012, the perceived degree of being financially constrained among all firms is at a relative low level of overall 20%, but more than doubles in 2009. This finding mirrors the cyclical expanding and contracting in credit supply as illustrated in Figure **??**.[4]

There is, however, one important detail. Before 2009 small (and medium) sized firms appear to be more constrained relative to larger firms, an observation in line with aforementioned theoretical predictions. The increase in perceived credit constraints at the outbreak of the Financial Crisis in 2009, is largest for *large* firms, despite the higher initial values of the other two size categories. While measurement issues might play a role in this case (i.e. the index measures self-reported constraints), it is still notable that the differences are this strong. Hence, the graph casts doubt that the conventional perception that smaller and more financially constrained firms are hit disproportionally strong by adverse economic effects applies in the case of Germany during the Crisis.

- Insert Figure **??** *here -*

4 Data description

4.1 Data set

The empirical analysis is based on proprietary firm-level microdata provided by Deutsche Bundesbank, the so-called USTAN database. The database contains very detailed firm-level information on balance sheet, profit and loss statement items as well as bibliographic information of mainly small- and medium sized firms. Because Bundesbank collects these firm-level data for regulatory purposes, the data base includes highly granular information; see **?** for a detailed documentation.

When constructing our sample, we exclude all firms active in financial, insurance and services sectors as well as those firms that do not report information on their sector. We drop observations with below 10,000 Euro of average assets per employee or less than five employees, because we cannot reasonable assume them to represent firms that actively participate in financial markets. We exclude firms that cannot be uniquely identified as belonging to either SME categories.[5] We restrict the time frame of our analysis to the years 2006-2010, capturing both the boom period

[4] Descriptive statistics on Deutsche Bundesbank's bank lending survey support this (Figure **??**, Appendix B).

[5] Table **??** (Appendix A) includes the cutoff criteria according to the European Commission's recommendation (2003/361/EC) on the definition of small- and medium-sized enterprises.

before as well as the bust period after 2008, respectively. Finally, to avoid survivorship bias, we allow firms to enter and leave the database freely as long as they do not enter after 2008.

The resulting data set covers 74,561 observations, equivalent to 18,113 firms, for the period of five years. The size and sectoral distributions of firms are displayed in Tables **??** and **??** (Appendix A), respectively. Roughly 75% of sample firms are categorized as micro-, small-, or medium-sized. This number is certainly lower than the actual share of SME in Germany, however, our sample criteria enable us to preserve the most relevant observations and still maintaining a rich enough basis to conduct a thorough analysis.

4.2 Descriptives

Descriptive statistics in Table **??** provide first insights on key differences among SME and large firms. Small firms are on average i) more dependent on bank debt[6], ii) more profitable, but iii) associated with a higher level of risk, which is reflected in higher operating risk as well as lower holdings of tangible assets (i.e. potential collateral). These statistics reflect that small firms are typically on a different stage of the firm life-cycle, which is confirmed by the differences in the mean age. All aforementioned differences are statistically significant at the one percent level as (unreported) t-tests show.

- Insert Table **??** *here -*

Our description moves several steps further to provide more detailed information on the underlying data. First, Table **??** (Appendix A) takes a closer look at firms' liability composition by estimating the liability ratios of a given balance sheet item. While the share of total bank debt is higher for small firms, this observation changes when differentiating among bank loans with a maturity of up to one year and longer-termed bank loans. As such, smaller firms have a much higher short-term borrowing (17.3 versus 12.1 percent of liabilities), whereas larger firms obtain more long-term debt. This is likely to reflect different levels of risk associated to these firm categories. Overall, the differentiated perspective on SME versus large firms' balance sheet position as well as firm characteristics illustrates why smaller firms are assumed to be more vulnerable to exogenous shocks in the loan supply. These insights mirror findings from previous literature on the financing differences between SME and large firms and strengthen the validity of our sample.

Second, Appendix **??** provides linear regression analysis as a mean of an advanced descriptive analysis on the financing pattern of SME and large firms across our sample period. Findings confirm the validity of our dataset regarding the most common priors. Further, the linear analyses leave space for interpretation on whether small firms are affected by the crisis disproportionally.

[6] As such small firms hold higher levels of bank debt and have fewer debt sources available. The latter is reflected in a higher borrowing diversity index score as well as lower shares in firms active at both capital and bond markets.

Third, the interest rate is central for our analysis. We calculate it the the fraction of interest expenses in a given period over the corresponding amount of firms' average bank debt held during the period. 24 percent of observations do not have any outstanding bank loans, which could be either because of zero demand or full rationing. To account for this, we impute a fictive interest rate for those firms with zero loans using a CEM matching procedure. For precautious reasons, we separately run robustness test for the disequilibrium estimations in which we compare results with and without these imputed rates. For an elaborate description on this subject see Appendix **??**.

5 Methodology

5.1 Considerations on financing constraints

Financing constraints are not directly observable such that empirical investigations rely on indirect proxies (**?**). On a broader perspective, **?** show that dependence on external funding is industry-specific. On a more micro-level, approximations are applicable to only certain firms, for instance, those that actually exhibit dividend payments or bond ratings (see e.g.**?**). Others, like for example **?**, are applicable more broadly by using firm characteristics such as size and age. What these firm-level measures typically have in common is that they define *being small* as a constraint a priori. This imposes issues regarding our empirical investigation, regardless of whether it is indeed true that smaller firms are particularly susceptible to financing constraints. Because we aim to explore differential effects among small and large firms' extent to be constrained during the crisis, our approximation of financing constraints cannot be directly linked to firm size. Moreover, previous work on the loan markets identifies high cyclicality of bank debt, which makes equilibrium conditions less likely to hold in the market (**?**).

To address these concerns, we base our approach to quantify financing constraints on likelihood functions proposed in **?** and **?**, which enable us not only to incorporate observable characteristics for all types of firms but also to depart from the equilibrium assumption about loan markets. We follow **?** in applying an estimation method for markets in disequilibrium with unknown sample separation.

An important element of our approach is that demanded and supplied quantities (Q^d and Q^s) are conceptually distinct. The following linear system describes demand and supply

$$\begin{aligned} Q_{it}^d &= \left(X_{it}^d\right)' \beta^d + X_{it}' \alpha^d + \varepsilon_{it}^d, \\ Q_{it}^s &= \left(X_{it}^s\right)' \beta^s + X_{it}' \alpha^s + \varepsilon_{it}^s. \end{aligned} \tag{1}$$

of firm i at time t. The shocks are independently and identically, normally distributed with zero

mean and variance-covariance matrix

$$\Sigma = \begin{pmatrix} (\sigma^d)^2 & \sigma^d\sigma^s\rho \\ \sigma^d\sigma^s\rho & (\sigma^s)^2 \end{pmatrix},$$

where we allow the shock to be either correlated or independent, that is $\rho = 0$ or $\rho \neq 0$, respectively. The explanatory variables in the demand and supply sides do not necessarily coincide. Explanatory variables that are common in both equations are denoted as X_{it}. Equation specific variables are denoted as X_{it}^k, for all $k \in \{d, s\}$). Markets are assumed not to clear in these specifications and the observed quantity may thus either belong in the supply or in the demand side. As such, our disequilibrium approach combines the equations of system (**??**) with the disequilibrium condition

$$Q_{it} = \min\{Q_{it}^d, Q_{it}^s\} .$$

The probability of observing a particular quantity consists of two parts. Either the observation belongs to the demand side, or to the supply side. Without loss of generality, the equilibrium case can be included in either the demand or the supply side. We adopt the convention that equilibrium observations belong in the supply side. Given that an observation belongs in the k-side (with $k, j \in \{d, s\}$ and $k \neq j$), its density is given by

$$\frac{\phi\left(h_{it}^k\right)}{\sigma^k}\left[1 - \Phi\left(z_{it}^j\right)\right],$$

where ϕ denotes the standard normal density and Φ denotes the standard normal distribution. The term $\frac{\phi\left(h_{it}^k\right)}{\sigma^k}$ is the density of observing the demanded or supplied quantity that corresponds to h_{it}^k, depending on the value of k.[7] The term $1 - \Phi\left(z_{it}^j\right)$ is an adjustment that accounts for the case that $Q_{it}^j > Q_{it}^k$. Combining the above, the log-likelihood of this setting is given by

$$l = \sum_{it} \log\left\{\frac{\phi(h_{it}^d)}{\sigma^d}\left[1 - \Phi(z_{it}^s)\right] + \frac{\phi(h_{it}^s)}{\sigma^s}\left[1 - \Phi(z_{it}^d)\right]\right\}. \tag{2}$$

The log-likelihood Equation (**??**) specializes **?** (**?**, Eq. 2.9) for demand and supply shocks that are jointly normally distributed and gives the unconditional log-likelihood of the unknown sample separation disequilibrium method. We describe the extensive margin of credit rationing by using the imputed interest rates for cases in which no interest is observed in our estimations. We thereby assume fully credit-rationed firms to face discouragingly high interest rates such that they do not obtain any loans.

[7] To simplify the presentation of the methodology, we introduce the notation $h_{it}^k = (Q_{it} - \left(X_{it}^k\right)' \beta^k - X_{it}'\alpha^k)/\sigma^k$, where Q_{it} is the observed quantity, and $z_{it}^k = (h_{it}^k - h_{it}^j\rho)/\sqrt{1-\rho^2}$ for $k, j \in \{d, s\}$ and $k \neq j$.

5.2 Measuring financial constraints and their probabilities

The output of the disequilibrium estimation allows us to move beyond the comparative analysis of individual demand and supply determinants. We construct two unit-independent measures for the intensity of financing constraints. The first measure calculates the probability of resembling a financially constrained firm in a given year for each observation in our sample following **?** (**?**, Eq. 2.2). The probability of an observation representing a financially constrained firm is equal to the probability of the firm being in an excess demand regime, i.e.

$$\hat{\pi}_{it}^{d} = \mathrm{P}(Q_{it}^{d} > Q_{it}^{s}) = \Phi\left(\theta_{it}\right) \ , \tag{3}$$

where Φ denotes the standard normal distribution. Contrasting related studies we do not set a particular probability threshold, which determines whether a firm is financially constrained (or not). Hence, our approach is independent from arbitrary cutoff classifications and simultaneously allows examining the entire distributions of financing constraints probabilities for different subsamples of firms, years, or industries. This enables a unbiased and thorough assessment of whether SME are hit more severely than large firms. In order to calculate this probability, we have to specify θ_{it}, which is a continuous-domain measure of the intensity of financing constraints. It can be directly constructed based on the output of the disequilibrium estimation methods, namely

$$\theta_{it} = \frac{\hat{Q}_{it}^{d} - \hat{Q}_{it}^{s}}{\sqrt{\hat{\sigma}_{d}^{2} + \hat{\sigma}_{s}^{2} - 2\hat{\sigma}_{d}\hat{\sigma}_{s}\hat{\rho}}} \ .$$

We refer to the statistic θ_{it} as the expected excess demand of firm i in period t normalized by the standard deviation of the difference of the demand and supply shocks estimate for all observations in the sample. Both the numerator and the denominator are expressed in quantity units. Thus, θ_{it} provides an assessment of financial constraints that does not depend on the unit of measurement.

In addition to this, we calculate a second measure, which specifies a statistic value of excess demand by the difference between expected excess demand and supply relative to the expected supply for loans. Unlike the first measure in Equation (**??**), it does not represent an estimated probability but rather a continuous variable capturing the extend of excess demand, i.e.

$$\mathcal{F}_{it} = \frac{\hat{Q}_{it}^{d} - \hat{Q}_{it}^{s}}{\hat{Q}_{it}^{s}} \ . \tag{4}$$

In $\mathcal{F}_{it}$, the estimated excess demand is it is normalized by expected supply, which is observation dependent and, thus, idiosyncratic. However, just as θ_{it} it is independent of the unit of measurement. By regressing a set of independent variables on $\mathcal{F}_{it}$, we can depict their explanatory effect as determinants of financial constraints. As such, we are able to investigate whether size

characteristics are indeed relevant in explaining a potential increase in financing constraints over the course of the financial crisis.

In general, our model allows firms to be either in an excess demand or excess supply regime. The intuition behind this may be the following. Lack of market clearing in the lending market could be caused by the fact that new information gathering and processing is costly, and that the banks face menu costs (**?**, **?**).[8] Information asymmetries might make it hard to decide whether changes in the demand for loans are temporary, and whether the changes are idiosyncratic or whether such changes are uniform to the whole market. The presence of information asymmetries and menu costs may also induce banks to define a target retail rate as a function of long-term market interest rates. Thus, it is plausible to assume the prevalence of both excess demand or supply, i.e. disequilibrium in the bank lending market, at least in the short run.

5.3 Variable specifications of the model

The variable specifications of our model follows previous literature on disequilibrium models (e.g **?**, **?**, **?**). Further, our exclusion restrictions are based on the logic that both loan demand and supply are driven by the indirect cost of obtaining a loan, respectively providing a loan.

First, we assume that demand side determinants are mostly affected by the relative cost of funding sources. Bank debt is considered a rather expensive funding option (**?**). Demand for it should thus be particularly affected by its price and the availability of other, less expensive substitutes (**?**, **?**).

Hence, we model loan demand as a function of the interest rate (*interest*) which is specified in Appendix **??** and financing alternatives. For the latter we use a set of variables, namely alternative non-bank debt sources which we measure by a borrowing diversity concentration index[9] (*bdiversity*) and internal funding via cash flows (*cash*). Lower concentration and higher levels of internally generated funds both resemble a larger availability of alternative funding options, which should thus decrease demand for bank debt. On top of this, we include a more direct measure for firms' (long-term) financing needs ($finneed$) proxied by firms' capital expenditures. Higher needs should positively related to bank debt.

Second, supply side determinants relate to default costs expressed as the risk associated with the potential borrower. As such, banks' decision to supply loans should be determined predominantly by firms idiosyncratic characteristics. We thus specify loan supply as a function of the borrowing firms' ability to receive payments on their business activities (*risk*) as measured by accounts

[8] See also **?** for a relevant discussion about the pass-through of policy rates to retail bank rates in the Euro Area.

[9] Borrowing diversity measures the overall number of different debt types used by a firm. Empirically, we specify it in the spirit of a normalized Herfindahl index, which takes into account other non-bank external debt sources. The larger the index, the fewer different sources are used. We thus specify the borrowing diversity of firm i in period t that uses n debt sources (DS_{it}), which sum up to a total level of debt, TD_{it}, such that $bdiversity_{it} = \frac{CM_{it}-(1/n)}{1-(1/n))}$, with $CM_{it} = \sum_{n=1}^{N}(DS_{it}^{n}/TD_{it})^2$.

receivables divided by total assets. Further, the ability to provide collateral (*collateral*) measured by firms' share of tangible assets similarly signals a firm specific risk factor. Hence, both higher shares of receivables and tangible assets should improve firms' creditworthiness and relate to loan supply positively. Additionally, we expect profitability ($profitability$) to increase the underlying risk associated with a borrower. While literature does not provide a clear answer to the relationship between firm growth and leverage, we therefore follow **?** and argue that high growth reflects riskier and more volatile cash flows. We measure profitability as return on asset, that is firms' earnings before interest and taxes (ebit) as a fraction of total assets.

In this context, it is important to note that banks set prices according to borrowers risk and not demanded quantities. Thus, banks first decide how much they are willing to lend before they subsequently bargain the interest rate with firms (**?**). Similarly, **?** demonstrate that credit rationing occurs despite - or even because of - the willingness of certain firms to pay high interest rates. In line with this, **?** specify the determinants of interest rate formation as i) the risk premium, ii) risk-free cost of capital and iii) transaction and operating costs as well as iv) expected inflation. Following these considerations as well as the aforementioned studies on the topic, we therefore do not consider the interest measure as a supply side determinant for bank loans.

In addition to those function specific parameters, we propose firm size as well as a set of controls to affect demand as well as supply for loans simultaneously. Including firm size ($size$) helps to control for the firm-specific risk and the need for bank debt alike, thereby addressing both loan demand and supply factors.We measure size by the logarithm of assets but also include an indicator variable for SME in several specifications. Similar to this, controlling for time fixed-effects ($year\text{-}fe$) is important, as it allows, for instance, controlling for both banks' refinancing costs with the European Central Bank as well as business cycle specific fluctuations in the need for funding. Further, the heterogeneity in loan demand and supply is also dependent on possible industry-specific features ($industry\text{-}fe$). Finally, as the dependent variable, we specify firms loan ratio as the end of the period total amount of bank loans obtained from credit institutions as a fraction of total assets.[10] Table **??** (Appendix A) contains all variable definitions and their empirical specifications. Formally, we can summarize the above such that

[10]Because information on individual loan maturities is not available, we do not investigate whether results are sensible towards using new loans as dependent variable in detail. Arguably, it is possible approximating new loans by means of the accounting equality between the observed outstanding amounts and reimbursements of existing loans. Note, however, that this approach needs to be based on restrictive and not easily verifiable assumptions about loans' reimbursement rates. In unreported regressions, we thus use the difference between previous and current years' loans, capped at zero, which does not affect the general interpretation of our results.

$$X_{it}^{d} = \{interest\,,\, bdiversity\,,\, cash\,,\, finneed\}\,,$$

$$X_{it}^{s} = \{risk\,,\, collateral\,,\, profitability\}\,,\text{ and}$$

$$X_{it} = \{size\,,\, year\text{-}fe\,,\, industry\text{-}fe\}$$

6 Results

6.1 Disequilibrium model estimates

Table **??** provides the parameter estimates of our disequilibrium analysis for different model specifications, incorporating all sample years (i.e. crisis and non-crisis periods). In Column I the error terms of the two equations are correlated.[11] All parameters show the expected signs: alternative funding sources and costs of debt relate negatively to firms' loan demand whereas financing needs relate positively to it. For example, starting with the interest rate, we see that a 1-percentage point increase in the interest rate decreases the demand with 0.0055. Holding this coefficient together with the mean value reported in Table **??** (0.222) resembles a 2.5 percent drop in loan demand. This magnitude is comparable to what other studies already discussed have found. Moreover, in this general setup, we find firm size to be an important determinant for the demand and supply of bank loans, with both a lower demand and banks supplying less to smaller firms. In addition to this, the year dummies account for the business-cycle differences in loan demand and supply. The estimates report a strong aggregate decrease in demanded and supplied amounts of loans beginning in 2009. The effect is larger for the supply (-0.0229) compared to the demand (-0.0094). This observation also applies for 2010 and confirms descriptive statistics.

- Insert Table **??** *here -*

Our main specification on which we base the estimations of financing constraints is in Column III. Here we additionally control for Mundlak fixed effects (**?**), that is time invariant, firm-specific averages of the independent variables. The averages are taken, if available, from the pre-sample years 2003-2005. This approach allows us to address endogeneity concerns within the disequilibrium framework. While the magnitude of most coefficients only changes slightly, the signs remain consistent across specifications. A notable exception is the size regressor in the supply equation, which turns positive. Hence, this specification suggests that larger firms have a lower demand for

[11] The estimate shows that the shocks are indeed correlated across the two equation (rho = 0.7790). Restricting $\rho = 0$ in Column II only modestly changes estimates of the other coefficients compared to those reported in Column I. Hence, we can focus on the models where the restriction $\rho = 0$ is not enforced without loss of generality.

loans despite the fact that they face higher supply. This is an observation well in line with the idea of financially constrained small firms.

In the final column, we further control for the one year lag of the dependent variable. In line with previous literature (e.g. **?**), we thereby want to check whether our specification of the dependent variable suffers precision. Because we only observe the stock of outstanding debt at the end of the period, we might not capture the relevant dimension of firm borrowing. More specifically, if there was a large difference between the stock of loans and the amount of new loans issued, this might systematically affect results. Because estimates on this specification are qualitatively not different from previous estimates, we plausibly argue that this issue does not apply in our case.[12]

6.2 Rationing: Probability of excess demand and its determinants

Figure **??** illustrates the distribution of our calculated probabilities on whether a firm is financially constrained as defined by Equation (**??**) both for SME and large firms, during years of economic growth and recessions.[13] There are three main observations to that. First, not surprisingly, the distributions for both subcategories of firms shifts towards the right during crisis years, representing a tightening in credit conditions. More specifically, this implies that the probability of an observation representing a financially constrained firm increases for both SME as well as large firms. Second, irrespective of the particular time frame, SME have on average a higher probability to experience a situation of excess demand. Before and during the crisis the distribution the measure for small firms is located to the right compared respective distributions for large firms. Once again, this observation is in line with previous literature. Third, comparing the relative increase between the pre-crisis average and the 2009 value for both SME and large firms shows that large firms' share increased stronger than those of SME.

- Insert Figure **??** *here -*

To be more precise on this, we calculate the share of firms for which the normalized excess demand measure (Equation **??**) is positive, i.e. where estimated demand is higher than supply. These firms can be considered as facing problems in obtaining sufficient bank loans. Table **??** which contains the corresponding mean values for each individual year between 2006 and 2010 of this exercise. Figure **??** illustrates the evolution graphically by indexing 2008 values (=100) of financing constraints. For small firms, the average probability of being financially constrained increases by about 4.9 percent (3.6 percentage points). At the same time, for large firms this

[12] To analyze whether these estimations are driven by the imputed interest rates as described in the previous section, we repeat this analysis excluding firms with zero loans. Table **??** (Appendix A) summarizes these findings. We cannot observe major differences in the estimations and therefore argue that our imputation does not affect the results systematically. Further, consistent with our approach to use one model for the entire time frame, Table **??** (Appendix A) indicates qualitatively similar estimates across sub-samples of firms and time.

[13] Figure **??** (Appendix B) plots the overall shift in the distribution of this measure across sample years.

increase is higher in both relative and absolute term, of course, despite the fact that they depart from different levels. The average probability increases by 7.7 percent (4.4 percentage points).

- Insert Table **??** *here -*

- Insert Figure **??** *here -*

One obvious problem when analyzing credit constraints over the course of an economic crisis are confounding effects arising from firms that leave the data base. Over the course of an adverse event, such as the Great Recession, survivorship can have a strong impact on the findings. If a significant fraction of firms drop out of the database, average effects might simply be a mechanical effect. In fact, in our sample 4,203 firms (out of 18,113) do not appear after 2008 anymore. This certainly does not automatically imply firms' bankruptcy, but still allows comparing pre-crisis values of our probability measure across these two subgroups. Figure **??** (Appendix B) displays that firms , which drop out the database are ex ante more financially constrained (0.629) compared to those remaining in the dataset (0.595). Presumably at least a certain fraction of these firms leaves the database because of bankruptcy. This finding can be considered as a plausibility check on the validity of our measure. More importantly, because it is drop outs that have a higher probability of being financially constrained ex ante, the shift for the surviving firms is even more pronounced as compared to considering the entire distribution of firms before the crisis. Hence, this exercise reveals that it is not surviving firms, respectively the absence of drop outs, that systematically drive results. In contrast, our main findings can be rather interpreted as the lower bound of the shift in the probability of being financially constrained.

6.3 Determinants of excess demand

As a next step of our empirical investigation, we utilize our second measure of financing constraints as defined in Equation (**??**) to assess which of the variables in our disequilibrium model framework explain variation in the degree of excess demand. Table **??** displays respective estimates of a set of linear regression explaining our continuous measure of financing constraints, estimated excess demand ($\mathcal{F}_{it}$), as dependent variable.

- Insert Table **??** *here -*

As expected, Column I displays that the interest rate as well as alternative funding resources relate negatively to estimated excess demand, while the riskiness of firms relates positively to estimated excess demand. These findings are statistically significant at the one percent level. Further, the positive, and statistically significant year dummies reflect that the level of excess

demand for the average firm becomes more sizable during 2009 and 2010 as compared to the pre-crisis years. Remarkably, two parameters are not able to explain variation estimated excess demand, financing needs and firm size. In this case, the size variable captures the variation across all firms, because there is no additional variable controlling for this dimension.

By splitting the sample, we can explore whether these insights vary according to pre-crisis (Column II) and crisis years (Column III). A general observation is that coefficients vary only slightly in magnitude[14] – with one notable exception, the firm size measure. The coefficient is statistically significant and negative (-0.055) for the sample covering the years of economic upswing (2006-2008). This implies, that size is a determining factor for the level of excess demand.i.e. the level of estimated excess demand is higher for smaller firms, which is an observation well in line with previous findings. However, we find a statistically *insignificant*, positive effect (0.035) for firm size for the years 2009 and 2010. Everything else equal, this implies that small firms are not more likely to be in an excess demand setting during the period of the Financial Crisis. One has to acknowledge that descriptive statistics on other explanatory factors such as the availability of collateral, diversity of borrowing sources or the level of risk leave SME on average more prone to facing financing constraints. Still, our results suggest that firm size is not able to explain these constraints, *per se*.

We confirm this notion in the last specification (Column IV), which additionally includes an indicator variable for SME. The firm size measure now captures the effect only within each respective size category. Within these subgroups there is not statistically significant variation, ceteris paribus. More important is the coefficient of interest in this specification, the SME dummy. Just like in Column III, the coefficient is negative but does not hold at any conventional level of statistical significance, in this case.

Furthermore, Table **??** (Appendix A) contains estimation specifications on sample splits according to SME and large firms both before and during the crisis. Results show heterogeneity with respect to the magnitude of the parameters explaining the probability of an observation to be in a excess demand regime. As such, estimates confirm that collateral becomes more important for SME during the crisis (compare Columns I and III). For large firms, this applies only to a smaller extend. However, for these firms the interest rate as well as the risk indicator become more important, which is in line with the idea that borrowing becomes more difficult also for this subgroup. Importantly, estimates confirm that firm size is only a determinant for smaller firms.[15] This mirrors findings from the main estimation by showing that even within the group of small firms, size is only a determinant before the crisis, whereas during the crisis other factors are more

[14] For example, the availability of collateral appears more important in mitigating the probability of financing constraints during the crisis years (-2.326) as compared to before (-1.789).

[15] Because of the sample split,these comparisons are within groups. For SME, the coefficient of firm size is negative and statistically significant (-0.149) before the crisis but turns insignificant and small during the crisis (0.018).

important in determining financing constraints.[16]

6.4 Extensions: Alternative mechanisms

Our estimates indicate that it is not SME *per se*, which are affected most by the Financial Crisis. Thus, we extend our investigation by considering its impact on other (non bank debt) dimensions. As a first exercise, Figure **??** (left graph) shows that both types of firms exhibit higher levels of the borrowing diversity index during 2009 as compared to pre-crisis periods (i.e. 2006 and 2007). This reflects a concentration on *fewer* debt sources during the crisis and indicates a tightening of external funding across multiple debt categories. While, this effects seems to be larger for SME, the overlapping whiskers show that the differences between small and large firms are not statistically significant. In contrast, one year after the onset of the crisis, in 2010, borrowing diversity measures differ. While the coefficient for SME is still positive and significant, the coefficient for large firms is statistically not different from zero. With regard to this parameter, SME appear to be slightly more affected by the crisis, at least in the medium-term.

- Insert Figure **??** *here -*

To investigate whether SME actually mitigate the adverse shock of the Financial Crisis by prudent behavior, Figure **??** (right graph) displays the evolvement of cash and cash equivalents holdings. The plot shows that firms indeed increase their cash holdings in 2009 strongly. The effect is highly significant and translates roughly to a 20 percent increase for the median SME. The effect holds for both SME and large firms but appears more persistent for smaller firms. Higher associated costs of financial distress can explain why particularly SME build up cash buffers as a reaction to the overall slowdown in economic activity (**?**).

Combining the two findings from Figure **??** with our previous results in this paper suggests that firms substitute external funding by building up cash buffers. This provides an explanation how firm are actually capable in dodging the economic slowdown during the Financial Crisis. Notably, this assessment is not limited to large firms but instead particularly applies for SME.

As a final step of the analysis on alternative outcomes, we assess the consequences of the economic slowdown in terms of real economic activity. While it might well be that SME and large firms are affected equally in terms of borrowing activities, they still might differ with respect to other firm-level outcomes. Figure **??** (Appendix B) repeats the graphical analysis for firm-level investment and thereby reveals that firms strongly decrease their capital expenditures with the

[16] All our analyses control for industry fixed effects to adjust for variation arising from sector specific heterogeneity. For two reasons, we further refrain from repeating our analysis on specific industries. First, marcoeconomic policy is typically based on average parameters and not on particular industries. Thus the relevance on respective industry-by-industry findings for the purpose of a unified policy implications is limited. Second, in order to obtain relatively stable results in the analysis of non-linear models, we have to ensure a reasonable size of the underlying sample.

onset of the Financial Crisis in 2009. Notably, also the impact on investment appears virtually equivalent for small and large firms.[17]

7 Conclusion

This paper investigates the evolution of financial constraints of German firms throughout the Financial Crisis during the late 2000s. To measure the intensity of financing constraints from banking sources, the empirical analyses is based on a granular firm-level panel dataset provided by Deutsche Bundesbank. Instead of adopting an ad-hoc measure of the financial constraints, the paper estimates them using a disequilibrium econometric specification. The estimated constraints are furthermore used to examine whether the crisis had different implications for SMEs and large enterprises. The focus is placed on bank funding-sources as Germany is historically considered to be a bank-based economy, and thus, suggests that the scarcity of funding opportunities stemming from the banking sector is a good indication of firms' financial difficulties.

The analysis shows that SMEs and large firms are not disproportionally affected by the financial crisis. Indeed, both before and during the crisis, SMEs exhibit on average higher probabilities of being in a financially constrained state. The effect of the crisis, however, on financial constraints is not significantly greater for small firms in comparison with large ones. The financial constraints obtained by the disequilibrium model are furthernore employed in examining the driving factors of financial constraints for small and large enterprises during the crisis' years. The main finding from this part of the analysis is that, controlling for other factors, a firm's asset-size is not significant in determining the intensity of financial constraints. Instead, non-banking funding alternatives and internal funds are more important in mitigating financial constraints.

The paper's results are in line with a series of findings using data from other European countries, all which question whether the SME classification as being a particular vulnerability when it comes to financing. Instead, it seems reasonable to focus on to what degree bank dependent firms tend to be more vulnerable to adverse economic events. Firms with alternative funding sources are more resilient. Furthermore, our results demonstrate that this observation is central both before and after the crisis.

These findings have important implications from a policy perspective. Instead of focusing on general at policies that alleviate financial constraints from bank sources based on firm size, it is more appropriate to address financing difficulties at a more specialized level. Institutionalizing and increasing the availability of funding sources other than bank-funding and setting margins for minimum internal fund holdings are two examples of potentially appropriate targeted policies.

[17] The drop of the coefficients is not only statistically significant but also economically meaningful; translating to a 30.1 percent (1.6 percentage points) slump in expenditures for the average firm in 2009.

Tables from the main part:

Table 1: Descriptive statistics by firm size category

	All	**SME**	**Large**
Loan-ratio	0.222	0.234	0.189
Borrowing diversity	0.372	0.385	0.333
Profitability	2.358	2.536	1.835
Internal funds	0.094	0.103	0.069
Financing needs	0.054	0.053	0.057
Operating risk	0.296	0.301	0.283
Collateral	0.308	0.281	0.386
Firm size	9.284	8.454	11.725
Age	27	25	40
Quoted (in %)	7.21	2.80	20.19
Bond market (in %)	3.15	1.03	9.39

Notes: This table displays displays mean values of several financial variables for the overall sample, SME, and large firms in respective columns. All variables are defined as specified in Table **??** (Appendix A). In addition to this, *age* is defined as the median age, *quoted* and *bond market* resemble the share of sample firms that are listed on the stock market and those having used the bond market as a source of external finance, respectively. Data source: **?**, own calculations.

Table 2: Disequilibrium model: baseline specifications

Dependent variable:		Bank loan ratio			
		(I)	(II)	(III)	(IV)
Demand equation	Interest rate	-0.5555***	-0.6092***	-0.5356 ***	-0.3514***
		(0.0095)	(0.0116)	(0.0120)	(0.0448)
	Borrowing diversity	0.8194***	1.0879***	0.8087***	1.2403***
		(0.0093)	(0.0091)	(0.0121)	(0.0370)
	Internal funds	-0.2383***	-0.2798***	-0.2775***	-0.5222***
		(0.0089)	(0.0111)	(0.0123)	(0.0195)
	Financial needs	0.0838***	0.0248**	0.0676***	0.2339***
		(0.0082)	(0.0103)	(0.0103)	(0.0206)
	Firm size	-0.0148***	-0.0168***	-0.0115***	-0.0180***
		(0.0004)	(0.0005)	(0.0023)	(0.0012)
	Year: 2007	0.0067***	0.0073***	0.0049***	0.0053
		(0.0021)	(0.0028)	(0.0022)	(0.0056)
	Year: 2008	0.0024	0.0016	0.0009	-0.0059
		(0.0021)	(0.0028)	(0.0023)	(0.0055)
	Year: 2009	-0.0094***	-0.0105***	-0.0139***	-0.017***
		(0.0022)	(0.0029)	(0.0025)	(0.0055)
	Year: 2010	-0.0113***	-0.0126***	- 0.0168***	-0.0145***
		(0.0021)	(0.0029)	(0.0024)	(0.0056)
	Sigma (D)	0.0089***	0.0080***	0.0090***	0.0194***
		(0.0002)	(0.0001)	(0.0002)	(0.0009)
Supply equation	Risk	-0.1750***	-0.1796***	-0.0766***	0.0021
		(0.0060)	(0.0056)	(0.0102)	(0.0021)
	Collateral	0.3218***	0.2766***	0.3261***	0.0136***
		(0.0059)	(0.0053)	(0.0113)	(0.0020)
	Firm size	-0.0089***	-0.0102***	0.0289***	-0.0010***
		(0.0006)	(0.0006)	(0.0033)	(0.0002)
	Profitability	-0.0101***	-0.0099***	-0.0034**	-0.0027***
		(0.0008)	(0.0007)	(0.0016)	(0.0008)
	Year: 2007	0.0001	0.0003	-0.0025	0.0083***
		(0.0032)	(0.0030)	(0.0034)	(0.0016)
	Year: 2008	-0.0025	-0.0017	-0.0071**	0.0088***
		(0.0031)	(0.0030)	(0.0024)	(0.0015)
	Year: 2009	-0.0229***	-0.0204***	-0.0278***	-0.0035***
		(0.0031)	(0.0030)	(0.0034)	(0.0011)
	Year: 2010	-0.0252***	-0.0238***	-0.0339***	-0.0064***
		(0.0032)	(0.0031)	(0.0035)	(0.0012)
	Sigma (S)	0.0516***	0.0507***	0.0506***	0.0065***
		(0.0004)	(0.0004)	(0.0004)	(0.0000)
	Rho	0.7790***	-	0.7933***	-0.3296***
		(0.0150)	-	(0.0160)	(0.0221)
D-S relation:		Correlated	Independent	Correlated	Correlated
Additional controls:					
Industry-FE		Yes	Yes	Yes	Yes
Mundlak correction		No	No	Yes	Yes
Lagged dep. variable		No	No	No	Yes

Notes: This table displays the main regression results from the disequilibrium model explaining bank loan to asset ratios. Demand and supply determinants are defined as specified above. In Column II error terms are uncorrelated, in Column III we introduce additional Mundlak dummies, i.e. firm-specific time invariant mean values of the independent regressors based on the three years prior to the sample (2003-2005), Column IV includes the lagged dependent variable on both the demand and the supply side. All regressions control for industry fixed-effects, which are omitted in the output. Standard errors are displayed in parentheses below coefficients. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

Table 3: Regression estimates: excess demand determinants before and during the crisis

	2006	**2007**	**2008**	**2009**	**2010**
SME	0.7003	0.7173	0.7288	0.7646	0.7555
Large	0.5505	0.5771	0.5793	0.6237	0.5915

Notes: This table contains mean values of the probability of a firm experiencing excess demand for bank loans. The probability as defined in Equation (**??**) is displayed for SME and large firms as well as for each year of the sample period separately. Data source: **?**, own calculations.

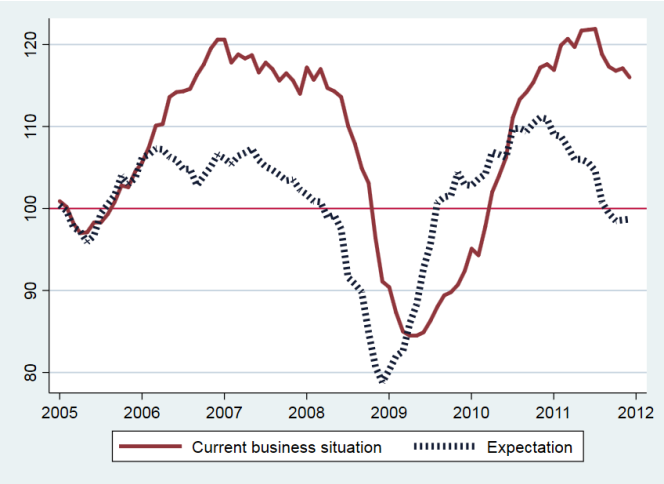
Table 4: Regression estimates: excess demand determinants before and during the crisis

Dependent variable:	Est. excess demand			
Sample years:	All	Pre-crisis (2006-2008)	Crisis (2009-2010)	
	(I)	(II)	(III)	(IV)
Interest rate	-2.897***	-2.492***	-2.182*	-2.734***
	(0.327)	(0.418)	(1.184)	(0.315)
Borrowing diversity	4.998***	5.178***	5.550***	4.872***
	(0.123)	(0.166)	(0.399)	(0.106)
Internal funds	-1.550***	-1.884***	-1.585**	-0.843***
	(0.234)	(0.311)	(0.784)	(0.208)
Financing needs	-0.003	-0.227	-0.230	-0.040
	(0.318)	(0.414)	(1.106)	(0.294)
Firm size	-0.018	-0.055***	0.035	-0.009
	(0.014)	(0.019)	(0.046)	(0.018)
Risk	5.173***	5.492***	5.812***	4.384***
	(0.150)	(0.203)	(0.489)	(0.130)
Collateral	-2.031***	-1.789***	-2.447***	-2.179***
	(0.141)	(0.193)	(0.455)	(0.121)
Profitability	0.290***	0.368***	0.299***	0.164***
	(0.020)	(0.027)	(0.066)	(0.018)
Year: 2007	0.051	0.098		
	(0.073)	(0.077)		
Year: 2008	0.102	0.095		
	(0.074)	(0.077)		
Year: 2009	0.355***			
	(0.074)			
Year: 2010	0.398***		-0.045	0.039
	(0.074)		(0.152)	(0.040)
SME				-0.097
				(0.073)
Constant	-1.900***	-1.892***	-2.395***	-1.292***
	(0.181)	(0.238)	(0.304)	(0.238)
Additional controls: Industry-FE	Yes	Yes	Yes	Yes
Observations	74,496	45,254	29,242	29,242

Notes: This table displays regression results on a set of regressions explaining estimated excess demand as a dependent variable as defined in Equation (**??**). All specifications include industry fixed-effects. Specifications include our full sample (Column I) as well as a sample split according to pre-crisis years (Column II) and crisis years (Columns III-IV). Standard errors are displayed in parentheses below coefficients. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

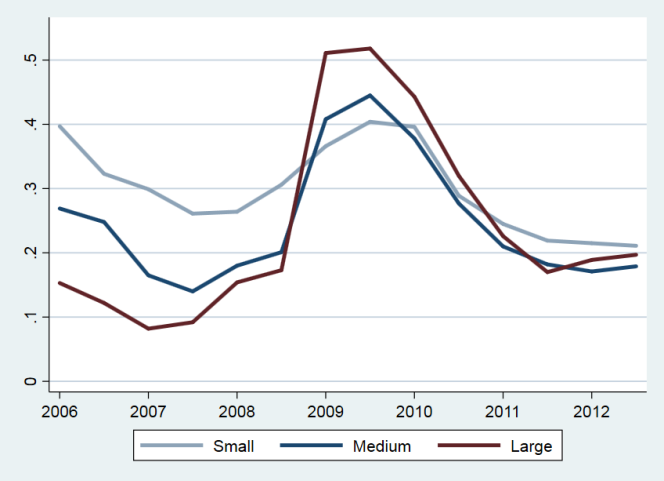
Figures from the main part:

Figure 1: Business climate, Germany 2005-2012



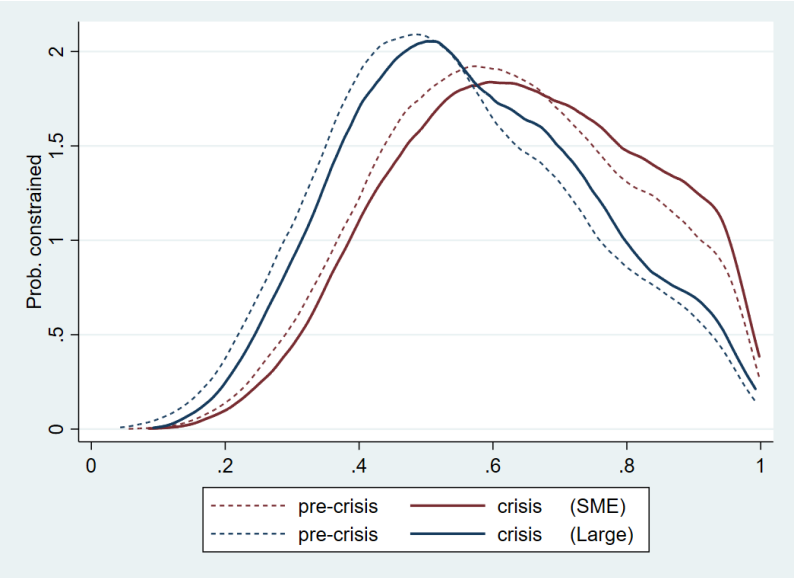
Notes: The figure plots the responds to the Ifo Business Climate Index. Responders have the choice to answer how they perceive the two situation with the choices "good", "satisfactory", and "poor". Every month approximately 7,000 participants from firms in manufacturing, construction, wholesaling, and retailing are requested to evaluate their respective business situation. Higher values imply an aggregate improvement in the current, respectively expected, business situation. The year 2005 is indexed as 100.

Figure 2: Perceived credit restrictions among German firms 2006-2012



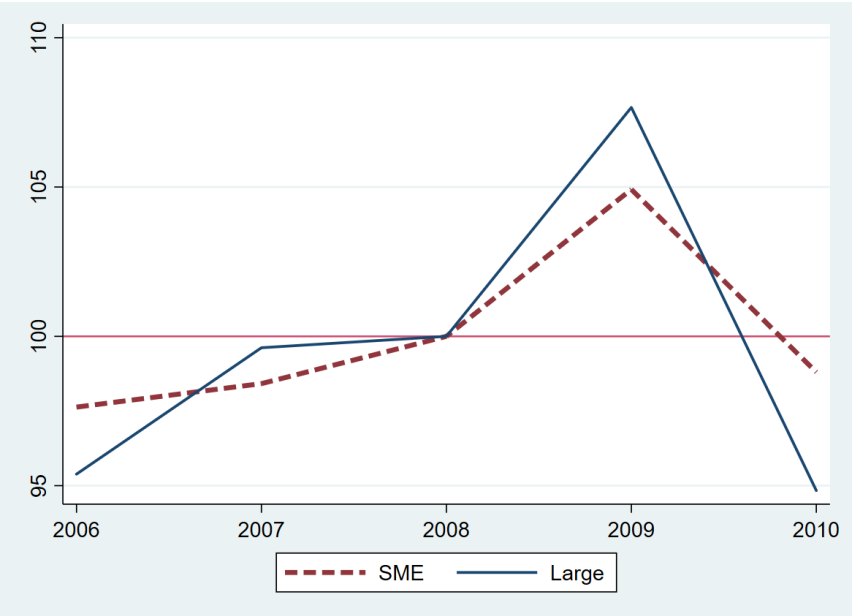
Notes: The figure plots the responds to the Ifo Credit Constraint Indicator for manufacturing firms. To calculate the intensity of credit constraints, firms are asked to answer the question: "How would you assess the current willingness of banks to extend credit to businesses?" Respondents choose between the answers "accommodating", "normal", and "restrictive".

Figure 3: Probability of expected excess demand: SME versus large firms



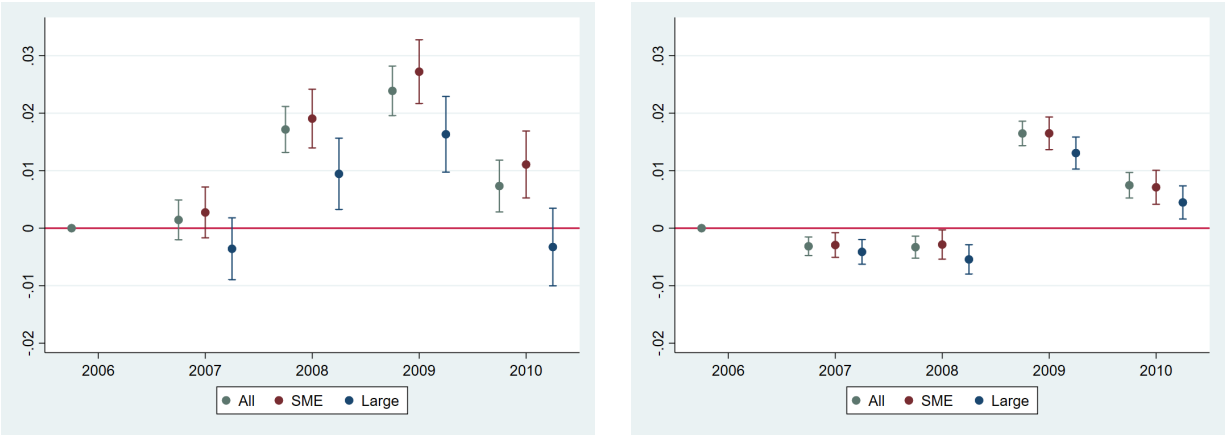
Notes: This figure displays the probability distributions of an observation representing a financially constrained firm, i.e. being the excess demand regime as defined in Equation (**??**). Distributions are plotted separately for SME (red) and large firms (blue), both during economic upswings and recessions, i.e. comparing the sample pre-crisis years 2006-2008 (dashed lines) with the crisis year 2009 (solid lines). Data source: **?**, own calculations.

Figure 4: Share of financially constrained firms, SME versus large (2008=100)



Notes: The figure displays the share of firms that are estimated to exhibit estimated excess demand for bank loans as specified by Equation (**??**) and distinguishes among firms that are observed in the database during the years 2009 and 2010 (survivors) and those not observed (drop outs). The lines correspond to the pre-crisis distributions for survivors (blue line) and drop outs (red line). The dashed line represents the distribution of firms during the crisis, i.e. survivors during 2009 and 2010. Data source: **?**, own calculations.

Figure 5: Coefficient plot: borrowing diversity and cash holdings between 2006-2010



Notes: The figure plots correlation coefficients of three separate regressions with equivalent model specifications. Estimations use three different samples: 1) full sample, 2) SME, and 3) large firms. The econometric specification is: $\Omega_{it} = \alpha_i + \beta_\tau year_{2006+\tau} + \Omega_{i\,t-1} + X_{i\,t-1} + \varepsilon_{it}$, with Ω_{it} being the borrowing diversity index (left graph) as defined in Table **??** (Appendix A), or the cash and cash equivalents to total asset ratio (right graph), and X_{it} a vector of firm-specific control variables of firm i at time t, α_i are firm-fixed effects. The coefficients plotted are β_τ for each year, relative to 2006. Whiskers represent 95 percent confidence intervals. Standard errors are heteroscedasticity-consistent and clustered at the firm level. Data source: **?**, own calculations.

Appendix A: Tables A1-A12

Table A1 : SME definition and sample distribution

	Definition			Sample		
	Employees	**Turnover**	**Balance sheet**	**Obs.**	**(in %)**	**Germany** (ref. 2017)
SME	< 250	≤ 50	≤ 43	55,650	(74.6)	99.5
Micro	<10	≤ 2	≤ 2	1,876	(2.5)	82.6
Small	10 - 49	≤ 10	≤ 10	19,879	(26.7)	14.5
Medium	50 - 249	≤ 50	≤ 43	24,314	(32.6)	2.4
Large	≥ 250	> 50	> 43	18,911	(25.4)	0.5
Total				74,561	(100.00)	(100.00)

Notes: The table displays the official definition on small and medium-sized enterprises in accordance to the European Commission's recommendation (2003/361/EC) in the first three columns. The values for *turnover* and *balance sheet* are denoted in million Euro. Next, the table displays the number of observations and the relative share in percent of total observations, respectively, according to these subgroups. The criteria have to be fulfilled in two consecutive years in order for a firm to classify for either one of the categories. The last column displays the actual size distribution for Germany in 2017 according to the Structural Business Statistics Database of **?**. Source of sample data: **?**, own calculations.

Table A2 : Sample distribution across sectors

Category	**Observations**	**(in %)**	**SME (in %)**	**Large (in %)**
Manufacturing	35,140	(47.13)	(41.88)	(62.58)
Electricity, gas and water supply	2,595	(3.48)	(2.20)	(7.26)
Construction	3,546	(4.76)	(5.12)	(3.70)
Wholesale and retail trade	29,398	(39.43)	(46.04)	(19.96)
Transportation and storage	2,410	(2.82)	(2.87)	(4.29)
IT and communication	1,472	(1.97)	(1.89)	(2.23)
Total	74,561	(100.00)	(100.00)	(100.00)

Notes: The table displays the distribution of observations in our main sample across sectors according to NACE Rev. 2 main categories, including the percentage as share of total. In order to avoid too small group sizes, we combined the electricity and gas with the water supply sectors (NACE Rev. 2 primary codes D and E). The percentage shares for SME and large firms corresponds to the total within those size categories. Data source: **?**, own calculations.

Table A3 : Composition of the liability side: SME versus large firms

Category	**Overall**	**SME**	**Large**
Bank debt (total)	0.298	0.308	0.268
Bank debt (short-term)	0.160	0.173	0.121
Bank debt (long-term)	0.138	0.135	0.147
Trade credit	0.209	0.211	0.201
Bonds	0.004	0.002	0.012
Loans from affiliates	0.183	0.189	0.165
Provisions	0.183	0.163	0.242
Others	0.123	0.127	0.112
Total	1.000	1.000	1.000

Notes: This table displays descriptive statistics on the composition of firms' liabilities. Column I displays mean values of respective variables for the overall sample, whereas the second and third columns show the mean values for respective subgroups, SME and large firms, respectively. All variables are defined as the balance sheet position (*category*) as a fraction of total liabilities. Unless indicated otherwise, we aggregate the positions across short- and long-termed liabilities. Data source: **?**, own calculations.

Table A4 : OLS regression estimates: the Financial Crisis and bank borrowing

Dependent variable:	Loan ratios:					
	Total				Short-term	Long-term
	(I)	(II)	(III)	(IV)	(V)	(VI)
SME × 2009		-0.003*	-0.003**		0.000	-0.003**
		(0.001)	(0.001)		(0.001)	(0.001)
Micro/small × 2009				0.000		
				(0.002)		
2007	0.001	0.001	0.002	0.001	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
2008	0.000	0.000	0.001	0.000	0.002	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
2009	-0.015***	-0.013***	-0.014***	-0.015***	-0.012***	-0.002
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0001011)
2010	-0.018***	-0.018***	-0.018***	-0.018***	-0.013***	-0.006***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Additional controls:						
Firm-FE	Yes	Yes	Yes	Yes	Yes	Yes
Lagged dependent var.	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.23	0.23	0.25	0.23	0.08	0.15
Observations	69,055	69,055	49,025	69,055	69,055	69,055

Notes: This table displays regression results from linear regression models explaining loan to asset ratios. The dependent variables are defined as total bank loans (Columns I-IV), short-term bank loans (Column V), and long-term bank loans (Column VI) as a fraction of total assets, respectively. Short-term is defined as a maturity of up to one year. All specifications include a vector of firm-specific control variables (i.e. loan demand and supply relevant variables as specified above), firm-fixed effects, and the one year lag of the respective dependent variable. Results on these control variables are omitted but their use is indicated below. In addition to the displayed year-fixed effects, Columns II-VI include interaction terms of the crisis year 2009. Column III displays results run on a subsample that excludes small and micro sized firms. In Column IV, the crisis year is interacted with a dummy equal to one for firms that are either small or micro sized enterprises. Standard errors (in parentheses below coefficients) are heteroscedasticity-consistent and clustered at the firm level. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

Table A5 : Evolution of interest rates, 2006-2010

	2006	**2007**	**2008**	**2009**	**2010**
SME	10.61	10.84	11.01	9.02	10.35
Large firms	10.07	10.07	10.34	9.02	9.25
Difference	*0.54***	*0.45***	*0.67***	*0.00*	*1.10***

Notes: This table displays interest rates for sample firms over for the years 2006 until 2010. Values refer to the average interest rates of imputed rates as defined in section 3 (in percent). The last row shows the interest spread, i.e. the difference in means of SME and large firms. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

Table A6 : Descriptive statistics: Observations with and without loans

	Loans = 0	**Loans > 0**	**Difference**
Borrowing diversity	0.493	0.334	0.159
Profitability	2.626	2.274	0.352
Internal funds	0.122	0.085	0.037
Financing needs	0.039	0.059	-0.020
Operating risk	0.355	0.277	0.077
Collateral	0.218	0.336	-0.118
Firm size	9.067	9.350	-0.283
Age	26	28	-2
Quoted (in %)	5.34	7.81	-2.47
Bond market (in %)	1.07	3.81	-2.74
Observations	17,954	56,607	-

Notes: This table displays repeats descriptive statistics from Table **??** separately for observations with zero loans (Loan = 0) and those observations with a positive amount of outstanding bank loans (Loans > 0). The third column shows the difference between the former and the latter. Data source: **?**, own calculations.

Table A7 : Interest rates: original and imputed rates

	Original	**Imputed only**	**Difference**
Q1	0.031	0.053	-0.022
Q5	0.041	0.061	-0.021
Q10	0.047	0.066	-0.019
Q25	0.058	0.074	-0.016
Q50	0.079	0.080	-0.001
Q75	0.118	0.085	0.033
Q90	0.194	0.092	0.102
Q95	0.273	0.100	0.173
Q99	0.467	0.128	0.339
Mean	0.106	0.081	0.025
Std. dev.	0.082	0.015	

Notes: This table displays summarizes the distribution of imputed and original values of interest rates. Original interest values are obtained by dividing interest expenses from a given period by the amount of outstanding debt at the end of the period. Imputed rates are calculated using a CEM matching approach for those firms with zero loans outstanding. The rows display different quantiles as indicated in the first column. That last column displays the difference between original and imputed rates. In the bottom of the table both the mean value of the interest rate for both categories and the corresponding standard deviation are displayed. Data source: **?**, own calculations.

Table A8 : Original and imputed rates: Pre-crisis and crisis years

Time frame:	**Pre-crisis** (2006-2008)			**Crisis years** (2009-2010)		
	Original (I)	**Imputed** (II)	**Difference** (III)	**Original** (IV)	**Imputed** (V)	**Difference** (VI)
Q1	0.036	0.053	-0.018	0.027	0.053	-0.026
Q5	0.044	0.066	-0.022	0.036	0.061	-0.025
Q10	0.049	0.073	-0.024	0.043	0.064	-0.021
Q25	0.061	0.079	-0.018	0.055	0.069	-0.014
Q50	0.082	0.083	-0.001	0.074	0.075	0.001
Q75	0.122	0.088	0.035	0.111	0.080	0.031
Q90	0.201	0.095	0.106	0.183	0.087	0.096
Q95	0.288	0.102	0.186	0.255	0.094	0.161
Q99	0.500	0.128	0.372	0.421	0.127	0.294
Mean	0.110	0.084	0.026	0.098	0.076	0.022
Std. dev.	0.086	0.013		0.075	0.017	

Notes: This table displays summarizes the distribution of imputed and original values of interest rates analogue to Table A6 (Appendix A). The rows display different quantiles as indicated in the first column. In the bottom of the table both the mean value of the interest rate for both categories and the corresponding standard deviation are displayed. Columns I-III display statistics for the years 2006 until 2008, whereas Columns IV-VI display statistics for the years 2009 and 2010. Data source: **?**, own calculations.

Table A9 : Variable definitions

Category	**Specification**	**Definition**	
Dependent variable:	Bank loans	Bank loan ratio ($loan\,ratio$)	$= \frac{\text{total bank debt}}{\text{total assets}}$
Demand function:	Interest rate	Interest rate ($interest$)	$= \frac{\text{interet paid on bank debt}}{\text{total bank debt}}$
	Financing alternatives	Borrowing diversity of external debt sources ($bdiversity$)	$= \frac{CM - (1/n)}{1 - (1/n)}$ with $CM_{it} = \sum_{n=1}^{N} (DS_{it}^{n} / TD_{it})^2$
	Internal funding	Cash flow generated from operations ($cash$)	$= \frac{\text{cash flow}}{\text{total assets}}$
	Financing needs	(Long-term) investments in capital ($finneed$)	$= \frac{\text{capital expenditures}}{\text{total assets}}$
Supply function:	Risk indicator	Ability to receive payments ($risk$)	$= \frac{\text{accounts receivable}}{\text{total assets}}$
	Collateral	Availability of tangible assets ($collateral$)	$= \frac{\text{tangible assets}}{\text{total assets}}$
	Profitability	Ability to repay debt ($profitability$)	$= \frac{\text{ebit}}{\text{total assets}}$
Others:	Size	Firm size ($size$)	$= log(assets)$
	SME	Size category (SME)	= 1 if firm is an SME , 0 otherwise

Table A10 : Disequilibrium model estimates on non-zero lenders

Dependent variable:		Bank loan ratio			
		(I)	(II)	(III)	(IV)
Demand equation	Interest rate	-0.6781***	-0.7229***	-0.6702***	-0.1028***
		(0.0082)	(0.0112)	(0.0099)	(0.0127)
	Borrowing diversity	0.7181***	0.8325***	0.6858***	0.4629***
		(0.0066)	(0.0098)	(0.0087)	(0.0132)
	Internal funds	-0.2618***	-0.3245***	-0.2848***	-0.2865***
		(0.0077)	(0.0120)	(0.0103)	(0.0078)
	Financial needs	0.1107***	0.0880***	0.0992***	0.1601***
		(0.0077)	(0.0116)	(0.0098)	(0.0077)
	Firm size	-0.0137***	-0.0098***	-0.0104***	0.0027
		(0.0004)	(0.0023)	(0.0022)	(0.0017)
	Year: 2007	0.0062***	0.0058**	0.0045**	0.0084***
		(0.0019)	(0.0028)	(0.0021)	(0.0015)
	Year: 2008	0.0022	-0.0024	-0.0118	0.0041***
		(0.0019)	(0.0029)	(0.0021)	(0.0016)
	Year: 2009	-0.0155***	-0.0207***	-0.0206***	-0.0113***
		(0.0020)	(0.0448)	(0.0022)	(0.0017)
	Year: 2010	-0.0154***	-0.0220***	-0.0214***	-0.0146***
		(0.0020)	(0.0031)	(0.0023)	(0.0016)
	Sigma (D)	0.0122***	0.0125***	0.0124***	0.0043***
		(0.0001)	(0.0002)	(0.0002)	(0.0001)
Supply equation	Risk	-0.1870***	-0.0976***	-0.0512**	0.0278***
		(0.0118)	(0.0189)	(0.0211)	(0.0074)
	Collateral	0.2620***	0.2524***	0.3026***	0.1173***
		(0.0109)	(0.0191)	(0.0217)	(0.0079)
	Firm size	-0.0143***	-0.0088	-0.0117*	0.0177***
		(0.0011)	(0.0063)	(0.0063)	(0.0023)
	Profitability	-0.0078***	-0.0058**	-0.0101**	-0.0132***
		(0.0016)	(0.0029)	(0.0031)	(0.0011)
	Year: 2007	-0.0033	-0.0037	-0.0026	0.0057***
		(0.0059)	(0.0065)	(0.0063)	(0.0022)
	Year: 2008	-0.0005	-0.0005	0.0011	0.0029
		(0.0059)	(0.0067)	(0.0065)	(0.0022)
	Year: 2009	-0.0232***	-0.0263***	-0.0275***	-0.018***
		(0.0059)	(0.0067)	(0.0065)	(0.0023)
	Year: 2010	-0.0220***	-0.0239***	-0.0227***	-0.012***
		(0.0061)	(0.0069)	(0.0065)	(0.0024)
	Sigma (S)	0.0597***	0.0652***	0.0586***	0.0093***
		(0.0009)	(0.0011)	(0.0010)	(0.0001)
	Rho	0.7328***	.	0.7500***	0.8304***
		(0.0168)	.	(0.0183)	(0.0201)
D-S relation:		Correlated	Independent	Correlated	Correlated
Additional controls:					
Industry-FE		Yes	Yes	Yes	Yes
Mundlak correction		No	Yes	Yes	Yes
Lagged dep. variable		No	No	No	Yes

Notes: This table displays the main regression results from the disequilibrium model explaining bank loan to asset ratios. Demand and supply determinants are defined as specified above. In Column II error terms are uncorrelated, in Column III we introduce Mundlak dummies, i.e. firm-specific time invariant mean values of the independent regressors based on the three years prior to the sample period (2003-2005). Column IV includes the lagged dependent variable on both the demand and the supply side. All regressions include industry fixed-effects, which are omitted in the output. Standard errors are displayed in parentheses below coefficients. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

Table A11 : Disequilibrium model: boom versus bust years

Dependent variable:		Bank loan ratio			
Timeframe:		Pre-crisis (2006-2010)		Crisis (2009-2010)	
Size category:		SME (I)	Large (II)	SME (III)	Large (IV)
Demand equation	Interest rate	-0.6457***	-0.4103***	-0.5781***	-0.5404***
		(0.0133)	(0.0189)	(0.0229)	(0.0324)
	Borrowing diversity	0.8240***	0.7450***	0.8783***	0.8048***
		(0.0129)	(0.0229)	(0.0203)	(0.0361)
	Internal funds	-0.2028***	-0.3308***	-0.2773***	-0.2793***
		(0.0118)	(0.0291)	(0.0163)	(0.0486)
	Financial needs	0.0530***	0.1025***	0.0735***	0.2006***
		(0.0107)	(0.0229)	(0.0173)	(0.0303)
	Firm size	-0.0155***	-0.0172***	-0.0158***	-0.0150***
		(0.0009)	(0.0012)	(0.0014)	(0.0017)
	Year: 2007	0.0052**	0.0133***		
		(0.0024)	(0.0036)		
	Year: 2008	-0.0001	0.0119***		
		(0.0024)	(0.0037)		
	Year: 2010			-0.0026	-0.0012
				(0.0028)	(0.0043)
	Sigma (D)	0.0089***	0.0078***	0.0095***	0.0073***
		(0.0003)	(0.0004)	(0.0004)	(0.0004)
Supply equation	Risk	-0.1895***	-0.1576***	-0.1553***	-0.1806***
		(0.0090)	(0.0157)	(0.0106)	(0.0177)
	Collateral	0.3348***	0.2652***	0.3421***	0.2541***
		(0.0092)	(0.0149)	(0.0105)	(0.0162)
	Firm size	-0.0043***	-0.0120***	-0.0054***	-0.0089***
		(0.0014)	(0.0019)	(0.0017)	(0.0022)
	Profitability	-0.0120***	-0.0147***	-0.0051***	-0.0026
		(0.0038)	(0.0020)	(0.0014)	(0.0026)
	Year: 2007	-0.0022	0.0055		
		(0.0038)	(0.0054)		
	Year: 2008	-0.0069*	0.0098*		
		(0.0007)	(0.0053)		
	Year: 2010			-0.0051	0.0038
				(0.0.0037)	(0.0051)
	Sigma (S)	0.0577***	0.0352***	0.0539***	0.0335***
		(0.0007)	(0.0007)	(0.0007)	(0.0008)
	Rho	0.7814***	0.8340***	0.7556***	0.7003***
		(0.0211)	(0.0333)	(0.0313)	(0.0664)
D-S relation:		Correlated	Correlated	Correlated	Correlated
Additional controls:					
Industry-FE		Yes	Yes	Yes	Yes
Mundlak correction		Yes	Yes	Yes	Yes

Notes: This table displays the main regression results from the disequilibrium model. The bank loan to asset ratio is the dependent variable. Demand and supply determinants are defined as specified above. We re-estimate the baseline regression on split samples, according to the pre-crisis period (2006 - 2008) in Columns I and II and the crisis period (2009 - 2010) in Columns III and IV as well as SME (Columns I and III) and large firms (Columns II and IV), respectively. Regressions further include industry fixed-effects, which are omitted in the output. Shocks between the error terms of all specifications are correlated. Standard errors are displayed in parentheses below coefficients. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

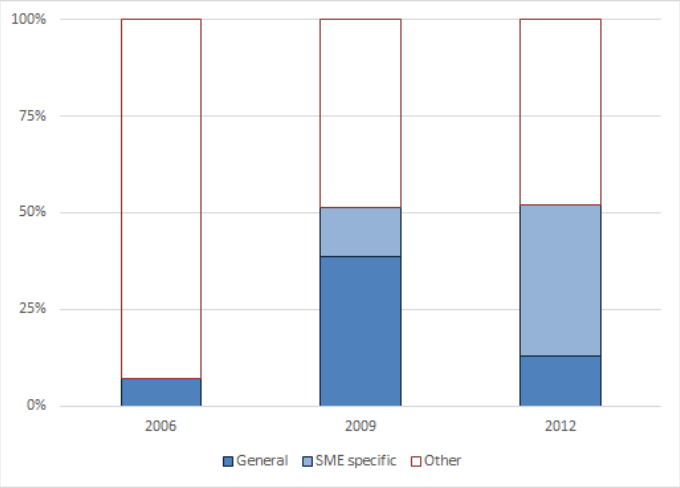
Table A12 : Excess demand determinants: SME versus large firms

Dependent variable:	Est. excess demand			
Sample years:	Pre-crisis (2006-2008)		Crisis (2009-2010)	
Firms size	SME	Large	SME	Large
	(I)	(II)	(III)	(IV)
Interest rate	-2.942***	-1.267***	-2.789***	-2.930***
	(0.473)	(0.556)	(0.578)	(0.810)
Borrowing diversity	5.097***	5.329***	4.995***	5.908***
	(0.177)	(0.261)	(0.185)	(0.316)
Internal funds	-1.479***	-4.565***	-1.351***	-1.192
	(0.309)	(0.725)	(0.335)	(0.963)
Financing needs	-0.237	0.212	-0.265	0.810
	(0.430)	(0.729)	(0.501)	(0.945)
Firms size	-0.149***	0.048	0.018	0.052
	(0.032)	(0.040)	(0.034)	(0.047)
Risk	5.026***	5.402***	4.633***	6.742***
	(0.210)	(0.359)	(0.221)	(0.425)
Collateral	-1.720***	-1.571***	-2.550***	-1.836***
	(0.203)	(0.320)	(0.208)	(0.193)
Profitability	0.290***	0.521***	0.231***	-0.028
	(0.028)	(0.061)	(0.030)	(0.061)
Constant	-0.894***	-3.168***	-1.705***	-2.464***
	(0.319)	(0.048)	(0.344)	(0.655)
Additional controls:				
Industry-FE	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes
Observations	34,015	11,239	21,601	7,641

Notes: This table displays regression results on a set of regressions explaining estimated excess demand (specified in Equation (**??**) as dependent variable. We estimate the regressions on split samples, according to the pre-crisis period (2006 - 2008) in Columns I and II and the crisis period (2009 - 2010) in Columns III and IV as well as SME (Columns I and III) and large firms (Columns II and IV), respectively. All specifications include industry fixed-effects. Specifications include our full sample (Column I) as well as a sample split according to pre-crisis years (Column II) and crisis years (Columns III-IV). Standard errors are displayed in parentheses below coefficients. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. Data source: **?**, own calculations.

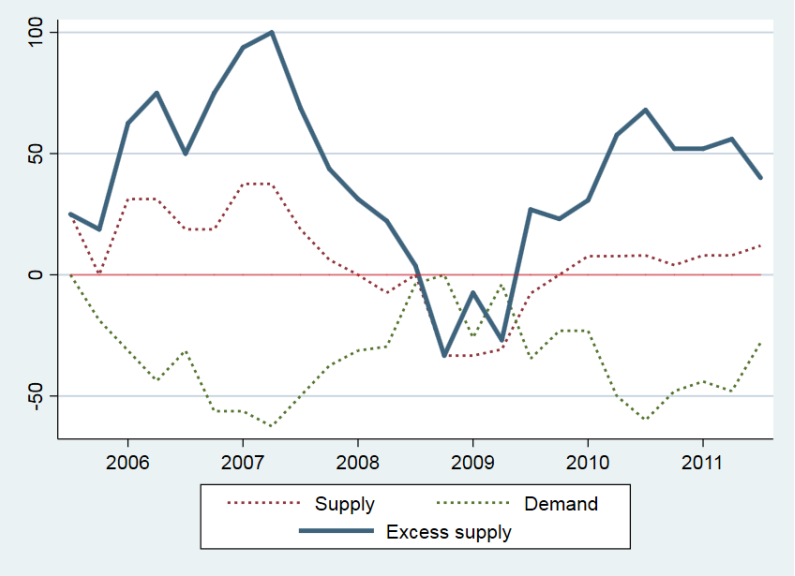
Appendix B: Figures A1-A7

Figure A1 : Share of ECB Presidents' speeches addressing credit issues



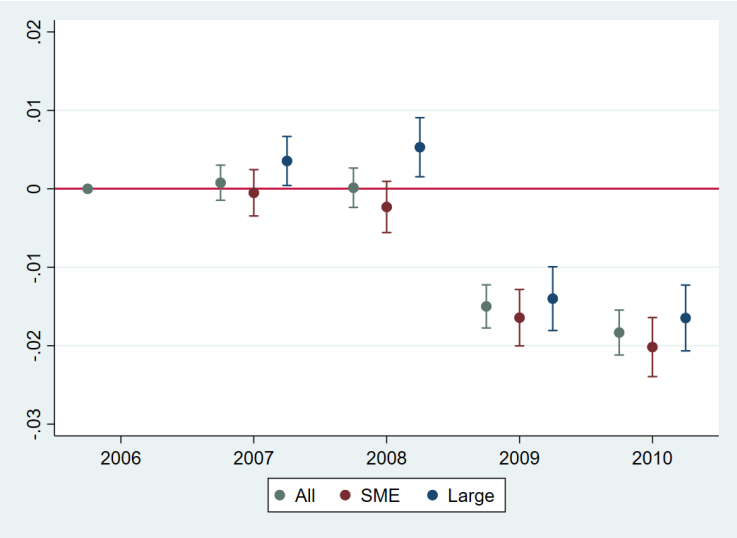
Notes: This figure shows the share of speeches by ECB presidents during the years 2006, 2009 (both Trichet), and 2012 (Draghi) that addressed i) general credit issues, ii) credit issues particularly mentioning SME in the Eurozone, and iii) all remaining speeches. Note the absolute number of speeches varies across the three observed years (n= 23 in 2006, n=39 in 2009, n=29 in 2012). The speeches include all official speeches during the respective year that were published on the website of the **?**. Qualification for either one of the three categories was based on word searches; the list of words can be obtained from the authors upon request. The fraction of SME-related speeches about credit issues increased from 0% to 13%, to 39%, while the fraction on credit issues overall (including SME-related) increased from 7% to 51%, to 52% in respective years.

Figure A2 : Excess supply and demand for loans to German SME, 2006-2012



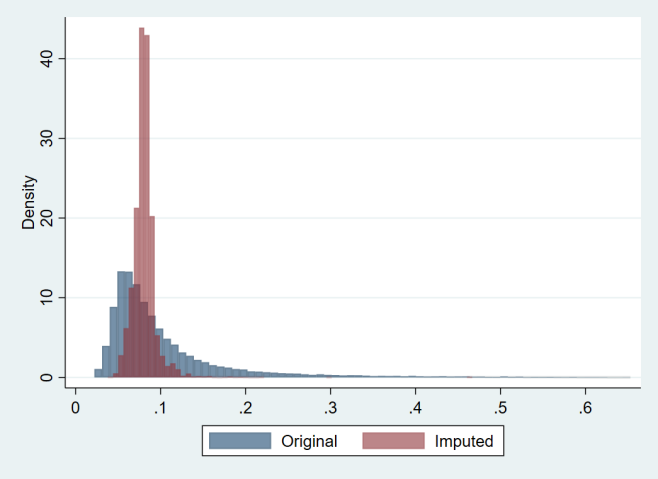
Notes: The graph indicates the difference between loan supply and loan demand by German SME as measured by Bank Lending Survey of Deutsche Bundesbank (**?**). Values thereby represent rolling two-quarter averages of the differences. Positive values indicate excess supply, whereas negative values indicate excess demand. The table illustrates the credit crunch that incurred between Q4 2008 and Q1 2010.

Figure A3 : Coefficient plot: loan ratios between 2006-2010



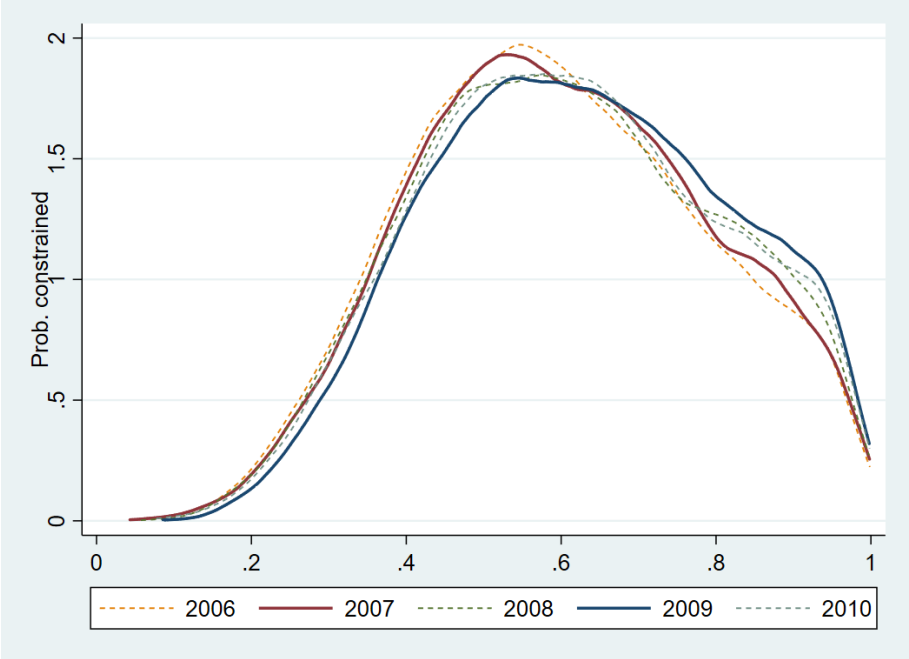
Notes: The figure plots correlation coefficients of three separate regressions with equivalent model specifications but different subsamples: 1) full sample, 2) SME, and 3) large firms, respectively. The econometric specification is: $loan_{it} = \alpha_i + \beta_\tau year_{2006+\tau} + X_{it} + loan_{i\,t-1} + \varepsilon_{it}$, with $loan_{it}$ being the total bank loan to asset ratio and X_{it} a vector of firm-specific control variables of firm i at time t, α_i are firm-fixed effects. The coefficients plotted are β_τ for each year, relative to 2006. Whiskers represent 95 percent confidence intervals. Standard errors are heteroscedasticity-consistent and clustered at the firm level. Data source: **?**, own calculations.

Figure A4 : Distribution of interest rates: original versus imputed



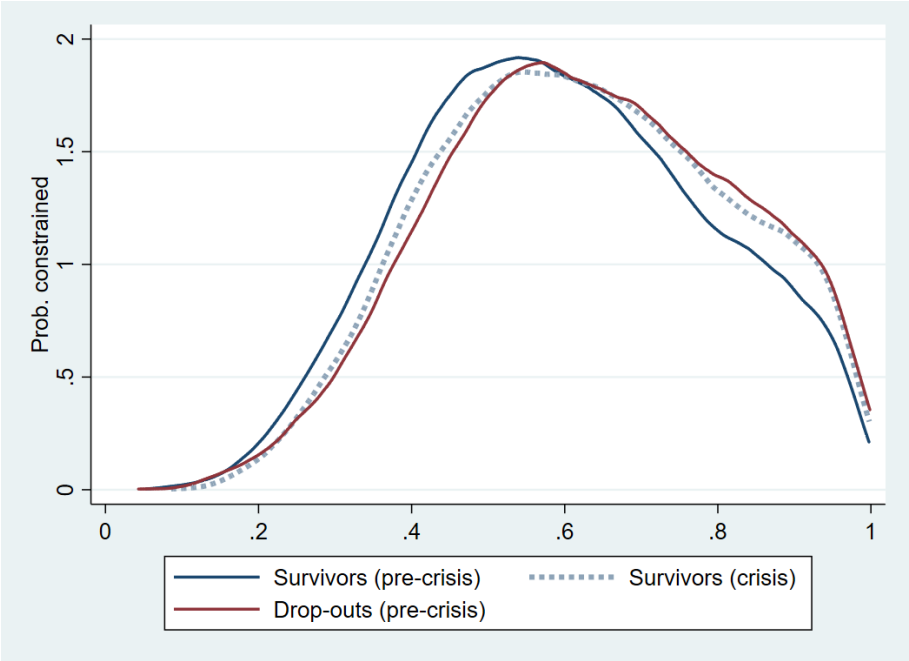
Notes: This figure displays the distributions of both imputed (red) and original (blue) interest rates. Imputed rates are calculated based on CEM matching as described in section 3.4.2. Data source: **?**, own calculations.

Figure A5 : Probability of excess demand: Distribution in boom and bust years



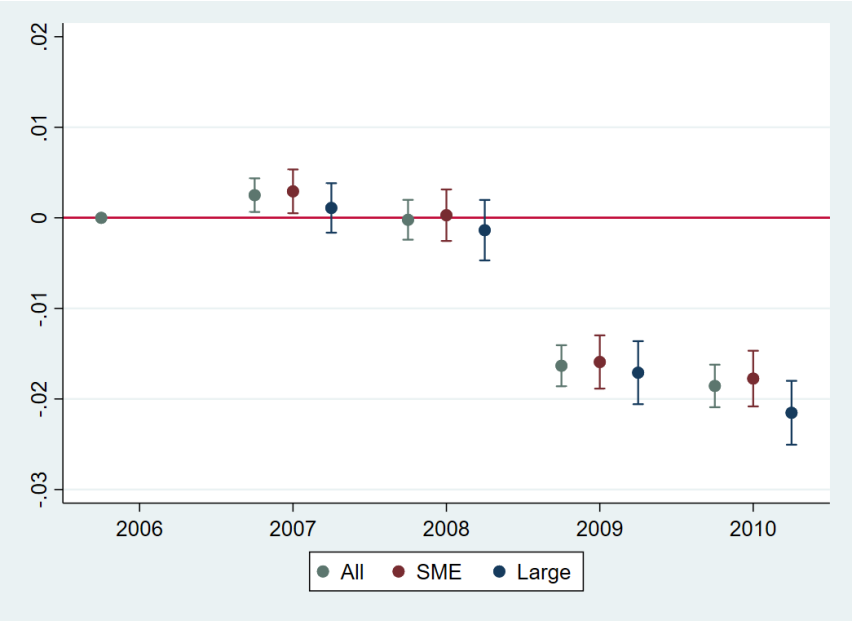
Notes: The figure displays the distribution of the excess demand measure as specified in Equation (**??**) for each year between 2006 and 2010.The years at the peak of the economic upswing in 2007 (blue) as well as at the bottom of the crisis in 2009 (red) are highlighted. The remaining years are plotted in dashed lines. Data source: **?**, own calculations.

Figure A6 : Probability of excess demand: survivors and drop outs



Notes: The figure displays the distribution of firms' probability of being financially constrained as specified in Equation (**??**) and distinguishes among SME and large firms. The line correspond to the unweighted averages among these subgroups indexed (=100) by their 2008 value. Data source: **?**, own calculations.

Figure A7 : Coefficient plot: capital expenditures between 2006-2010



Notes: The figure plots correlation coefficients of three separate regressions explaining firms' capital expenditures – analogously to Figure **??**. Only the econometric specification differs: $capex_{it} = \alpha_i + \beta_\tau year_{2006+\tau} + X_{it} + capex_{i\,t-1} + \varepsilon_{it}$, with $capex_{it}$ being the capital expenditures to total asset ratio and X_{it} a vector of firm-specific control variables of firm i at time t, α_i are firm-fixed effects. Data source: **?**, own calculations.

Appendix C :

Advanced descriptives – linear regression analyses

Figure **??** (Appendix B) plots estimated coefficients of year dummies, obtained from a dynamic reduced form regression on total bank debt to asset ratios of firms. Regressions control for a vector of firm level characteristics related to both demand and supply side factors of borrowing, including firm-fixed effects. Estimates of an autoregressive panel data model with fixed effects are biased toward zero (see **?**). Assuming that the bias is more or less the same for the two groups, SME and large firms, we can still evaluate the difference of the year dummies between the two groups. The plotted year dummies and the corresponding 95 percent confidence intervals therefore denote the movement of loan ratios relative to the base year 2006. Overall, firms' loan ratios remain relatively constant until 2008, while dropping sharply in 2009. The drop is significant both on statistically and economically: Controlling for confounding factors, the median firm decreases its loan ratio on average by 8.2 percent from the years 2008 to 2009, i.e. by 1.5 percentage points from 18.1 to 16.6 percent.

We repeat the regression for SME and large firms separately, which illustrates the individual effects of the crisis on these subgroups. Because the plotted coefficients move along a very similar path, it appears that firms exhibit a very similar decline in bank credit throughout the sample time frame independent of their size. Only in 2008 coefficients deviate slightly, indicating that large firms still increased their loan ratios relative to 2006, whereas small firms did not. Arguably, the drop for large firms appears more sudden relative to that of SME. Regarding SME and large firms separately shows that the relative decrease in lending very similar for larger firms. The median large firms decreases its loan ratio by 9.0 percent (or 1.4 percentage points), whereas the median SME decreases its loan ratio by 8.6 percent (or 1.6 percentage points).

To test these observations more thoroughly, in Table **??** (Appendix A) we re-estimate the first set of regressions but interact a dummy variable indicating whether a firm is an SME with the year dummy for 2009 (Column II). The coefficient is negative and significant at the 10 percent level but relatively small (-0.003). This results suggests a relatively stronger impact for SME compared to large firms. The size of the coefficient, however, just suggests an average difference of 0.3 percentage points. Further estimates show that effects are not particularly driven by small or micro firms but rather from the entire subcategory of SME (Columns III and IV).

As an important addition to these observations, Table **??** (Appendix A) summarizes average costs of borrowing across the years 2006 until 2010. Overall interest rates evolve in a cyclical patter: they increase slightly towards the peak of the economic upswing in 2007 and 2008, before dropping significantly in 2009. This reflects also the movement of the main refinancing rate offered

by the European Central Bank during those years. While this rate was 3.75 in 2007 and late 2008, it was lowered drastically to 1.00 percent in mid 2009, making is significantly less expensive for banks to obtain liquidity. A reduction in the policy rate is expected to translate into a decrease in lending rates for firms. For example, **?** document that the pass-through of monetary policy to rates on bank loans of non-financial firms worked well in the aftermath of the Crisis in the case of Germany. In terms of credit rationing, however, the decrease in average rates might also resemble a rationing of high-interest paying firms.

Moreover, small firms face on average higher interest rates as compared to their larger counterparts across all years. Interest rates reflect the risk adjusted price for obtaining a loan. Because the average small firm is statistically more likely to default compared to the average large firm (**?**), it is plausible that SME in our sample bear higher interest rates on average. The cyclical pattern applies for both subgroups of firms. One notable exception is the crisis year of 2009, when firms of both size categories have, on average, virtually the same interest rate. During the Financial Crisis the spread between small and large firms appears to have been closed. Thus, this observation in our data confirms statistics on the perceived tightening in lending conditions, i.e. the Ifo index (Figure **??**).

Descriptive evidence mainly provides two key insights. First, findings are well in line with both descriptive statistics and previous research on specific differences across firms and time, which overall confirms the validity of our results. Second, these first analyses are not able to robust provide evidence that SME are affected by the crisis disproportionally regarding their use of external debt and interest spreads. Despite giving indicative information, these results do not answer the question whether and how financing constraints evolved over the course of the Financial Crisis for small and large firms.

Appendix D :

Interest rate considerations

The interest rate is one central element in our setup. Because no individual loan level data is available, we measure financing costs by dividing the annually reported interest expenses by the corresponding amount of firms' average bank debt held during the period. For a non-negligible number of observations (not firms), the amount of bank loans outstanding is zero, i.e. 24 percent. There are potentially two reason for this: the firm is either (fully) rationed and does not obtain a loan *or* it has a zero demand for loans. Unobserved interest rates pose a distinct estimation issue for analyzing the extensive margin of credit rationing.

Table **??** (Appendix A) displays descriptive statistics on observations with a positive amount of outstanding debt and those with zero loans. The latter on average hold more internal funds and has lower capital expenditures (i.e. financing needs). Overall, zero lenders obtain fewer external funding from other sources which is reflected in lower shares of capital and bond market access as well as an overall higher concentration on fewer resources (i.e. borrowing diversity concentration index). All these characteristics may point at a lower demand for bank debt. At the same time, however, these firms exhibit higher growth rates, are younger, hold fewer collateral and are overall more risky. These features actually point towards a potentially lower supply. Hence, combining these aspects does not necessarily deliver actual insights on whether these firms do not obtain any loans or whether they voluntarily refrain from obtaining loans. This might suggest that zero borrowers actually comprise both types of firms.

We address this estimation issue in several ways. First, we impute a hypothetical interest rate for observations with zero loans and zero interest rates. Second, we run separate regressions that only include those firms obtaining positive amounts of loans, i.e. here we focus on the intensive margin on rationing. This dual approach allows us to directly compare results without fearing to obtain biased estimates from imputing artificial rates or estimating exclusively the intensive margin of constraints.

For imputing a hypothetical interest rate, we use a non-parametric method of controlling for the confounding influences in our observational data, the so-called Coarsened Exact Matching (CEM) as proposed in **?**, by matching borrowing with (supposedly) non-borrowing firms.[18] CEM allows assigning each firm into stratas, which share pre-defined matching characteristics and thereby assigns one or more non-zero interest rate firms to one or more zero interest rate firms. We then take the strata-specific median interest rate for firms with positive interest rates and assign this rate to firms with zero interest rates. In order to account for firm-specific as well as macroeconomic

[18] See **?** for a comprehensive summary.

heterogeneity, we use 8 bins on firm size (measured by the logarithm of total assets), 5 age categories as well as bins for each industry and year as matching variable, respectively.[19] Hence, borrowing and non-borrowing firms need to have comparable properties with regard to these conventional characteristics. For example, a large and incumbent firm with zero loans for a given year will be assigned a rather low interest rates similar to large and incumbent firms with a positive amount of loan. In contrast, a young and small firm which is observed with no loan will be assigned rather a high interest rate. By including firms' size and age characteristics we aim at using an efficiently small but precise set of variables that relate to the capital structures of the firm. This is in line with **?** who conclude that these two variable are sufficient in explaining borrowing conditions. Our approach reasonably presumes that both the capital structure and macro-level factors are most decisive for the level of interest. Further, these specifications are broad enough to enable high matching rates: Too many matching variables would result in fewer but not necessarily more precise matches. We are able to assign imputed rates on more than 99 percent of firms with zero loans.

Figure **??** illustrates the distribution of original interest rates as well as imputed interest rates graphically. Because imputed interest rates are based on the median within a strata, they are rather centered around the observed median and tend not to contain rates from the tails of the distribution. The observed distribution has a longer right tail which is likely due to our calculation approach. Expectedly, the average rate of the generated interest rates (8.1 percent) is therefore below the average original interest rate (10.6 percent) as displayed in Table **??** (Appendix A). A t-test confirms that this differences is statistically significant at the on percent level. However, with respect to the median of the generated and original rates, the two values are virtually equivalent (8.0 percent for imputed versus 7.9 percent of original values). Table **??** (Appendix A) displays the same statistic differentiating among pre-crisis and crisis periods.

[19] The five age categories are: 1: ≤ 5; 2: $6-10$; 3: $11-20$; 4: $21-50$; 5: >50 years, respectively. The industries are the following NACE Rev. 2 main categories: C, D, E, F, G, and J. To avoid outliers affecting our matching, we declare observations before the matching as missing for which we observe implausible rates repeatedly, i.e. if the interest rates are larger than 0.5 for more than two observations of a particular firm and truncate the variable at the 2.5 and 97.5 percentile. Whenever certain observations fall into a bin without closest neighbor, this observation is not considered for a match.