Creditor concentration: an empirical investigation

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Abstract

Most of the literature addressing multiple banking assumes equal financing shares. However, unequal, concentrated or asymmetric bank borrowing is widespread. This paper investigates the determinants of creditor concentration for German firms using a comprehensive bank-firm level dataset for the time period between 1993 and 2003. We document that lending is very often concentrated and, consequently, that relationship lending is important, not only for the small firms but also for the larger firms in our sample. However, we also find that risky, illiquid, large and leveraged firms spread their borrowing more evenly between multiple lenders. On the other hand, the degree of concentration increases with the profitability of the relationship lender. Relationship lending may spur financing provided by other banks, especially if the relationship lender is a public sector bank and if the other banks are large or do not have to tie up additional funds in capital.

Keywords: bank relationships, asymmetric financing, banking competition

JEL Codes: G21, G32, G33

Non-technical summary

In this paper, we empirically investigate the degree of creditor concentration of German firms by exploring the asymmetry in borrowing. Under asymmetric or concentrated bank borrowing we understand the situation when firms predominately borrow from one relationship lender and parallel borrow smaller amounts from multiple arm's-length lenders. The German financial system with its Hausbank notion presents itself an ideal environment to study creditor concentration since many firms borrow not only from their Hausbank but also seek funding, to a varying degree, from other banks.

Although there is an evidence of the asymmetry in borrowing only a few recent papers model creditor concentration (Elsas, Heinemann and Tyrell (2004), Guiso and Minetti (2004), Bannier (2005, 2006) and Schuele (2006)). We contribute to this emerging literature by empirically investigating the degree of creditor concentration of German firms.

In this paper (i) we suggest concentration as a more detailed measure of bank-firm relationships; (ii) we study the impact of firm and market characteristics and the characteristics of the relationship lender on our measures of creditor concentration; (iii) we study the impact of the financing decisions of the relationship lender on the lending behavior of other banks.

To investigate these issues we use a comprehensive dataset collected by the Deutsche Bundesbank. The dataset is a matched bank-firm level dataset with 16,713 firm-bank-year observations consisting of three sources: the German credit register *(MiMik)*, firm balance sheets *(Jalys/Ustan)* and bank balance sheets *(BAKIS)*, for a period of eleven years between 1993 and 2003.

Our findings suggest that firm, bank and market characteristics are important determinants of the degree of the concentration in financing. We find that higher quality

firms and firms with more redeployable (liquid) assets choose more concentrated borrowing. Therefore, our study confirms hypotheses in Detragiache, Garella and Guiso (2000) and Bris and Welch (2005) about the positive effect of firm quality on creditor concentration. Smaller firms and less leveraged firms have a higher concentration in their borrowing as well. Additionally, the degree of creditor concentration is positively related to the regional market concentration of bank lending.

Moreover, we find that the characteristics of the relationship lender have an influence on the degree of creditor concentration. Concentration increases with the increase in the profitability of the relationship lender. This finding confirms Detragiache, Garella and Guiso (2000).

Finally, we find that financing decision of the relationship lender is positively correlated with the lending behavior of other banks. Other banks tend to extend their lending with the increase in the exposure of the relationship lender. This tendency appears to be stronger if the relationship bank is a public sector bank rather than a private bank. However, there are also some limits to this tendency, set by the size and by the capital of the other banks.

Our results suggest that those firms that are low in quality and have illiquid assets per se will be most affected by the distress of the relationship bank if the relationship bank is not able to continue financing. According to our findings these firms, however, have a lower degree of concentration in their borrowing and tend to increase their borrowing from other banks.

Nicht technische Zusammenfassung

In diesem Papier wird die Gläubigerkonzentration deutscher Unternehmen untersucht, wobei die Analyse der Asymmetrie bei der Kreditaufnahme im Vordergrund steht. Unter Asymmetrie und Gläubigerkonzentration verstehen wir eine Situation, in der die Firmen ihre Kredite überwiegend von der Hausbank aufnehmen und gleichzeitig kleinere Kredite bei anderen Instituten beanspruchen. Für eine solche Untersuchung bietet das deutsche Finanzsystem mit seinem Hausbankprinzip ideale Rahmenbedingungen, denn viele Firmen verschulden sich nicht nur bei Ihrer Hausbank, sondern suchen sich darüber hinaus – in unterschiedlichem Umfang – alternative Finanzierungsquellen.

Obwohl man Asymmetrie bei der Kreditaufnahme von Firmen beobachtet, gibt es nur sehr wenige wissenschaftliche Papiere, die sich mit der Gläubigerkonzentration der Unternehmen beschäftigen (Elsas, Heinemann and Tyrell (2004), Guiso and Minetti (2004), Bannier (2005, 2006) und Schüle (2006)). Mit unserem Papier tragen wir zu dieser Literatur bei, indem wir empirisch den Grad der Gläubigerkonzentration bei deutschen Unternehmen untersuchen.

Konkret (i) schlagen wir Gläubigerkonzentration als ein genaueres Maß für die Untersuchung von Bank-Firmen-Beziehungen vor; (ii) untersuchen wir den Einfluss der Firmen-, Markt- und Hausbank-Charakteristika auf die Gläubigerkonzentration der Unternehmen; (iii) analysieren wir den Einfluss der Finanzierungsentscheidungen der Hausbank auf das Kreditverhalten von anderen Banken.

Als Datenbasis verwenden wir einen von der Deutschen Bundesbank erhobenen Datensatz, der bank- und firmenspezifische Informationen umfasst und damit eine dynamische Untersuchung der Gläubigerkonzentration erlaubt. Im Datensatz enthalten sind insgesamt 16.713 Beobachtungen (Unternehmens-Banken-Jahre), die den elfjährigen

Zeitraum zwischen 1993 und 2003 abdecken und aus drei Quellen stammen: Evidenzzentrale für Millionenkredite *(MiMik)*, Firmenbilanzen *(Jalys/Ustan)* sowie Bankbilanzen *(BAKIS)*.

Unsere Ergebnisse deuten darauf hin, dass Firmen-, Bank- und Marktcharakteristika wichtige Determinanten der Gläubigerkonzentration darstellen. Unter anderem zeigt sich, dass Firmen mit besserer Bonität und liquiden Aktiva zu einer höheren Gläubigerkonzentration bei der Kreditaufnahme tendieren. Demzufolge bestätigt unsere Studie die Hypothesen von Detragiache, Garella und Guiso (2000) und Bris und Welch (2005) bezüglich des positiven Einflusses der Bonität von Firmen auf die Gläubigerkonzentration. Dies gilt auch für kleinere Firmen und Firmen mit niedrigem Fremdkapitalanteil. Außerdem ist die Gläubigerkonzentration um so höher, je konzentrierter die Kreditvergabe bei einigen wenigen Banken in der Region ist.

Darüber hinaus zeigt sich, dass die Profitabilität der Hausbank mit einer höheren Gläubigerkonzentration einhergeht. Auch dieses Ergebnis bestätigt Detragiache, Garella und Guiso (2000).

Schließlich können wir zeigen, dass die Kreditentscheidung der Hausbank positiv mit dem Kreditvergabeverhalten anderer Banken korreliert. Andere Institute scheinen um so eher bereit zu sein, einen Kredit zu gewähren, je höher der Kredit der Hausbank ist. Dieser Effekt wird verstärkt, wenn es sich um ein öffentlich-rechtliches Institut und nicht um eine private Bank handelt. Allerdings begrenzen Größe und Kapitalisierung der anderen Banken diese Bereitschaft.

Unsere Ergebnisse legen zunächst nahe, dass Unternehmen von geringer Bonität und mit illiquiden Aktiva besonders betroffen sein könnten, wenn Ihre Hausbank zu zurückfallenden Kreditgewährung gezwungen wäre. Tatsächlich zeigen unsere Untersuchungen aber, dass gerade bei diesen Unternehmen eine geringere

Gläubigerkonzentration bei der Kreditaufnahme vorliegt und diese Firmen in der Regel ihre Kreditaufnahme bei anderen Banken erhöhen können.

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Creditor Concentration: An Empirical Investigation*

I. Introduction

Multiple banking is an important economic phenomenon. There is cross-country evidence that many firms establish relationships with multiple banks. Houston and James (1996), for example, show that more than 60 percent of listed US firms have multiple bank relationships. And Ongena and Smith (2000), analyzing bank relationships in 20 European countries, show that only less than fifteen percent of the firms borrow from a single bank and that the average number of bank relationships is greater than five. Even small firms that would benefit most from relationship lending, borrow from multiple banks (Guiso and Minetti, 2004).

Many studies focus on the optimal number of creditors, the determinants and the impact of multiple bank relationships. One key explanation for observing multiple bank relationships is that it reduces the hold-up problem of relationship lending (Rajan, 1992 and von Thadden, 1992). But multiple banking can lead to coordination failure in case of default (Bolton and Scharfstein, 1996; Hart, 1995; Dewatripont and Maskin, 1995). Bolton and Scharfstein (1996) show that multiple bank lending lowers the liquidation value of the firm and only the firms of the highest credit quality tend to borrow from multiple creditors.

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Bris and Welch (2005), on the other hand, argue that higher quality firms choose fewer creditors signaling their confidence of not going bankrupt given that concentration enhances their creditors' bargaining power.

Other studies emphasize the banks' perspective as well when exploring the optimal number of relationships. Detragiache, Garella and Guiso (2000), for example, explain how multiple relationships arise from the firms' need for diversification of bank liquidity risk. Carletti (2004) explores how the number of bank relationships affects banks' monitoring incentives, and Carletti, Cerasi and Daltung (2005) analyze banks' incentives to finance a firm jointly with other banks when they have limited lending abilities and monitoring is important.

However, most of the literature addressing multiple banking assumes equal financing shares (in contrast, a large proportion of the literature deals with majority versus minority equity holders). However, unequal, asymmetric or concentrated bank borrowing is widespread, as firms often borrow extensively from one relationship lender and smaller amounts from multiple arm's-length lenders. Petersen and Rajan (1994), for example, examine lending relationships of US firms and report that the degree of concentration in borrowing decreases in firm size.

Creditor concentration may play a pivotal role in balancing the hold-up problem of relationship lending with the coordination failure of multiple bank lending but only a few recent papers model creditor concentration. Elsas, Heinemann and Tyrell (2004) analyze the optimal debt structure for multiple but asymmetric bank financing. They emphasize the role of the relationship lender in mitigating the coordination problem. They show that firms with low expected cash flows or with assets of lower liquidation value prefer asymmetric financing. And Guiso and Minetti (2004) argue that banks prevent unsound firms from defaulting for the purpose of seizing their assets during the restructuring process. As a

result, firms with more valuable and redeployable assets tend to spread their borrowing more unevenly to prevent this kind of behavior by the relationship lender during restructuring because, with higher asymmetry, less informed banks would have no incentive to continue the project (see also Bannier, 2005 and 2006, and Schuele, 2006, among others).

We contribute to this emerging literature by empirically investigating the degree of creditor concentration of German firms. Our analysis of creditor concentration is not only motivated by recent unpublished theoretical work but also by unexplored implications in recently published theoretical papers. The diversification argument in Detragiache, Garella and Guiso (2000), for example, also explains creditor concentration. Firms that choose single relationship banking in their model can just as easily borrow from non-relationship banks if their relationship bank has liquidity problems.

The German financial system presents itself as an ideal environment to study creditor concentration. Many firms borrow not only from their Hausbank but also seek funding, to a varying degree, from multiple other banks (see Elsas and Krahnen, 1998). A comprehensive dataset collected by the Deutsche Bundesbank over a long period of time allows us to dynamically investigate creditor concentration. The dataset is a matched bank-firm level dataset consisting of three sources: The German credit register, firm balance sheets and bank balance sheets, for a period of eleven years between 1993 and 2003. This unique dataset allows us to observe individual lender shares and to analyze the pervasive presence of creditor concentration in Germany.

We first construct alternative measures of creditor concentration originally designed to measure market concentration. We then study the impact of firm and bank characteristics on our measures of creditor concentration. In particular, we focus on the characteristics of the relationship lender, which we identify as the bank with the largest financing share.

Finally, controlling for firm and bank characteristics, we explore the impact of the largest exposure on the size of the other exposures.

We comprehensively document that creditor concentration is a pervasive phenomenon. Consequently, relationship lending seems important, not only for the small firms but also for the larger firms in our sample. We further find that higher quality firms and firms with more redeployable assets concentrate their borrowing. The degree of creditor concentration is also positively related to the regional market concentration of bank lending, confirming that many firms are geographically limited in their funding choices.

The characteristics of the relationship lender have an influence on the degree of creditor concentration as well. Concentration increases when the relationship lender is more profitable, for example. An increase in financing provided by the relationship lender further coincides with increases in financing provided by the other lenders. The other lenders seem to align their credit decisions with those of the relationship lender but only within the limits set by their own size and without tying up their funds in capital. Overall, our results indicate the importance of firm, bank and market characteristics in determining the concentration of financing.

The remainder of the paper is organized as follows. In Section II, we present selected theoretical models dealing with the issue of multiple banking, explore their implications for asymmetric financing and review recent other work modeling creditor concentration. In Section III, we describe the data and the methodology. We present the main estimation results in Section IV, followed by a series of robustness tests in Section V. Section VI concludes our findings.

II. Literature Review

A. Number of Relationships

A growing theoretical literature addresses the issue of the optimal number of creditors. Models explaining the existence of multiple credit relationships differ in their timing (see Figure 1), mechanisms, outcomes and relevance for the asymmetry question. In this section, we compare the mechanisms and the different outcomes of recent theoretical models (Table 1 summarizes this discussion).

Bolton and Scharfstein (1996) explore the impact of the debt structure on the renegotiation that may take place in the case of firm default. The optimal debt structure, they argue, balances the benefits and costs of multiple banking. Multiple bank relationships discourage managers from strategically defaulting on a loan. But, when default is caused by liquidity problems, as in Hart and Moore (1989) and Bolton and Scharfstein (1990), multiple lending is costly since it reduces the expected liquidation value of assets. Bolton and Scharfstein (1996) further explain how the optimal debt structure depends on firm characteristics. Firms with low default risk and asset complementarity should borrow from two creditors. However, when outside buyers highly value the assets, it is more attractive for firms to borrow from one creditor to maximize the liquidation value.

Bris and Welch (2005) argue that due to free-riding and coordination problems dispersed creditors face difficulties collecting their claims during bankruptcy. A firm that opts for multiple creditors *ex ante* assumes a better bargaining position in the case of financial distress *ex post*. As a result, according to Bris and Welch, higher quality firms can signal their confidence of not going bankrupt by selecting only a few creditors.

Firms may also seek to diversify bank liquidity risk by engaging multiple financiers. According to Detragiache, Garella and Guiso (2000), for example, establishing multiple

relationships reduces the risk of early liquidation of a project (if liquidity shocks across banks are imperfectly correlated). Their model predicts that multiple banking is more likely when banks are less fragile (but adverse selection is more severe), judicial enforcement is inefficient and the investment projects of the firm are not very profitable. Once in the multiple banking region, the optimal number of relationship banks increases with bank fragility, the efficiency of enforcement and the profitability of the projects.

The three models discussed so far may also provide an insight into asymmetric financing. Bolton and Scharfstein (1996) and Bris and Welch (2005) both emphasize the coordination problems arising with multiple creditors. An increase in the asymmetry in the financing shares makes coordination easier by either decreasing the likelihood of liquidation or by signaling firm quality. Detragiache, Garella and Guiso (2000) already note asymmetry in their single banking region. When adverse selection is mild, firms opt for single relationship banking as they can easily borrow from non-relationship banks if a liquidity shock affects their relationship bank. However, under the multiple banking regime, the model has no implications with respect to the financing shares.

B. Asymmetry in Borrowing

Elsas, Heinemann and Tyrell (2004), Guiso and Minetti (2004), Bannier (2005, 2006) and Schuele (2006) tackle the issue of asymmetric bank financing. Elsas, Heinemann and Tyrell (2004), for example, examine the optimal debt structure and find that especially firms characterized by high asset specificity (a high expected loss given default from the banks' perspective or a lower liquidation value) and firms with low expected cash flows prefer asymmetric financing. With efficient coordination, expected firm profits decrease in the size of the financing share of the relationship lender that collects all of the benefits. However, the presence of the relationship lender may still be beneficial for the firm since it

allows for continuation in more states of the world. As a result, the expected profits of the many arm's-length lenders actually increase in the financing share of the relationship lender as it is more likely that these small credits will be repaid. The authors also analyze the relationship between the liquidation value of the firm and the share of the relationship lender. They infer a non-linear relationship.

Guiso and Minetti (2004) investigate how the informational advantage of a relationship lender would affect the reorganization process of a firm in distress. They show that the optimal allocation of information by the firm across multiple banks is related to the redeployability of the firm's assets and its restructuring costs. A relationship lender can easily recognize both the value of the firm's assets and the quality of a project. However, the relationship lender may use this greater restructuring ability opportunistically to extract rents during reorganization. Thus banks may decide to continue bad projects if firms have more valuable and more redeployable assets. Firms with this type of assets may prefer a higher asymmetry in allocating their information rights across creditors to prevent such opportunistic behavior. They argue that as the degree of asymmetry increases, smaller creditors would have fewer incentives to continue a project since the relationship lender would get all of the benefits. Guiso and Minetti (2004) test their predictions on a sample of US firms and report a negative impact of the share of illiquid assets on the degree of creditor concentration.

Bannier (2005) models the reasons as to why asymmetric bank financing exists. Her model predicts that the higher information precision obtained by a relationship lender leads to a lower probability of an inefficient credit withdrawal for firms with low expected cash flows. While, for firms with high expected cash flows, the opposite holds true and asymmetric financing still results in fewer inefficient credit decisions compared to financing by a single lender and by multiple lenders with equal shares. Bannier (2006)

investigates asymmetric financing and optimal firm policy. The degree of asymmetry enables the firm to signal its willingness to abstain from strategically defaulting, eliminating the risk of inefficient credit withdrawal.

Schuele (2006) examines how a relationship bank can lend in forbearance and, by its ability to signal, play a coordinating role for the other creditors. The roll-over decision of a relationship bank will be positively related to its financing share and inversely related to the value of collateral.[1]

Coordination problems are not an issue in the case of bankruptcy when lenders are forced to cooperate. German banks coordinate successfully by forming creditor pools when the firm is in distress (Brunner and Krahnen, 2001). Consequently, theoretical arguments explaining the role of the relationship lender under multiple and asymmetric borrowing need to be adjusted to fit this scenario. However, for the refinancing stage, coordination problems and the role of the large lender remain highly relevant. Coordination problems may also be an issue in syndicated loans; Sufi (2007), for example, investigates how information asymmetry influences loan syndicate structure. In contrast, we focus on creditor concentration at firm level.

III. Data and Methodology

A. Data Sources

We employ a unique matched bank-firm level dataset that contains annual information from 1993 to 2003. The data combines three databases, i.e. the credit register *(MiMik)*, the

[1] In other models that analyze the certification role of intermediaries, the quality of the creditor's information is guaranteed by the size of its own investment in the firm. Jean-Baptiste (2005), for example, argues that this investment could serve as a credible signal as long as the price of the loan is taken into account while Takeda and Takeda (2006) analyze how the refinancing decision of a large lender affects other lenders' and the firm's behavior. This approach is in line with the model by Biais and Gollier (1997) where trade credit with its informational content has an impact on the credit decisions of banks.

balance sheet data for the firms (*Jalys*/*Ustan)* and the balance sheet data for the banks (*BAKIS*[2]). These data sources make it possible to observe individual lender shares of German banks at firm level and to combine this information with firm and bank-specific balance sheet information.

1. Credit Register

The Deutsche Bundesbank's credit register *(MiMik)* is the main data source for the individual exposures of German banks to firms. The data contains information on large exposures of 1.5 million Euros (formerly 3 million DM) and above. German banks are required to report their exposures exceeding this reporting threshold to the Deutsche Bundesbank on a quarterly basis.[3] Therefore, exposures to small and medium-sized firms might be underrepresented in this database. However, if the sum of the exposures to firms in a borrower unit exceeds the threshold of 1.5 million Euros, the individual exposure to a firm in that borrower unit is reported, even if it is a small exposure. This reporting partly abates the bias in the credit register towards medium and large-sized firms.

The data in the credit register is not consolidated.[4] Bank exposures to firms in the credit register are defined fairly broadly, e.g. they include not only corporate loans but also corporate bonds.[5] In the credit register we are able to distinguish between on-balance sheet

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[2] *BAKIS* is *the BAKred Information System*. The German Federal Banking Supervisory Office *(Bundesaufsichtsamt für das Kreditwesen (BAKred))* is one of the three supervisory agencies that merged in 2002 to form the current national supervisor, the Federal Financial Supervisory Authority *(Bundesanstalt für Finanzdienstleistungsaufsicht)*.

[3] For a more detailed definition, see Section 14 of the Banking Act (Deutsche Bundesbank, 2001). If exposures of 1.5 million Euros or above existed during the reporting period but are partly or fully repaid, the remaining exposure is reported even if the amount is zero. We take the actual amounts of the exposures into consideration.

[4] The consolidation of the data implies that the inter-office positions between a head institution and its domestic subsidiaries are netted out and the positions are allocated to a single corporate banking group (*Konzern*).

[5] For a more detailed definition of the bank exposures, see Section 19 of the Banking Act (Deutsche Bundesbank, 2001). The following items are deemed not to be bank exposures: shares in other enterprises and securities in the trading portfolio.

and off-balance sheet items.[6] We choose to use only on-balance sheet positions since the inclusion of off-balance sheet exposures leads to an overstatement of the actual exposures due to guarantees provided by banks to the other banks. The credit register also contains information on firm identity, location, industry, legal form and the date of bankruptcy (if applicable).

2. Firm and Bank Balance Sheet Data

We also use *Jalys/Ustan* and *BAKIS* to construct firm and bank-specific variables. *Jalys/Ustan* contains annual financial statement information for many German firms.[7] For 2003, for example, the dataset contains records on 9,977 firms. The credit register is matched with the firm-specific data from *Jalys/Ustan* first. After matching, our sample consists of 2,402 firms over the entire period.[8]

The dataset is finally matched with *BAKIS. BAKIS* contains bank financial statements as well as information on the banking groups for all German banks. For 2003, for example, the dataset contains records on 2,265 banks. After matching, the sample consists of an average number of 276 banks / year.[9]

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[6] For example, lease receivables, mortgage loans, publicly guaranteed loans, and inter-bank loans (with a residual maturity of up to one year) are listed separately under on-balance sheet activities. Off-balance sheet items include derivatives (other than written option positions), guarantees assumed to cover these and other off-balance sheet transactions (Deutsche Bundesbank, 1998).

[7] There are four balance sheet types in *Jalys/Ustan*: opening balance sheet (*Eröffnungsbilanz*), main balance sheet (*Rumpfbilanz*), tax balance sheet (*Steuerbilanz*) and commercial balance sheet (*Handelsbilanz*). However, our matched dataset consists mainly of firms with either a tax balance sheet (2/3rds of the sample) or a commercial balance sheet. Considering possible reporting differences among balance sheet types, we re-estimate our specifications including only firms with a tax balance sheet as a robustness check. The results remain unchanged.

[8] See the Appendix for a more detailed description of the matching process.

[9] In our study, we include all banking groups in Germany. During the time period, many bank mergers took place. See the Appendix for a detailed description of the treatment of bank mergers.

B. Measuring Concentration of Borrowing

We analyze concentration of borrowing at firm level using alternative measures originally designed to measure market concentration. Concentration in an industry can be measured in a variety of ways. Bikker and Haaf (2000) compare ten different concentration measures. The Herfindahl-Hirschman Index (*HHI*) is one of the most frequently used indices to measure market concentration and it often serves as a benchmark. The *HHI* captures the entire distribution of shares. For our application, the *HHI* is defined as:

$$HHI_{jt} = \sum_{i=1}^{n} s_{ijt}^2, \tag{1}$$

where s_{ijt} equals $Loan_{ijt}$ divided by $Total\ Loans_{jt}$, and where $Loan_{ijt}$ equals the amount of credit granted by bank i to firm j in year t and $Total\ Loans_{jt}$ is the total amount of credit obtained by firm j in year t. The index is sometimes criticized because it attaches greater weight to larger shares as each share is used as its own weight.

Hannan (1997) studies whether the *HHI* can adequately account for both market share inequality and the number of banks in the industry. He decomposes the *HHI* into two terms:

$$HHI_{jt} = (V_{jt}^2 / N_{jt}) + (1 / N_{jt}), \tag{2}$$

where V_{jt}^2/N_{jt} is the share of inequality divided by the number of banks and $1/N_{jt}$ is the inverse of the number of banks. His decomposition is relevant for our study because we explore the asymmetry in financing. As in Hannan (1997), we subtract the inverse of the number of banks, $1/N_{jt}$, from the *HHI* to obtain V_{jt}^2/N_{jt}, which we label the Share of Inequality Index (*SII*).[10] We estimate all models both with an *HHI* and an *SII*.

[10] One important difference is that the *HHI* is the dependent variable in our model.

Horvath (1970) suggests a comprehensive measure of concentration, which reflects both relative dispersion and absolute magnitude. The *Comprehensive Industrial Concentration Index* (*CCI*) is defined as:

$$CCI_{jt} = s_{1jt} + \sum_{i=2}^{n} s_{ijt}^2 (1 + (1 - s_{ijt})) \qquad (3)$$

The index is computed as the sum of the proportional share of the leading bank (largest exposure) and the total of the squares of the other banks' shares, weighted by a multiplier that reflects the shares of the remaining part. The *CCI* weighs the squared share of smaller exposures by $(2 - s_{ijt})$. Therefore, compared with the *HHI*, the *CCI* is more sensitive to the changes in the smaller shares and, possibly, more suitable for measuring concentration in cartel markets (Stordal, 2004). Given the presence of concentrated borrowing in the German financial system, we also employ the *CCI* as an alternative measure.

Finally, we also calculate a simple linear concentration measure. We take the sum of the three largest borrowing shares to compute the concentration of a firm to its three largest creditors, *CR3:* $CR3_{jt} = \sum_{i=1}^{3} s_{ijt}$

Figure 2 presents the time variation in our concentration measures. All measures are relatively stable over the sample period, except for the decrease in the last year. A sharp decrease in the number of firms in the sample in 2003 may be partly responsible, a selection issue we address in the robustness section.

C. Addressing the Effects of the Reporting Threshold

The existence of a reporting threshold of 1.5 million Euros potentially introduces a bias in the sample. Using *HHI* as the concentration measure helps us to deal with the bias since it puts less weight on the smaller financing shares that are more likely to be below the

threshold. Still, the index is possibly consistently overestimated for small firms for which larger shares are also unobserved.

We deal with this threshold issue in two ways. First, we simply exclude all small firms in robustness checks. Second, and in order to deal with the effects of the reporting threshold more systematically, we calculate the *HHI* using two opposite assumptions about the composition of the unobserved part of the loans in the credit register. The amount of the unobserved part of the loans for a particular firm is defined as the difference between the $Total\ Loans_{jt}$, taken from the firm's balance sheet, and the sum of loan exposures, $Loan_{ijt}$, taken from the credit register. Under the first assumption, the unobserved part of loans is concentrated in one bank as long as it is not above 1.5 million Euros (because otherwise it would have been observed in the credit register):

$$HHI_{jt} = \sum_{i=1}^{n} (Loan_{ijt} / Total\ Loans_{jt})^2 + [(Total\ Loans_{jt} - \sum_{i=1}^{n} Loan_{ijt}) / Total\ Loans_{jt}].^2 \quad (4)$$

But if the unobserved part of loans is above 1.5 million Euros, the amount will be distributed among banks. The first bank gets assigned up to 1.499 million Euros, which is the maximum loan amount that is potentially unobservable; the second bank gets assigned the remaining part up to 1.499 million Euros; and so on. This procedure makes our calculations more precise. Formally, we define the *HHI* as:

$$\begin{aligned} HHI_{jt} = & \sum_{i=1}^{n} (Loan_{ijt} / Total\ Loans_{jt})^2 + \sum_{i=1}^{k} (1.499 / Total\ Loans_{jt})^2 \\ & + \ [(Total\ Loans_{jt} - (\sum_{i=1}^{n} Loan_{ijt} + 1.499\ k_{jt})) / Total\ Loans_{jt}]^2, \end{aligned} \quad (5)$$

where k_{jt} is the integer number obtained by dividing the unobserved part of the loans by 1.499. We use both measures alternatively in our estimations and compare the results.

Under the second assumption, the rest of the loans is diversified across an infinite number of banks. As a result, the remaining terms in the *HHI* equal zero:

$$HHI_{jt} = \sum_{i=1}^{n} (Loan_{ijt} / Total\ Loans_{jt})^2 + 0. \qquad (6)$$

We first estimate the regression models under the more realistic assumption that the unobserved part of loans is concentrated, then re-estimate all models under the assumption that the unobserved part is diversified among an infinite number of banks.[11]

Tables 2 and 3 present the structure of the relationships based on the two assumptions. Number of creditors, share of firms with a single bank or multiple banks and share of loans are first reported using the available data in the credit register. The figures imply that more than half of German firms borrow from a single bank. However, due to the reporting threshold, a considerable part of the loan exposures, around 30 percent in the case of the single bank, are not observable in the database. Assuming that the unobserved loans are concentrated in one bank with a maximum tolerable amount of 1.499 million Euros, we find that the share of firms with a single bank is thirteen percent instead of 55 percent. Moreover, as Table 3 shows, the average number of relationships increases from 2.14 to 3.97 when we assume the unobserved part of loans is concentrated.

D. Description of Explanatory Variables

We explain the degree of concentration with firm, bank and market-specific variables. The definition and measurement of the variables is summarized in Table 4. Empirical studies that investigate firm characteristics as the determinants of relationship lending typically focus on size, age, profitability/cash flow and financial leverage (e.g. Detragiache, Garella and Guiso, 2000; Harhoff and Körting, 1998 and Machauer and Weber, 2000).

Size is an important factor in determining the borrowing behavior of a firm. We measure size as the log of Total Assets of the firm. It is argued that smaller firms benefit more from

[11] We also randomize over the two assumptions and re-estimate all models featuring the *HHI* and *CCI*. The results remain virtually unchanged.

relationship banking due to their informational opaqueness. In addition, ownership structure might be related to the informational opaqueness as well (Volpin, 2001). However, we do not have information about ownership concentration in our data. To proxy for ownership structure, we include a dummy variable identifying the legal form of the enterprise (corporation or partnership).

For profitability, we use Return on Assets (ROA). Financial Leverage, computed as Financial Debt to Total Assets of the firm, shows the dependence of the company on bank debt. It is used as a proxy for the riskiness of the company as well. Probability of Default is a proxy for the quality of the firm.[12] To measure asset specificity, we use the Share of Illiquid Assets (i.e., Intangibles plus Fixed Assets to Total Assets).[13]

We are also interested in exploring whether regional characteristics play a role in determining the concentration of firms in their creditors. Therefore, we control for banks' concentration in the region where the firm is located. We measure regional lender concentration using the HHI of the loans in that particular region. We do not control for firms' access to other sources of financing such as bonds. The sample firms are rather bank dependent in their financing and the share of bonds is negligible in the data with a mean value of 0.002. Table 5 summarizes the descriptive statistics for all explanatory variables.

Detragiache, Garella and Guiso (2000) argue that firms may diversify bank liquidity risk by establishing multiple relationships. By including bank characteristics such as size and

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[12] Probability of Default (PD) is calculated in Krueger, Stoetzel and Trueck (2005) who explain ratings using balance sheet variables. Their predicted *Z*-Score is transformed to calculate the PD variable: $PD=e^Z/(1+e^Z)$. Since the PD is an estimated variable, it is necessary to adjust the standard errors when including it as an explanatory variable (as we use standard errors that are robust to heteroskedasticity, we need not be concerned about such an adjustment).

[13] Intangible assets reported on the balance sheet in Germany contain only the purchased intangible assets, such as patents. We exclude the intangible assets from the Share of Illiquid Assets and re-estimate all specifications. Results remain unchanged. Fixed assets may capture the impact of collateral on the degree of informational asymmetry. Since information on collateral is not available in the data, we exclude "land" and "buildings", which are commonly used as collateral, and re-estimate our model. Alternatively, we use "cash" instead of fixed assets to measure liquidity. All results remain virtually unchanged. We also note that our sample consists of relatively large firms that are typically under less pressure to post collateral.

fragility, we explore the impact of bank characteristics on the firms' choice of multiple banking as well as the degree of concentration in borrowing. We basically investigate the impact of the characteristics of the relationship lender, identified as the lender with the largest share in financing. In empirical work, several proxies are used to distinguish between relationship lenders and transactional lenders. These are the length of relationship between the firm and the bank, loan categories (Detragiache, Garella and Guiso, 2000) and survey responses by banks if they consider themselves to be the Hausbank of their borrowers (Elsas and Krahnen, 1998). Since we do not have access to this type of information, we take the largest financing share as a proxy for relationship lending. Elsas, Heinemann and Tyrell (2004) and Guiso and Minetti (2004) also use shares as a proxy for relationship lending. Moreover, Elsas (2005) finds evidence (using credit files of a few large German banks) of a strong connection between the share of financing and the probability of being the relationship lender. We further investigate the stability of relationship lending defined using the largest share of a firm. For fourteen percent of firm-year observations, firms change their relationship lender compared to the previous year. This suggests our relationship definition is likely to be conservative as the hazard rate is high compared to other estimates in the literature (Ongena and Smith, 2001; Farinha and Santos, 2002).

We further focus on the impact of the largest exposure on other exposures. We expect a relationship between the size of the largest exposure and the size and characteristics of the other exposures. In Elsas, Heinemann and Tyrell (2004), the expected profits of small lenders increase in the exposure of the largest lender. This might imply a positive relationship between the largest exposure and the sizes of the other bank exposures. Moreover, Bannier (2005) argues that the behavior of a relationship lender is observable to the other banks and coordinates their actions. And in Schuele (2006) and Takeda and

Takeda (2006), the relationship bank also influences the transactional lenders through its refinancing decisions. On the other hand, the ability of the relationship lender to extract rents could increase in its financing share implying that the largest lender will get all of the benefits and smaller lenders would not be willing to participate further in lending. Hence whether and how the size of the largest exposure affects the other bank exposures remains an empirical question that we will also address in the next section.

IV. Results

A. Explaining Creditor Concentration

We first explore the determinants of creditor concentration.

$$\begin{aligned} Degree\ of\ \ Asymmetry_{jt} = \beta_0 + \sum_{k=1}^{K} \beta_{1k} Firm_{jtk} + \sum_{n=1}^{N} \beta_{2n} Bank_{jtn} \\ + \beta_3 Regional\ \ Concentration_{jt} + \gamma z_t + \varepsilon_{ijt}, \end{aligned} \tag{7}$$

where *Degree of Asymmetry*$_{jt}$ captures the degree of asymmetry for firm *j* at time *t*, which is measured by the Herfindahl-Hirschman Index (*HHI*), the Comprehensive Industrial Concentration Index (*CCI*), the Share of Inequality Index (*SII*) and the three bank Concentration Ratio (*CR3*), respectively. *Firm*$_{jt}$ captures firm-specific characteristics. *Bank*$_{jt}$ denotes the characteristics of the largest lender (the largest lender is defined as a lender with the largest share of financing). The error term is given by $\varepsilon_{ijt} = \eta_i + \eta_j + \varpi_{ijt}$, where η_i and η_j are bank and firm-specific fixed effects and ϖ_{ijt} is a disturbance term with $\omega_{ijt} \sim iid(0, \sigma_\omega)$. Moreover, we add a set of year dummy variables, z_t, in order to capture omitted macroeconomic developments.

Previous studies often model the firm's decision process in two steps: first, the firm decides whether or not to take one or multiple creditors, then the firm decides how many

banks or how concentrated it wants to borrow conditional on being in the multiple banking region (Detragiache, Garella and Guiso,, 2000 and Guiso and Minetti, 2004). We leave the two-stage empirical specification reflecting this two-step decision process to the robustness section. In this section, we take the creditor concentration as continuous, varying between 0 and 1, where 1 presents the choice of one single creditor.

Table 6 presents the main results under the assumption that the unobserved part is concentrated (see 3.2.1, Equation 5). Panel A includes only firm-specific variables. In the first two columns we take the number of banks the firm borrows from as the dependent variable. This helps us to see which factors increase the number of banks that firms choose to borrow from and whether these factors are different from the ones that affect the degree of concentration. The other columns explain our alternative measures for concentration. The *F*-Test and the Breusch-Pagan-Test both indicate panel estimation techniques are to be preferred. Because the Hausman-Test rejects random effects in multiple specifications, we opt to report the results from the fixed effects models.

Probability of Default and Financial Debt alternatively act as a proxy for the quality of the firm and these variables are included in different specifications to avoid multicollinearity. Probability of Default is positively related to the number of banks (*Log N*) and significantly negative in all other specifications, indicating that firms with a higher probability of default are expected to have a higher number of banks and a lower degree of creditor concentration. The magnitude of the coefficient is economically relevant as well since an increase from 0.01 to 0.05 is estimated to decrease the *HHI* by 0.09 and the *SII* by 0.06. Such an increase in Probability of Default is not unrealistic when considering the size of the standard deviation of 0.01 for the entire sample. In fact, it is even more plausible for years with low economic growth. This finding is in line with the Bris and Welch (2005) model in which high quality firms want more concentrated credit (but it seemingly

contradicts the arguments by Guiso and Minetti (2004) that the quality of the firm may not be related to the degree of concentration). The magnitude of the coefficient when explaining the degree of concentration is the highest for the specification with the *HHI* as the dependent variable. This implies that for larger shares in financing, a change in Probability of Default matters more, since *HHI* attaches greater weight to larger shares.

The size of the firm has a positive (negative) impact on the number (concentration). Thus, larger firms not only tend to diversify their creditors, they also spread their borrowing more evenly. This impact seems to originate in the asymmetry, not only in the number of banks, since we also estimate that the model with alternative concentration measures is less affected by the number of banks, and we find this impact to be robust.

Illiquid Assets, our proxy for the redeployability of assets, is inversely related to the concentration measures in most of the specifications, a result also found by Guiso and Minetti (2004). Financial Debt is also positively (inversely) related to the number of banks (degree of concentration). The higher the bank indebtedness, the lower the degree of concentration might be given the need for an increased number of creditors. On the other hand, Financial Debt is often used as a proxy for risk as well. In this respect, the result does not contradict the finding for the Probability of Default. Profitability of the firm (ROA) is not significantly related to creditor concentration but it is to the *Log N*. For the dummy variable indicating the legal form of the firm, irrespective of whether it is a corporation or a partnership, we do not find strong evidence that corporations differ systematically from partnerships with regard to concentration of borrowing.

In Panel B, we include the characteristics of the relationship lender, which is defined as the bank with the largest financing share. The coefficients of the firm-specific variables do not differ from the ones in Panel A. The ROA of the relationship lender is significantly related to the dependent variable (except in the specification explaining *SII*). This finding is

also in line with the predictions in Detragiache, Garella and Guiso (2000) concerning the liquidity problems of the relationship lender. The results imply that a one-percentage point increase in the earnings of the relationship lender is expected to increase the *HHI* by 1.91 percentage points. The negative and insignificant coefficient for Capital Adequacy is positive and significant when explaining the *SII*. The finding of a positive relationship is consistent with the literature on the market discipline of banks imposed from the borrowers' side.[14] However, the impact of the coefficient needs further investigation since we do not find the same result for other concentration measures. Moreover, it is positively related to *Log N* as well. The size of the relationship bank and Risk Provisions do not have an impact on the degree of concentration.

We also include dummies denoting the ownership structure of the bank, i.e. Public Sector Banks, Cooperative Sector and Other Banks (banks with special functions) taking Commercial Banks as the reference group. We find that only the coefficient of Other Banks is positively significant when explaining *Log N* and the *SII*, implying that if the relationship lender belongs to the group of Other Banks rather than being a commercial bank, both the number of banks and the degree of concentration is higher. Moreover, we find that the regional concentration of banks, HHI Region, is positively related to the firm's concentration of borrowing but it does not have an impact on the number of banks the firm borrows from.[15]

To summarize, risky, illiquid, large and leveraged firms that are located in a region with fiercer banking competition and that are engaged with an unprofitable relationship bank,

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[14] In Allen, Carletti and Marquez (2005) capital acts as a commitment device to monitor borrowers. Kim, Christiansen and Vale (2005) find that banks avoid losses as a strategic variable to soften competition. Billett, Flannery and Garfinkel (2005) explore the effect of lenders' credit ratings on the borrowing firms' equity returns and find evidence for a positive relationship.

[15] Alternatively, we use the (Log) Number of Lenders present in a region to measure regional concentration but do not report the results here. The estimated coefficient on this variable is negative but statistically insignificant. All other explanatory variables remain unchanged.

spread their borrowing more evenly between multiple lenders. Overall, we find these results in line with predictions in Bris and Welch (2005) and Detragiache, Garella and Guiso (2000). We also find that similar factors affect both 'the number of banks' and 'the degree of concentration'. The main difference is that asset redeployability and regional concentration have no impact on the number of banks but a relatively strong and robust impact on creditor concentration.

B. Role of the Relationship Lender

Next we analyze the impact of the size of the largest exposure on the sizes of other exposures. Thus, our specification takes the form of:

$$\begin{aligned} Bank\ Exposure_{ijt} = {} & \beta_0 + \beta_1 Largest\ Exposure_{jt} + \sum_{m=1}^{M} \beta_{2m} Largest\ Lender_{jtm} \\ & + \sum_{n=1}^{N} \beta_{3n} Bank_{ijtn} + \beta_4 Regional\ Concentration_{jt} \\ & + \sum_{m=1}^{M} \beta_{5m} Largest\ Exposure_{jt} * Largest\ Lender_{jtm} \\ & + \sum_{n=1}^{N} \beta_{6n} Largest\ Exposure_{jt} * Bank_{ijtn} \\ & + \beta_{6n} Largest\ Exposure_{jt} * Regional\ Concentration_{jt} \\ & + \sum_{k=1}^{K} \beta_{7k} Firm_{jtk} + \gamma z_t + \varepsilon_{ijt}, \end{aligned} \tag{8}$$

where $Bank\ Exposure_{ijt}$ denotes bank lending of all banks in the sample except of the bank with the largest exposure (these banks are, therefore, called the "other lenders") and $Largest\ Exposure_{jt}$ captures the exposure of the largest lender to a firm j at time t. We assume simultaneity for the credit decisions of the relationship lender and the other lenders as modeled by Bannier (2005) and Schuele (2006). Specification (8) captures that the lending behavior of the other lenders may be influenced by their own characteristics (e.g. bank size, bank fragility), by the size of the loan extended by the relationship lender to the firm, by the characteristics of the relationship lender and by the firm characteristics. We

take the absolute values of exposures since the total exposures to a firm measured as financing shares in percentages total one.

Table 7 reports the estimation results for the impact of the Largest Exposure on the Other Exposures. Equation (8) is also estimated with fixed effects estimation techniques. The cross-sectional unit in these estimations is the loan exposure, including information on both firm and bank-level dimensions. The first specification, where we control for the characteristics of the relationship lender and other lenders, indicates that a 10 percent increase in the Largest Exposure is expected to increase Other Exposures by 5.7 percent. Hence the other lenders seem to align their credit decisions with those of the relationship lender. Other variables do not seem to matter for the financing decisions of other banks.

Next we include interaction terms of the Largest Exposure with the bank and market characteristics. The last specification includes firm characteristics as well. Surprisingly, we find that the coefficient of the Largest Exposure becomes negative and significant in the second specification. However, the total impact of the variable is still significantly positive when taking the interaction terms into account. The results also show that if the relationship lender is a public bank, this has a positive impact on the size of other exposures when compared to the case when the relationship lender is a commercial bank.

The interaction term with the (Log) Assets of other lenders has a positive coefficient throughout the rest of the specifications. In other words, smaller banks tend to adjust their credit decision with the financing decision of the relationship lender as long as their size allows them to extend more credit. In addition, the interaction term of the Largest Exposure with Capital Adequacy is negatively significant, possibly implying that as the other lenders tie up their funds in capital their willingness to extend credit decreases. The interaction with HHI Region is negatively related to the dependent variable but significant only at the ten percent level and in one specification.

The size of the firm ((Log) Assets) is positively related to the size of the Other Exposures as expected. Probability of Default is positively related to the dependent variable: as predicted by Bris and Welch (2005), low quality firms do not concentrate their borrowing as concentration may decrease their bargaining power in case of default.[16] The dummy variable for the legal form of the firm has a significantly negative coefficient, implying that if the firm is a corporation (rather than a partnership) other lenders will tend to lower their financing shares. We do not include the alternative set of firm-specific variables, such as financial leverage, in order to avoid a potential endogeneity problem for this specification since firm financial leverage might be affected by the changes in other lenders' exposures.

As explained before, we identify the relationship lender by the size of the financing share. Considering the presence of observations where the percentage of the largest share is low, we re-estimate Equation 8 by excluding the observations where the share of financing is below 20 percent and 30 percent respectively. The results are virtually unchanged.

Summarizing, the financing decision of a relationship lender is positively correlated with the lending behavior of other banks. However, other banks seem more inclined to extend credit the larger the exposure of the relationship lender, which is a public sector bank rather than a commercial bank; this is particularly the case if the other banks are not small or do not have to tie up additional funds in capital. Distressed, large or leveraged firms borrow more from the other banks.

[16] Following the model by Bris and Welch (2005), we also analyze the impact of firm quality on loan interest rates for firms with a single lender. Since interest rate information is not available, we compute this variable as interest rate expenses divided by financial debt of a firm minus average yields on debt securities. We do not find any relation between Probability of Default and interest rates, possibly because of the imprecise measurement of the loan rates.

V. Robustness

A. Unobserved Credit is Granted by Many Banks

To check the robustness of our results we compute the degree of concentration assuming that the unobserved part of credit is diversified among an infinite number of banks (see 3.2.1, Equation 6). We measure the degree of concentration by the Herfindahl-Hirschman Index (*HHI*) and by the Comprehensive Industrial Concentration Index (*CCI*) respectively.[17]

Table 8 presents similar specifications as in Table 6 for the newly defined concentration measures. The bottom-line is that changing the assumption about the unobserved part of credit does not substantially affect our estimation results. The signs and statistical significance for Probability of Default, Illiquid Assets and Financial Debt remain virtually unchanged. We note, however, that the coefficient on the size of the firm variable is not significant in Panel A. In addition, ROA Firm becomes positively significant.

The outcomes of Panel B, including bank and market-specific variables, deviate slightly from Table 6 as well. The findings for ROA Bank, Other Banks dummy as ownership type and HHI Region are parallel to the results of Table 6. On the other hand, the parameter for Capital Adequacy becomes negative and significant, a result which was not observed previously.

The bias in the degree of concentration introduced by the reporting threshold of 1.5 million Euros is possibly more pronounced for smaller firms. As an additional robustness check, we exclude the firms with a total asset value lower than five million Euros and re-estimate the model (but choose not to tabulate these results). As expected, the results are

[17] Remember that the *SII* is computed by decomposing the *HHI* and taking out $1/N_{jt}$. Since the number of banks is assumed to be infinite here, $1/N_{jt}$ equals zero and the *HHI* equals the *SII*.

closer to our earlier findings. ROA Firm is no longer significant, and Capital Adequacy Bank has a smaller coefficient and lower significance level. The significance of other coefficients is unchanged and even stronger for firm-specific variables. Moreover, there is an increase in the magnitudes of those parameters.

B. Sample Selection

Before the introduction of the euro, firms issuing commercial bills were required to report their balance sheets to the Deutsche Bundesbank. Only firms with solid creditworthiness were allowed to issue commercial bills. Since our data includes only firms that issued paper and reported to the Deutsche Bundesbank, a selection bias may be present in our estimates.

To assess the average quality of the firms in our sample, we compare the mean value of the probability of default in our sample with the values reported in Dietsch and Petey (2004). They investigate stationary default probabilities for French and German small and medium-sized enterprises (SMEs) from 1997 to 2001. The average PDs in both countries are in general much lower for large businesses. For instance, the average default probability for SMEs with turnover between one and seven million Euros equals 0.79% in their study, while for SMEs with turnover between seven and 40 million Euros the average default probability is only 0.14%. Our sample consists of even larger firms and the mean value of our probability of default equals 0.60%. Consequently, it seems unlikely that only high quality firms are present in our sample.

We further consider the fact that the number of the firms decreases over time owing to the regulatory changes related to the introduction of the euro. Starting in 1999, commercial bills lost their importance as securities and the number of firms reporting to the Deutsche Bundesbank decreased commensurately. We re-estimate our model ending the sample in

1999. The unreported results are very similar for all firm-specific variables though not for bank profitability and regional concentration.

C. Two- Stage Estimation

In this subsection, we follow the methodology by Detragiache, Garella and Guiso (2000) and Guiso and Minetti (2004) by applying a two-stage estimation. The first and third columns in both panels of Table 9 present the results for the first-stage probit estimating the probability of multiple banking. The other columns tabulate the coefficients on the determinants of the degree of concentration measured by the Share of Inequality Index *(SII)* conditional on being in the multiple bank region. As the identification variable, we choose the Legal Form Firm, a variable that was insignificant in the concentration estimations using the share inequality from the previous subsection. Moreover, given previous work, we do not have a strong reason to argue that the legal form of a firm should affect the asymmetry in bank financing. In the second stage, we also include the Mills ratio obtained from the first stage to correct for any selection bias.

The signs and statistical significance for most of the parameters in the second stage remain unchanged from Table 6. Illiquid Assets is not statistically significant when explaining the degree of concentration in Panel B. But as the first specifications of both panels show, Illiquid Assets is positively and significantly related to the probability of multiple banking. This result is in line with predictions in Bolton and Scharfstein (1996) and Guiso and Minetti (2004). When including the characteristics of the bank with the largest share, bank profitability appears to be insignificant in both stages, contradicting previous results. The probability of multiple banking decreases with the share of risk provisions of banks, as predicted by Detragiache, Garella and Guiso (2000) who show that the probability of multiple banking decreases in bank fragility. However, there is little

evidence for a relationship between Risk Provisions and the *SII*. Interestingly, the dummy for Other Banks is positively related to both probability of multiple banking and the degree of concentration.

To summarize, large and leveraged firms and firms with less liquid assets prefer multiple banking. Asset liquidity, however, does not have a strong impact on the degree of concentration. Risky, large and leveraged firms with a relationship lender that is a commercial bank choose to have lower degree of concentration in borrowing.

D. Other Robustness Tests

As an alternative linear measure for the degree of concentration, we also employ the largest share of financing. We find three differences to the main results.[18] Firstly, the size of the firm is no longer significant. Second, the ROA of the firm positively determines the share of financing. Thirdly, Capital Adequacy of the bank with the largest share is negatively related to the dependent variable.[19] These findings suggest that firm size matters for the smaller shares of financing but that firm profitability and capital adequacy of the large lender do not.

One may argue about the direction of causality between some bank-specific variables, such as Capital Adequacy and the degree of asymmetry. When a bank extends credit, this definitely has an impact on its capital ratio. Considering the possibility of an endogeneity problem, we re-estimate our regressions by excluding this variable. The results confirm our previous findings. As an alternative specification, we also include lagged bank-specific variables. The results remain mainly unchanged except for Illiquid Assets.

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[18] We choose not to tabulate any further results. All estimation results in the robustness section are available upon request.

[19] These findings are similar to the results reported in Section V.A. However, recall that those results are closer to the main results when we exclude smaller firms.

Next, we control for the industry affiliation of our sample firms. We choose not to include industry affiliation in our main specifications because we lack strong theoretical justification for doing so and because our measure is potentially noisy and incomplete. We find that our results are not driven by industry affiliation since our previous findings are robust to the inclusion of industry dummies.

VI. Conclusion

Motivated by seminal and more recent theoretical work, we investigate the determinants of creditor concentration for a unique and comprehensive sample of German firms. We focus on the degree of creditor concentration, i.e. the degree of asymmetry in the borrowing by firms from different banks. We use alternative measures of asymmetry and conduct a variety of other robustness exercises.

We contribute to the literature by documenting that creditor concentration is widespread and potentially also important for large firms. Firm quality and asset redeployability is positively related to the degree of concentration. The degree of creditor concentration increases with the increase in the profitability of the lender with the largest financing share and with the increase in the regional market concentration of bank lending. Other 'smaller' lenders align their credit decisions with those of the relationship lender to the extent that their size and their capital allow them to do so. Therefore, other banks tend to extend their lending with the increase in the exposure of the relationship lender. This tendency appears to be stronger if the relationship bank is a public sector bank rather than a commercial bank.

Overall our study confirms hypotheses in Detragiache, Garella and Guiso (2000) and Bris and Welch (2005) about the positive relationship between firm quality and creditor concentration. Profitability of the relationship lender and the size of the other lenders also play an important role. More theoretical and empirical work on creditor concentration

seems warranted. As direction for further research the question of interest is whether firms adjust their creditor concentration in response to exogenous shocks. Bank mergers in the banking industry can be considered as an exogenous shock for firms since after bank mergers the creditor concentration automatically deviates from its original level. Therefore, it will be interesting to investigate whether firms adjust their concentration after bank mergers towards its optimal level which depends on their firm specific characteristics.

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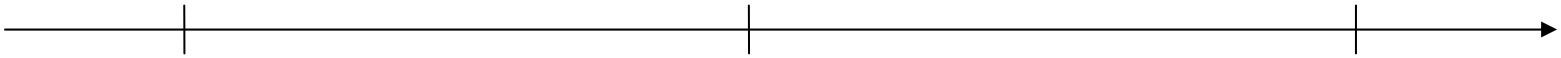
Figure 1: Timeline for Models on Multiple-Bank Relationships and Asymmetry



Monitoring	**Refinancing/Restructuring**	**Firm Default**
Carletti (2004)	Detragiache, Garella and Guiso (2000)	Bolton and Scharfstein (1996)
Carletti, Cerasi and Daltung (2005)	Guiso and Minetti (2004)	Bris and Welch (2005)
	Elsas, Heinemann and Tyrell (2004)	

Figure 2: Time Variation in the Degree of Concentration

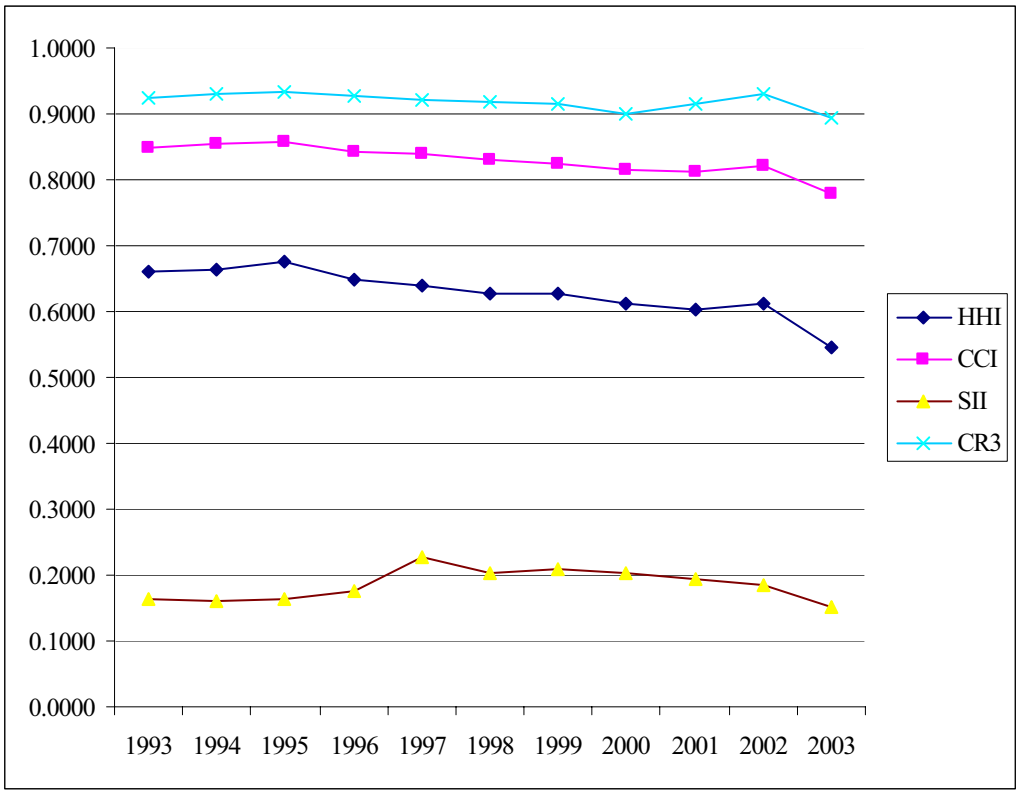


Table 1: Theoretical Models dealing with Borrowing Concentration

	Building Blocks	Mechanism	Outcome	Implication for Asymmetric Financing
Bolton and Scharfstein (1996)	• Inefficient renegotiation with multiple creditors following a default.	• Manager has to pay more to stop multiple creditors from liquidating the assets. • Decrease in liquidation value with multiple creditors.	Optimal for **high quality firms,** those with **low asset complementarities** and those with **less redeployable assets** to borrow from **multiple creditors**.	If the coordination problem can be mitigated with higher asymmetry in the financing shares of creditors, then **low quality firms,** those with **high asset complementarities** and those with **more redeployable assets** would have higher asymmetry in borrowing.
Bris and Welch (2005)	• Coordination problem for multiple creditors following a default. • Difficult to collect claims.	• Concentrated creditors spend more on lobbying and are in a better position. • Creditors are weaker when dispersed.	Signalling **higher firm quality** with **concentrated creditors** (confidence of not going bankrupt).	An increase in asymmetry can increase the bargaining power of creditors (without the need to decrease the number). Low quality firms would prefer multiple and symmetric bank financing.
Detragiache, Garella and Guiso (2000)	• Firms may diversify bank liquidity risk. • If refinancing from non-relation banks is possible, no need for multiple relationship banking.	• Banking fragility, efficient loan enforcement and profitability of the investment project affect the choice.	• **Multiple banking** with **less efficient loan enforcement** more likely when **banks are less fragile** and when **investment projects** of the firm are **not profitable**. • In the multiple region, the number of banks increases with profitability, with bank fragility and the efficiency of loan enforcement.	Non-monotonicity reflected in asymmetry: • Higher asymmetry (one relationship lender and non-relationship banks) with efficient loan enforcement, bank fragility and profitability. • Lower asymmetry in the relationship lending area.

Table 2: Structure of Relationships

This table summarizes the structure of credit relations for German firms for the period between 1993 and 2003. The number of observations is 7,699 firm-years. The first column reports the number of banks and the second column the share of firms having relations with that particular number of banks. The following columns report the share of loans taken by each bank ordered by size. Due to the reporting threshold in the credit register, a considerable part of relationships cannot be observed in the sample. Panel A presents the relationships observable in the credit register where the total share of loans is below 1. Panel B presents the structure that is computed under the assumption that the unobserved part of the loans is concentrated in one bank with a maximum tolerable amount of 1.499 million Euros. The third column in Panel B reports the share of maximum exposure for firms with n banks.

PANEL A: Relationships observable in the credit register

No. of banks	Share of firms with n banks	Share of loans from x^{th} bank (observable in the credit register)						
		1	2	3	Other	Total		
1	0.55	0.72				0.72	≠	1.00
2	0.22	0.62	0.20			0.82	≠	1.00
3	0.10	0.55	0.21	0.08		0.84	≠	1.00
Greater than 3	0.13	0.41	0.19	0.11	0.04	0.75	≠	1.00

PANEL B: Relationships according to the assumption that the unobserved part of loans is concentrated

No. of banks	Share of firms with n banks	Share of max exposure
1	0.13	1
2	0.43	0.69
3	0.19	0.58
Greater than 3	0.25	0.43

Table 3: Summary Statistics for the Number of Relationships and the Degree of Concentration

The table presents summary statistics for the number and the degree of concentration for German firms for 7,699 firm-years between 1993 and 2003. The degree of concentration is measured by the Herfindahl-Hirschman Index (*HHI*) and the Horvath (1970) Comprehensive Industrial Concentration Index (*CCI*), respectively. Panel A presents the relationships observable in the credit register. Panel B assumes the unobserved part of loans to be diversified among an infinite number of banks. Panel C presents the structure (including the number of relationships *N**) that is computed under the assumption that unobserved part of loans is concentrated in one bank with a maximum amount of 1.499 million Euros. The Share of Inequality Index *(SII)* is computed for Panel C by subtracting *1/Njt* from the *HHI*.

Variable	*No. Obs.*	*Mean*	*25th quantile*	*Median*	*75th quantile*	*Max*
PANEL A: Number of creditors observable in the credit register						
N	7,699	2.14	1	1	2	39
Panel B: Unobserved part of loans is assumed to be diversified among an infinite number of banks						
HHI	7,699	0.53	0.26	0.50	0.89	1.00
CCI	7,699	0.70	0.54	0.76	0.94	1.00
PANEL C: Unobserved part of loans is assumed to be concentrated						
*N**	7,699	3.97	2	2	3	252
HHI	7,699	0.64	0.43	0.60	0.95	1.00
CCI	7,699	0.84	0.76	0.87	0.98	1.00
SII	7,699	0.19	0.03	0.13	0.30	0.88
CR3	7,699	0.92	1.00	1.00	1.00	1.00

Table 4: Definition of Variables

Proxy for Variables	*Variable Name*	*Description*	*Source*
	Firm-specific variables		
Financial Leverage	**Financial Debt Firm**	Total Financial Debt / Total Assets	*Jalys* / *Ustan*
Profitability	**ROA Firm**	Return on Assets	*Jalys* / *Ustan*
Quality	**Probability of Default Firm**		Credit Register
Size	**(Log) Assets Firm**	Log Total Assets	*Jalys* / *Ustan*
Asset Specificity	**Illiquid Assets Firm**	(Fixed Assets + Intangible Assets) / Total Assets	*Jalys* / *Ustan*
Ownership Structure	**Legal Form Firm**	Dummy variable indicating the legal form of the firm (1=corporation, 0=partnership)	Credit Register
	Bank-specific variables		
Profitability	**ROA Bank**	Income Before Taxes / Total Assets	
Fragility	**Risk Provisions Bank**	Risk Provisions / Credit Exposure	*BAKIS*
	Capital Adequacy Bank		*BAKIS*
			BAKIS
Size	**(Log) Assets Bank**	Log Total Assets	*BAKIS*
Ownership Structure	**Public Sector**	Dummy variables taking Commercial Banks as the reference group	
	Cooperative Sector		
	Commercial Banks		
	Other Banks		
	Market-specific variables		
Regional Concentration	**HHI Region**	Lender Concentration in a region	Credit Register

Table 5: Descriptive Statistics

The table presents the descriptive statistics for both firm-specific and bank-specific variables. The number of observations is 16,713 firm-bank-years. All variable definitions are in Table 4.

Variable		*Mean*	*25th quantile*	*Median*	*75th quantile*	*Min*	*Max*
Firm-specific variables							
Financial Debt Firm	Share	0.38	0.19	0.37	0.54	0.00	0.98
ROA Firm	Share	0.02	0.00	0.01	0.05	-4.46	6.69
Probability of Default Firm	Share	0.01	0.00	0.00	0.01	0.00	0.14
Total Assets Firm	Mln Euros	44.40	3.66	7.43	19.18	0.07	4,716.61
Illiquid Assets Firm	Share	0.26	0.06	0.20	0.39	0.00	1.00
Legal Form Firm	Dummy	0.90	1	1	1	0	1
Bank-specific variables							
Total Assets Bank	Mln Euros	15,933	513	1,273	5,819	5.21	742,401
ROA Bank	Share	0.01	0.00	0.00	0.01	-0.07	0.08
Risk Provisions Bank	Share	0.02	0.01	0.02	0.03	0.00	0.60
Capital Adequacy Bank	Share	0.11	0.09	0.10	0.11	0.00	1.03
Market-specific variables							
HHI Region	Share	0.18	0.09	0.13	0.19	0.00	1.00

Table 6: Estimation Results for the Degree of Concentration

The table reports the fixed effects estimation results explaining the number and the degree of concentration measured by the Herfindahl-Hirschman Index (*HHI*), the Comprehensive Industrial Concentration Index (*CCI*), the Share of Inequality Index *(SII)* and "the *k* bank Concentration Ratio" denoting the sum of three largest shares *(CR3)* under the assumption that the unobserved part of loans are concentrated in one bank with a maximum amount of 1.499 million Euros. All dependent variables are firm-specific. Panel A includes only firm-specific variables. Panel B includes the characteristics of the largest lender (largest financing share) in addition to firm characteristics. All regressions include a constant and year dummies. Robust standard errors are in parentheses. All variable definitions are in Table 4. [a] Significant at 1%, [b] significant at 5%, [c] significant at 10%.

PANEL A

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Dependent variable	***Log N***	***Log N***	***HHI***	***HHI***	***CCI***	***CCI***	***SII***	***SII***	***CR3***	***CR3***
Firm-specific variables										
Prob. of Default Firm	**3.325[a]**		**-2.315[a]**		**-1.416[a]**		**-1.579[a]**		**-1.158[a]**	
	(0.898)		**(0.413)**		**(0.244)**		**(0.404)**		**(0.285)**	
(Log) Assets Firm	**0.269[a]**	**0.263[a]**	**-0.105[a]**	**-0.094[a]**	**-0.077[a]**	**-0.072[a]**	**-0.022[b]**	**-0.021[b]**	**-0.062[a]**	**-0.060[a]**
	(0.027)	**(0.026)**	**(0.013)**	**(0.012)**	**(0.007)**	**(0.007)**	**(0.010)**	**(0.010)**	**(0.010)**	**(0.009)**
Illiquid Assets Firm	0.104	-0.079	**-0.158[a]**	-0.058	**-0.066[a]**	-0.005	**-0.098[a]**	**-0.063[c]**	**-0.120[a]**	**-0.081[b]**
	(0.080)	(0.075)	**(0.040)**	(0.037)	**(0.025)**	(0.022)	**(0.035)**	**(0.034)**	**(0.033)**	**(0.032)**
Financial Debt Firm		**0.899[a]**		**-0.471[a]**		**-0.303[a]**		**-0.180[a]**		**-0.202[a]**
		(0.057)		**(0.026)**		**(0.016)**		**(0.024)**		**(0.023)**
ROA Firm		**-0.112[b]**		0.015		0.007		-0.036		-0.008
		(0.056)		(0.024)		(0.015)		(0.030)		(0.019)
Legal Form Firm	-0.014	0.004	0.005	-0.014	-0.001	-0.009	0.003	-0.009	**0.049[b]**	**0.045[b]**
	(0.054)	(0.052)	(0.026)	(0.024)	(0.016)	(0.015)	(0.022)	(0.021)	**(0.023)**	**(0.023)**
Observations	7,367	7,665	7,367	7,665	7,367	7,665	7,367	7,665	7,367	7,665
R-squared	0.09	0.17	0.05	0.14	0.06	0.17	0.03	0.04	0.03	0.05

Table 6 continued:

PANEL B

	(3)	(3)	(3)	(3)	(3)
Dependent variable	***Log N***	***HHI***	***CCI***	***SII***	***CR3***
Firm-specific variables					
Prob. of Default Firm	**3.683**	**-2.258[a]**	**-1.321[a]**	**-1.480[a]**	**-1.050[a]**
	(1.199)[a]	**(0.479)**	**(0.302)**	**(0.446)**	**(0.347)**
(Log) Assets Firm	**0.305**	**-0.117[a]**	**-0.084[a]**	**-0.026[b]**	**-0.059[a]**
	(0.035)[a]	**(0.016)**	**(0.010)**	**(0.013)**	**(0.012)**
Illiquid Assets Firm	0.182	**-0.169[a]**	**-0.070[b]**	-0.061	**-0.117[a]**
	(0.094)[c]	**(0.049)**	**(0.031)**	(0.042)	**(0.039)**
Legal Form Firm	-0.014	0.025	-0.008	-0.006	0.032
	(0.059)	(0.025)	(0.017)	(0.025)	(0.027)
Bank-specific variables					
ROA Bank	**-4.951[a]**	**1.907[a]**	**1.451[a]**	0.101	**2.142[a]**
	(1.195)	**(0.634)**	**(0.401)**	(0.557)	**(0.643)**
Risk Provisions Bank	-0.724	0.250	0.259	0.093	-0.062
	(0.655)	(0.375)	(0.239)	(0.314)	(0.474)
(Log) Assets Bank	0.005	-0.001	0.000	0.001	-0.002
	(0.007)	(0.003)	(0.002)	(0.003)	(0.004)
Capital Adequacy Bank	**0.784[c]**	-0.150	-0.030	**0.278[b]**	-0.036
	(0.413)	(0.156)	(0.106)	**(0.141)**	(0.165)
Public Sector Banks	-0.019	0.005	0.013	0.010	0.008
	(0.037)	(0.018)	(0.011)	(0.014)	(0.018)
Cooperative Sector	-0.048	-0.004	0.011	-0.013	0.025
	(0.046)	(0.022)	(0.015)	(0.018)	(0.025)
Other Banks	**0.110[c]**	0.014	0.016	**0.046[b]**	0.033
	(0.057)	(0.031)	(0.021)	**(0.023)**	(0.028)
Market-specific variables					
HHI Region	-0.072	**0.095[a]**	**0.050[b]**	**0.086[b]**	-0.053
	(0.066)	**(0.034)**	**(0.020)**	**(0.033)**	(0.036)
Observations	5,272	5,272	5,272	5,272	5,272
R-squared	0.10	0.05	0.06	0.03	0.03

Table 7: Impact of the Largest Exposure on Other Exposures

The table reports the fixed effects estimation results at the level of relationships (exposures). Exposures are in million Euros. *(L)* denotes for the characteristics of the bank with the largest exposure. All dependent variables are firm-bank-specific. All regressions include a constant and year dummies. Robust standard errors are in parentheses. All variable definitions are in Table 4. [a] Significant at 1%, [b] significant at 5%, [c] significant at 10%.

	(1)	(2)	(3)
	(Log) Other Exposures	**(Log) Other Exposures**	**(Log) Other Exposures**
(Log) Largest Exposure	**0.566[a]**	**-0.702[c]**	-0.592
	(0.078)	**(0.411)**	(0.431)
ROA Bank *(L)*	-3.697	4.332	2.133
	(4.614)	(6.966)	(6.822)
Risk Provisions Bank *(L)*	-1.794	-5.893	-5.159
	(3.848)	(5.557)	(6.372)
(Log) Assets Bank *(L)*	-0.011	-0.040	-0.040
	(0.030)	(0.043)	(0.044)
Capital Adequacy Bank *(L)*	-0.572	-1.739	-1.434
	(0.846)	(1.530)	(1.752)
Public Sector Banks	0.229	0.224	**0.407[a]**
	(0.140)	(0.142)	**(0.148)**
Cooperative Sector	0.522	0.506	0.441
	(0.330)	(0.324)	(0.292)
Other Banks	0.026	0.002	-0.095
	(0.206)	(0.211)	(0.211)
ROA Bank	-2.471	-5.484	-5.245
	(4.610)	(8.513)	(9.584)
Risk Provisions Bank	-1.187	-6.276	-8.023
	(0.843)	(5.955)	(6.412)
(Log) Assets Bank	0.271	-0.130	-0.089
	(0.207)	(0.245)	(0.261)
Capital Adequacy Bank	-0.203	3.635	3.606
	(1.058)	(2.397)	(2.547)
HHI Region	-0.752	0.050	0.064
	(0.675)	(0.677)	(0.688)
(Log) Largest Exposure * ROA Bank *(L)*		-5.065	-4.576
		(3.102)	(3.063)
(Log) Largest Exposure * Risk Provisions Bank (*L*)		2.462	2.090
		(2.486)	(2.883)
(Log) Largest Exposure * (Log) Assets Bank *(L)*		0.021	0.017
		(0.020)	(0.023)
(Log) Largest Exposure * Capital Adequacy Bank *(L)*		0.736	0.651
		(0.496)	(0.578)
(Log) Largest Exposure * ROA Bank		1.350	0.637
		(2.651)	(2.699)
(Log) Largest Exposure * Risk Provisions Bank		1.586	2.126
		(1.621)	(1.744)
(Log) Largest Exposure * (Log) Assets Bank		**0.109[a]**	**0.090[a]**
		(0.035)	**(0.034)**
(Log) Largest Exposure * Capital Adequacy Bank		**-1.259[b]**	-1.330
		(0.640)	(0.812)
(Log) Largest Exposure * HHI Region		**-0.366[c]**	-0.162
		(0.192)	(0.190)

Table 7 continued:

	(1)	(2)	(3)
	(Log) Other Exposures	(Log) Other Exposures	(Log) Other Exposures
Prob. of Default Firm			**14.351[b]**
			(5.941)
(Log) Assets Firm			**0.654[a]**
			(0.160)
Illiquid Assets Firm			0.012
			(0.414)
Legal Form Firm			**-0.977[a]**
			(0.332)
Partial Effect of (Log) Largest Exposure		***0.545[a]***	***0.436[a]***
		(0.080)	*(0.092)*
Observations	5,520	5,520	4,868
R-squared	0.07	0.09	0.11

Table 8: Robustness Tests / Unobserved Credit is Granted by Many Banks

The table reports the fixed effects estimation results explaining the degree of concentration measured by the Herfindahl-Hirschman Index (*HHI*) and the Comprehensive Industrial Concentration Index (*CCI*) under the assumption that the unobserved part of loans are diversified among an infinite number of banks. All dependent variables are firm-specific. Panel A includes only firm-specific variables. Panel B includes the characteristics of the largest lender (largest financing share) in addition to firm characteristics. All regressions include a constant and year dummies. Robust standard errors are in parentheses. All variable definitions are in Table 4. [a] Significant at 1%, [b] significant at 5%, [c] significant at 10%.

	PANEL A				*PANEL B*			
	(1)	(2)	(1)	(2)	(3)	(4)	(3)	(4)
Dependent Variable	*HHI*	*HHI*	*CCI*	*CCI*	*HHI*	*HHI*	*CCI*	*CCI*
Firm-specific variables								
Prob. of Default Firm	**-2.219[a]**		**-1.437[a]**		**-2.249[a]**		**-1.413[b]**	
	(0.545)		**(0.481)**		**(0.623)**		**(0.581)**	
(Log) Assets Firm	-0.016	-0.011	0.021	0.021	**-0.042[b]**	-0.032	-0.002	0.001
	(0.017)	(0.017)	(0.016)	(0.015)	**(0.021)**	(0.020)	(0.019)	(0.018)
Illiquid Assets Firm	**-0.124[b]**	-0.070	-0.063	-0.047	**-0.221[a]**	**-0.166[a]**	**-0.161[a]**	**-0.144[a]**
	(0.052)	(0.050)	(0.047)	(0.045)	**(0.061)**	**(0.061)**	**(0.053)**	**(0.053)**
Financial Debt Firm		**-0.218[a]**		-0.051		**-0.238[a]**		**-0.079[c]**
		(0.040)		(0.037)		**(0.046)**		**(0.042)**
ROA Firm		**0.086[b]**		**0.080[b]**		0.070		**0.064[c]**
		(0.042)		**(0.037)**		(0.043)		**(0.038)**
Legal Form Firm	0.037	0.033	**0.041[c]**	**0.048[c]**	0.044	0.038	0.025	0.034
	(0.029)	(0.029)	**(0.024)**	**(0.024)**	(0.032)	(0.032)	(0.026)	(0.027)
Bank-specific variables								
ROA Bank					**2.033[b]**	**1.761[b]**	**1.869[b]**	**1.684[b]**
					(0.889)	**(0.855)**	**(0.849)**	**(0.825)**
Risk Provisions Bank					-0.028	-0.030	-0.108	-0.060
					(0.546)	(0.532)	(0.522)	(0.510)
(Log) Assets Bank					-0.001	-0.001	-0.000	0.000
					(0.005)	(0.004)	(0.004)	(0.004)
Capital Adequacy Bank					**-0.501[b]**	**-0.481[b]**	**-0.456[b]**	**-0.412[b]**
					(0.212)	**(0.206)**	**(0.196)**	**(0.194)**
Public Sector Banks					-0.030	-0.031	-0.035	-0.033
					(0.024)	(0.023)	(0.022)	(0.022)
Cooperative Sector					-0.049	**-0.068[b]**	-0.049	**-0.064[b]**
					(0.030)	**(0.030)**	(0.030)	**(0.030)**
Other Banks					0.045	0.044	**0.051[c]**	**0.051[c]**
					(0.034)	(0.033)	**(0.031)**	**(0.030)**
Market-specific variables								
HHI Region					**0.087[b]**	**0.075[c]**	0.030	0.029
					(0.043)	**(0.041)**	(0.039)	(0.038)
Observations	7,367	7,665	7,367	7,665	5,272	5,487	5,272	5,487
R-squared	0.01	0.02	0.01	0.01	0.03	0.04	0.02	0.02

Table 9: Two-Stage Estimation

The table reports the two-stage estimation results; the first and third columns of each panel report the first stage probit results for the probability of multiple banking, the second and fourth columns of the panels report the degree of concentration measured by the share of inequality index *(SII)*. The *SII* is computed assuming that the unobserved part of loans is concentrated in one bank with a maximum amount of 1.499 million Euros. All dependent variables are firm-specific. Panel A includes only firm-specific variables. Panel B includes the characteristics of the largest lender (largest financing share) in addition to firm characteristics. All regressions include a constant and year dummies. Robust standard errors are in parentheses. All variable definitions are in Table 4. [a] Significant at 1%, [b] significant at 5%, [c] significant at 10%.

	PANEL A				*PANEL B*			
	(1)	*(2)*	(3)	(4)	(1)	*(2)*	(3)	*(4)*
	Prob	*SII*	Prob	SII	Prob	*SII*	Prob	*SII*
Firm-specific variables								
Prob. of Default Firm	1.871	***-1.857[a]***			4.472	***-1.546[a]***		
	(3.117)	***(0.451)***			(3.682)	***(0.485)***		
(Log) Assets Firm	**0.237[a]**	*-0.009*	**0.298[a]**	***-0.024[b]***	**0.230[a]**	*-0.023*	**0.277[a]**	***-0.032[b]***
	(0.021)	*(0.013)*	**(0.020)**	***(0.011)***	**(0.026)**	*(0.014)*	**(0.025)**	***(0.013)***
Illiquid Assets Firm	**0.389[a]**	***-0.069[c]***	0.030	***-0.057[c]***	**0.318[b]**	*-0.067*	-0.047	*-0.047*
	(0.128)	***(0.036)***	(0.129)	***(0.032)***	**(0.145)**	*(0.043)*	(0.152)	*(0.041)*
Financial Debt Firm			**1.587[a]**	***-0.248[a]***			**1.526[a]**	***-0.255[a]***
			(0.138)	***(0.036)***			**(0.160)**	***(0.040)***
ROA Firm			0.067	*-0.030*			0.060	*-0.049*
			(0.149)	*(0.033)*			(0.142)	*(0.032)*
Legal Form Firm	**-0.166[c]**		-0.009		-0.122		0.053	
	(0.087)		(0.090)		(0.101)		(0.106)	
Bank-specific variables								
ROA Bank					7.519	*0.664*	4.792	*0.322*
					(5.157)	*(0.581)*	(5.542)	*(0.534)*
Risk Provisions Bank					**-3.735[c]**	*-0.168*	**-4.462[b]**	*0.059*
					(2.024)	*(0.308)*	**(2.086)**	*(0.289)*
(Log) Assets Bank					0.020	*0.004*	0.026	*0.002*
					(0.020)	*(0.003)*	(0.019)	*(0.003)*
Capital Adequacy Bank					0.277	*0.149*	0.134	*0.072*
					(1.289)	*(0.131)*	(1.355)	*(0.124)*
Public Sector Banks					-0.029	*0.003*	-0.026	*0.006*
					(0.082)	*(0.013)*	(0.083)	*(0.012)*
Cooperative Sector					0.092	*-0.010*	0.081	*-0.021*
					(0.111)	*(0.017)*	(0.112)	*(0.016)*
Other Banks					**0.415[b]**	***0.071[a]***	**0.486[b]**	***0.058[a]***
					(0.191)	***(0.023)***	**(0.190)**	***(0.021)***
Market-specific variables								
HHI Region					-0.242	***0.086[b]***	-0.146	***0.082[a]***
					(0.169)	***(0.034)***	(0.183)	***(0.030)***
Mills Ratio		*0.101*		***-0.096[c]***		*0.067*		***-0.129[b]***
		(0.088)		***(0.054)***		*(0.097)*		***(0.062)***
Observations	7,367	*6,167*	7,665	6,408	5,272	*4,560*	5,487	*4,746*

Appendix

A Treatment of Bank Mergers

More than one hundred bank mergers took place during the sample period. There are different ways to handle bank mergers. We could exclude the banks that were involved in mergers, however, this procedure would lead to a considerable loss of information. Alternatively, we can consider the merged bank to be one institution during the entire time period. In this case, we need to aggregate the merging banks into one institution before the actual merger takes place. However, data breaks in this procedure are unavoidable since the aggregated data before the merger and the data of the merged bank mostly do not correspond well.

Given the difficulties involved in the aforementioned approaches, we choose to separate the pre-merger banks from the merged bank. In the end, we have three banks, which are treated independently. We repeat this procedure as often as a merger takes place. Each time a newly merged bank receives a new identification number, we drop the target banks in that year (or quarter). Our procedure has obvious drawbacks if one uses dynamic panel estimation techniques.

B Details on the Matching Process of Two Databases and Data Adjustments

The data in the credit register have been primarily gathered for regulatory purposes and some double counting may occur. We eliminate those double-counted exposures from the sample. For example, we do not include borrower units since they report the sum of the exposures of the firms that belong to that unit.[20] Moreover, actual exposures are double counted when partners of civil-law associations with joint partnerships or with limited personal liability *(Gesellschaften des bürgerlichen Rechts,* GbR*)* are jointly accountable for

[20] The borrower unit consists of different borrower firms. The term is defined in §19 (2) of the Banking Act.

the losses. In that case, the exposure of the GbR is reflected in the position of each partner with the same amount or with the amount corresponding to the liability limit of each partner.[21] We also exclude double-counted exposures reported in partners' shares.

We match the information on the firm exposures from the credit register with the information on the firm balance sheets from the *Jalys/Ustan* database. In order to carry out the matching we use firm-specific information in the credit register and in the *Jalys/Ustan.* Firm identity, location, industry and legal form allow us to match conservatively. Both databases cover the entire time period available.[22] We can identify 3,433 matches and, using these matches, we merge the data from the credit register with the data from the *Jalys/Ustan.* The data in the credit register are available on a quarterly basis, and the data from the *Jalys/Ustan* are available on a monthly basis where the balance sheet disclosure occurs once a year in a particular month of that year. The majority of the firms report their balance sheets at the end of the year. To avoid the problem of time mismatches for firms that have different balance sheet periods, we match the quarterly data from the credit register with the last month of each quarter of firm data from the *Jalys/Ustan*.

Additionally, we make some data adjustments. We compute a coverage ratio between the two databases and exclude observations with a coverage ratio above 120 percent.[23] The coverage ratio is calculated as follows:

$$Coverage\ Ratio_{jt} = ((\sum_{i=1}^{n} Loans_{ijt}) / Financial\ Firm\ Liabilities_{jt}) * 100\,, \qquad \text{(A1)}$$

[21] For more detailed information on the civil-law associations and the liability limits, see Deutsche Bundesbank (1998).

[22] The data in the credit register are available for 1993 onwards and the data in the *Jalys/Ustan* from 1989 onwards.

[23] The aim is to exclude the observations with a coverage ratio above 100 percent to eliminate data recording errors. However, we choose a tolerance level of 120 percent and correct the data for the degree of asymmetry measure.

where $Financial\ Firm\ Liabilities_{jt} = Credits_{jt} + Bond_{jt}$. Table A1 provides an overview of the distribution of the coverage ratio.

Table A1: Coverage Ratio

Variable	p10	p25	p50	p75	p90
Coverage Ratio	39.89	71.42	96.47	105.38	166.47

Table A2: Number of Firms in The Dataset With Data Adjustments

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	**Total**
Dataset after correction for borrower units and GbR partners												
Firms	1,311	1,208	1,311	1,294	1,177	961	836	787	727	579	245	**2,402**
After correction for coverage ratio above 120 per cent												
Firms	938	878	915	996	908	706	636	576	542	432	172	**2,076**

Table A2 presents the distribution of the number of firms over the years in the sample including the process of data adjustment. The number of firms diminishes over time with the introduction of the euro. Before the introduction of the euro, firms issuing commercial bills were required to report their balance sheets to the Deutsche Bundesbank since only firms with a solid creditworthiness were allowed to issue these commercial bills. With the introduction of the euro, commercial bills lost their importance as securities and the number of firms reporting to the Deutsche Bundesbank decreased commensurately.

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