Creditor Concentration: An Empirical Investigation*

Steven Ongena
CentER - Tilburg University & CEPR

Department of Finance, PO Box 90153, NL 5000 LE Tilburg, The Netherlands
Telephone: +31 13 4662417
E-mail: steven.ongena@tilburguniversity.nl

Günseli Tümer-Alkan
Center for Financial Studies & Tilburg University

Mertonstr. 17-21, HPF 73 D-60325 Frankfurt am Main, Germany
Telephone: +49 69 798-30062
E-mail: tumeralkan@ifk-cfs.de

Natalja v. Westernhagen
Deutsche Bundesbank
Department of Banking and Financial Supervision, Wilhelm-Epstein-Strasse 14
D-60431 Frankfurt am Main, Germany
Telephone: +49 69 9566-8437
Email: Natalja.von-Westernhagen@bundesbank.de

Preliminary Draft
This Version: November 15, 2006

Abstract

This paper investigates the determinants of creditor concentration for German firms. We focus on the degree of concentration in borrowing by firms from different banks, emphasizing the asymmetry in borrowing. We explore how firm and bank characteristics affect the creditor concentration of a firm using a matched bank-firm level dataset for the period 1993-2003. We find that risky, illiquid, large and leveraged firms borrow in more equal shares from multiple lenders. The degree of concentration increases when the relationship lender has higher profits, an increased level of risk provisions and a lower degree of capital adequacy ratio. We also find that other banks extend less credit the larger the exposure of a relationship lender that is large and profitable; and if the other banks are small or well capitalized.

Keywords: bank relationships, asymmetric financing, banking competition

JEL Codes: G21, G32, G33

*We are grateful to Franklin Allen, Elena Carletti, Jan P. Krahnen, Michael Wedow and participants at the European Corporate Governance Training Network (ECGTN) workshops (Zurich and Venice), the Deutsche Bundesbank workshop (Frankfurt) and the Brown Bag seminar at the University of Frankfurt for comments. Tümer-Alkan gratefully acknowledges financial support from the ECGTN. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Deutsche Bundesbank or their staff.

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 for 21 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 who 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 the reduction in hold-up (Rajan, 1992 and von Thadden, 2002). A single relationship lender may use the inside information it has about the borrower to extract rents. Establishing other bank relationships limits the rent extraction *ex post* by inducing competition among lenders.

But multiple banking can lead to coordination failure in case of default (Bolton and Scharfstein, 1996; Hart, 1995; Dewatripont and Maskin, 1995). On the one hand, an increase in the number of creditors and the ensuing inefficient renegotiation disciplines firm managers, as their incentives to strategically default on a loan will be reduced. On the other hand, there is also a cost in having multiple creditors because when default is due to liquidity there will be a decrease in efficiency.[1] Other studies focus on bank characteristics

[1] 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. Bris and Welch (2005),

when exploring the optimality of number of relationships. Detragiache, Garella and Guiso (2000), for example, explain multiple relationships as the need for diversification of bank liquidity risk by firms. When a relationship bank faces liquidity problems, having established multiple relationships reduces the risk of early liquidation of a project.[2]

However, most of the literature addressing multiple banking assumes equal financing shares. But unequal, "concentrated" or "asymmetric" 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 asymmetry in borrowing decreases as firm size increases.

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 study creditor concentration. Elsas, Heinemann and Tyrell (2004), for example, model the optimal debt structure for multiple but asymmetric bank financing. They emphasize the role of 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. Guiso and Minetti (2004), on the other hand, argue that banks keep unsound firms going for the purpose of seizing 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 behavior by the relationship lender during

---

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.

[2] Carletti (2004) explores how the number of bank relationships affects banks' monitoring incentives and provides an explanation why empirical evidence is not always in line with the theories on hold-up and soft budget constraint problems. Carletti, Cerasi and Daltung (2005) analyze banks' incentives to finance a firm together with other banks when they have limited lending abilities and monitoring is important.

restructuring (because with higher asymmetry less informed banks would have no incentives to continue the project).

We contribute to this emerging literature by investigating the degree of creditor concentration of German firms. 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 time period 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 time period of ten 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 different measures of creditor concentration borrowing from work in other strands of the literature. 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 other exposures.

We find that firm quality is positively related to the degree of creditor concentration, consistent with Bris and Welch (2005) and Detragiache et al. (2000). We find little evidence of a positive effect of the redeployability of assets on asymmetry. The characteristics of the relationship lender have an influence on the degree of concentration as well. The degree of concentration increases when the relationship lender currently has higher profits, but also surprisingly if the relationship bank has more nonperforming loans and a lower capital adequacy ratio. An increase in financing provided by the relationship

lender increases the amount of the financing provided by the other lenders. Other lenders follow the credit decisions by the relationship lender as long as their own size allows for this and as long as the relationship lender is not very powerful, i.e. capable of getting all the benefits.

The remainder of the paper is organized as follows. In section II, we present selected theoretical models in multiple banking, explore the implications for asymmetric financing and review recent work on creditor concentration that focuses on the asymmetry. In section III, we describe the data and the methodology. We present the main estimation results in section IV, followed with a series of robustness tests in section V. Section VI concludes.

II. **Implications of Models**

A. Number of Relationships

A growing theoretical literature addresses the issue of optimality of the number of creditors. 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 renegotiation in case of firm default. The optimal debt structure, they argue, balances the benefits and costs of multiple banking. On the one hand multiple bank relationships discourage managers from strategically defaulting on a loan. Following a default, the manager will have to pay more to stop the multiple claimholders from liquidating the assets than is the case with only one creditor. In this respect it is beneficial for the firm to have multiple creditors and inefficient renegotiations in default. On the other hand, when default is due to 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.

Consequently the optimal number of creditors arises from this tradeoff between the benefits and costs of multiple lending in default. Bolton and Scharfstein (1996) explain the optimal debt structure depending on firm characteristics and they show that the liquidation value is lower when two creditors are involved. This implies that for firms with low default risk and with low asset complementarity, borrowing from two creditors is optimal. On the other hand, when outside buyers place high valuation on assets, it is more attractive for firms to borrow from one creditor to maximize the liquidation value.

Bris and Welch (2005) on the other hand argue that dispersion weakens the hand of the creditors, since it is more difficult for dispersed creditors to collect claims in financial distress due to free-riding and coordination problems. Thus a firm that opts for multiple creditors ex-ante assumes a better bargaining position in case of financial distress ex-post. As a result a higher quality firm in Bris and Welch can signal its confidence of not going bankrupt by selecting only a few creditors.

Another explanation for multiple banking is that firms may seek to diversify bank liquidity risk. In Detragiache, Garella and Guiso (2000), for example, firms can engage multiple relationship lenders. When refinancing a project a firm would need to find financing from non-relationship banks if the relationship banks themselves face liquidity problems to rollover loans. However, due to adverse selection problems, the firm may face difficulties in obtaining refinancing. Establishing multiple relationships reduces the risk of early liquidation of a project, since if liquidity shocks across banks are imperfectly correlated at least one of the relationship lenders will be able to refinance.

In Detragiache et al. (2000) the size of the single banking region depends on the severity of the adverse selection problem, the efficiency of the judicial enforcement mechanism and the profitability of the investment project. The severity of the adverse selection problem is a decreasing function of banking fragility. On the other hand, non-

relationship lenders would be ready to refinance an investment project if it is profitable. If this is the case, multiple relationships bring no benefits but extra transaction costs. The model predicts that multiple banking is more likely when banks are less fragile (and adverse selection more severe), when judicial enforcement is inefficient, and when the investment projects of the firm are not very profitable. However, 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.

All three models discussed so far may also provide intuition on 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,[3] implying the possibility either to decrease the likelihood of liquidation or to signal firm quality. Detragiache et al. (2000) actually include creditor asymmetry as part of their framework. Indeed when adverse selection is mild, firms opt for single relationship banking but can also easily borrow from non-relationship banks in case liquidity shocks hit their relationship bank. On the other hand, under the multiple banking regime firms borrow from multiple relationship banks but the model has no implications with respect to the financing shares. Consequently in its empirical testing the paper focuses on the number of relationships not the degree of asymmetry.

[3]Coordination is also facilitated in Elsas et al. (2004), a model we will discuss shortly. On the other hand, Guiso and Minetti (2004) argue that project-, and not firm-, quality drives asymmetry (as asymmetry prevents the opportunistic continuation of bad projects). Guiso and Minetti (2004) further focus on the incentives of banks to restructure a firm, whereas Bolton and Scharfstein (1996) and Bris and Welch (2005) model the optimal debt structure after firm default.

To conclude, the models explaining relationship multiplicity differ in their timing (see Figure 1), mechanisms, outcomes and relevance for the asymmetry question. Next, we turn to discussing models that deal directly with asymmetric financing.

B. Asymmetry in Borrowing

Theoretical work focusing on the single versus multiple bank case assumes equal shares of borrowing. Empirical studies consequently focus on the number of creditors. However, the number of creditor relationships may provide only a limited picture of the tradeoffs the firm is facing. For example, a firm borrowing 900,000 Euros from one bank and 100,000 from a second bank is definitely faced with a different set of incentives than a firm that borrows 500,000 Euros from each bank. Models dealing with asymmetry in borrowing trade off the benefits of mitigating the coordination problem of multiple banking with the cost of hold-up problem of relationship lending.

The coexistence of one large relationship lender and other lenders with smaller shares of financing is a simple but realistic example underpinning the current theoretical work on asymmetric bank lending. In studies analysing the coexistence of one large investor and many diffused investors, the latter do not play an active role. In contrast, the recent theoretical work on asymmetric bank financing assumes that also the many non-relationship banks are active financiers. Depending on the degree of asymmetry, however, we can move closer to the single banking case where the hold-up problem may become more severe.

Recent work by Elsas, Heinemann and Tyrell (2004), Guiso and Minetti (2004) and Schuele (2006), for example, directly tackles the issue of asymmetric bank financing. Elsas et al. (2004) 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. For the firm there is a risk of a failure when many lenders withdraw simultaneously at the interim stage of the project. When there is no coordination risk and the credits are extended whenever this is efficient (i.e., when the cash flows of the project are higher than the liquidation value), the firm will prefer asymmetric financing because the largest lender will ensure the continuation of the project due to debt forgiveness in bad states of the world. Here, 'the largest lender' is defined as the bank with the largest financing share (i.e., size of exposure), not the bank with the largest size.

The presence of a large lender has an impact on both firm's and other lenders' profits. With efficient coordination, expected profits of the firm decrease in the size of the large lender since the large lender gets all the benefits. Although expected profits are negatively affected, the presence of the large lender may still be beneficial for the firm, since it allows for continuation in more states of the world. On the other hand, expected profits of small lenders increase in the size of the large lender, since if the set of states in which the project succeeds is larger it is more likely that small credits are paid off. The authors also analyze the relationship between the liquidation value of the firm and the size of the relationship lender. They infer a nonlinear relationship.

Guiso and Minetti (2004) analyze 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 to restructuring costs. A relationship lender can easily recognize both the value of the assets of a firm 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 even bad projects if firms have more valuable and more redeployable assets. Firms with such assets may prefer a

higher asymmetry in allocating their information rights across creditors to prevent this 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 the benefits. Guiso and Minetti (2004) test their predictions for a sample of US firms and report a negative relationship between the share of illiquid assets and the degree of creditor concentration.

Schuele (2006) models the coordination failure among creditors and examines how a relationship bank can engage in forbearance lending and thus have an impact on other creditors by its ability to signal. The rollover decision of a relationship bank is positively related to its financing share and inversely related to the value of collateral in Schuele (2006). Thus, the bank refinances the firm if the collateral value is sufficiently low, since a higher collateral value would benefit the bank in case of liquidation. Moreover, Schuele (2006) shows that a relationship bank has an influence on other transactional lenders' refinancing decisions by signaling either its informational advantage or with the size of its financing share.

In other models, which 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.

Coordination problems are not an issue in case of bankruptcy when lenders are forced to cooperate. German banks seem to 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 may need to be revised. Unfortunately no comprehensive data is currently available to test for the impact of creditor pools as well as collateral values. On the other hand, coordination problems and the role of the large lender remain highly relevant for the refinancing stage.

III. Data and Methodology

A. Data Sources

We use a unique matched bank-firm level dataset on a yearly basis from 1993 to 2003. The data consists of three databases, i.e. the Credit Register, the balance sheet data for the firms (*Jalys*/*Ustan)* and the balance sheet data for the banks (*BAKIS*, the *BAKred* Information System).[4] These data sources make it possible to observe individual lender shares of German banks at the firm level and to combine this information with firm- and bank-specific balance-sheet information.

1. Credit Register

The *Deutsche Bundesbank*'s Credit Register 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. On a quarterly basis, German banks are required to report their exposures to the *Deutsche Bundesbank* if total exposures to a particular borrower or the sum of exposures across the borrowers belonging to a single borrower unit have exceeded the threshold of 1.5 million Euros during that particular

[4] The *Bundesaufsichtsamt für das Kreditwesen* (The German Federal Banking Supervisory Office) is one of the three supervisory agencies that merged in 2002 to form the current national supervisor the *BaFin* (*Bundesanstalt für Finanzdienstleistungsaufsicht*).

quarter.[5] Therefore, exposures to smaller and medium-sized firms might be underrepresented in this database. On the other hand, if the sum of the exposures to firms in that borrower unit exceeds the threshold of 1.5 million Euros, the individual exposure to a firm belonging to a single borrower unit is reported, even if it is a small exposure. This fact partly diminishes the bias in the Credit Register towards medium- and large-sized firms.

The data in the Credit Register is not consolidated.[6] The bank exposures to firms in the Credit Register are defined fairly broadly, e.g., they include not only corporate loans but also corporate bonds.[7] In the Credit Register we are able to distinguish between on-balance-sheet and off-balance-sheet items.[8] 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 other banks. The Credit Register contains also information on firm identity, location, industry, legal form, and if the firm went bankrupt, the date of occurrence.

The data in the Credit Register have been primarily gathered for regulatory purposes and some double-counting may occur. 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 the losses. In that

---

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

[6] 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*).

[7] 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.

[8] 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).

case, the exposure of the GbR is reflected in the position of each partner with the same amount or with the amount according to the liability limit of each partner.[9] We systematically exclude the GbRs from the sample. However, the data still involves double-counted exposures reported in partners' shares. The information about partners is available but not the liability limits of the partners. For that reason we exclude the partners from the sample as well to be able to prevent double-counting in the data.

2. Firm and Bank Balance Sheet Data

We also use *Jalys/Ustan* and *BAKIS* to construct firm- and bank-specific variables. *Jalys/Ustan* contains yearly balance sheet information for many German firms. In 2003 for example the dataset contains records on approximately 9,977 firms. The Credit Register is matched with the firm-specific data from *Jalys/Ustan* first. After the match our sample consists of 2,563 firms over the entire period.[10]

The dataset is finally matched with *BAKIS. BAKIS* contains information on bank balance sheets and profit and loss accounts obtained from supervisory reports of all German banks, as well as information on the banking groups. In 2003 for example the dataset contains records on approximately 2,265 banks. After the match the sample consists of an average number of 276 banks / year.

In this paper, we include all banking groups in Germany. During the time period many bank mergers took place. We deal with mergers by creating a new bank after the merger and by treating pre-mergers banks as independent from each other before the merger.[11]

---

[9] For more detailed information on the civil-law associations and the liability limits, see *Deutsche Bundesbank* (1998).
[10] For a more detailed description of the matching process see the Appendix.
[11] For a more detailed description of the treatment of bank mergers see the Appendix.

B. Measuring Concentration of Borrowing

We analyze concentration of borrowing at the firm level using alternative measures originally designed to measure market concentration. Concentration in an industry is measured in a variety of ways in the literature. Bikker and Haaf (2000), for example, compare ten concentration measures in their extensive literature review. Among the ratios, the Herfindahl-Hirschman Index (*HHI*) is one of the most frequently used indices to measure market concentration and it often serves as a benchmark when evaluating other indices. 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 $Total\ Loans_{jt}$, with $Loan_{ijt}$ equals the amount of credit granted by bank *i* to firm *j* at time *t* and $Total\ Loans_{jt}$ are the total amount of credit obtained by firm *j* at time *t*. The index is sometimes criticized because it attaches greater weights 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 firms (banks in our case) in an industry. He decomposes the *HHI* into two terms. Applied to our data the decomposition is defined as follows:

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

where V_{jt}^2/N_{jt} is the share of inequality and the number of banks and $(1/N_{jt})$ is simply the inverse of the number of banks. His decomposition is relevant for our study because we explore the asymmetry in financing. We decrease the impact of the number of banks by regressing the *HHI* on $1/N_{jt}$ and by taking the residuals, an approach similar to Hannan (1997). One important difference is that the *HHI* is the dependent variable in our model.

We re-estimate the model both with the *HHI* and this alternative measure for share of inequality.

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

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

The index is computed as the sum of the proportional share of the leading bank (largest exposure) and the summation of the squares of shares of the other banks, weighted by a multiplier that reflects the shares of the remaining part (Bikker and Haaf, 2000). The *CCI* weighs the squared share of smaller exposures by $(2 - s_{ijt})$. Therefore compared with *HHI*, the *CCI* is more sensitive to the changes in the smaller shares and, possibly more suitable for measurement in cartel markets (Stordal, 2004). Given the presence of concentrated borrowing in the German financial system, we also use the *CCI*, in addition to the *HHI*, and compare the results.

C. Addressing the Bias

The existence of a reporting threshold of 1.5 million Euros introduces a bias in the degree of concentration. On the one hand, using *HHI* as the concentration measure would help to deal with the bias to some extent, since it puts more weight to larger shares. On the other hand, the index is possibly overestimated especially for small firms. For that reason, we re-estimate the empirical model by excluding small firms as a robustness check.

In order to deal with the bias we take two opposing assumptions for the unobserved part of the loans in the Credit Register. Information on the amount of the unobserved part of the loans is simply the difference of *Total Loans*$_{jt}$ taken from the firm accounting data

and the sum of loan exposures ($Loan_{ijt}$) in the credit register for that particular firm. The first assumption takes the rest of the loans as diversified across an infinite number of banks:

$$HHI_{jt} = \sum_{i=1}^{n} (Loan_{ijt} / Total\ Loans_{jt})^2 + 0. \quad (4)$$

Second, we assume the opposite, i.e., the unobserved part of loans as concentrated in one bank:

$$HHI_{jt} = \sum_{i=1}^{n} (Loan_{ijt} / Total\ Loans_{jt})^2 + [(Total\ Loans_{jt} - \sum_{i=1}^{n} Loan_{ijt}) / Total\ Loans_{jt}].^2 \quad (5)$$

If the unobserved part of loans is above 1.5 million Euros, the amount will be distributed among banks each 1.499 million Euros that is the maximum tolerable amount for a loan to be concentrated in one bank. This makes the assumption more precise, since an unobserved loan exposure should be below the threshold of 1.5 million Euros, otherwise it would be in the Credit Register as well. Thus, the formula takes the form:

$$\begin{aligned} HHI_{jt} = & \sum_{i=1}^{n} (Loan_{ijt} / Total\ Loans_{jt})^2 + \sum_{i=1}^{k} (1.499 / Total\ Loans_{jt})^2 \\ & + \ [(Total\ Loans_{jt} - (\sum_{i=1}^{n} Loan_{ijt} + 1.499\ k_{jt})) / Total\ Loans_{jt}],^2 \end{aligned} \quad (6)$$

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 in order to compare the results. This allows us to assess the sensitivity of the coefficients to either assumption.

Table 2 and 3 present the structure of relationships based on these 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 the German firms borrow from a single bank. However, due to the reporting threshold a considerable part of the loan exposures, around 30 percent for the single bank case, 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 fifteen percent instead of 54 percent. Moreover, as Table 3 shows the average number of relationships increases from 2.3 to 4.9 when we assume the unobserved part of loans to be concentrated.

D. Description of Explanatory Variables

We explain the degree of concentration with both firm- and bank-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 et al. (2000), Harhoff and Koerting (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 relationship banking due to their informational opaqueness and inability of producing hard information. In addition, ownership structure might be related to the informational opaqueness (Volpin, 2001). However, we do not have the information for ownership concentration in our data. To proxy for ownership structure, we include a dummy variable identifying the legal form of the enterprise, i.e. whether it is a corporation or a 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. To measure asset specificity we use two proxies: share of Illiquid Assets (i.e. Intangibles and Fixed Assets to Total Assets) and share of Intangible Assets. Table 5 summarizes the descriptive statistics for the firm- and bank-specific variables.

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

fragility, we explore the impact of bank characteristics on the firms' choice of multiple banking as well as the degree of asymmetry in borrowing. We also 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 length of relationship between the firm and the bank, loan categories (Detragiache et al., 2000) and surveys (Elsas and Krahnen, 1998). Since we do not have access to this type of information we take financing shares as a proxy for relationship lending. Elsas et al. (2004) and Guiso and Minetti (2004) also proxy relationship lending using shares. 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 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 other exposures. In Schuele (2006) and Takeda and Takeda (2006) for example the relationship bank can influence the transactional lenders through its refinancing decisions. 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. In Elsas et al. (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 other bank exposures. 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 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 we will try to address in the next section.

IV. Results

A. Explaining Creditor Concentration

We first explore the determinants of creditor concentration.

$$Degree\ of\ \ Asymmetry_{jt} = \beta_0 + \sum_{k=1}^{K} \beta_{1k} Firm_{jtk} + \sum_{m=1}^{M} \beta_{2m} Largest\ Lender_{jtm} + \sum_{n=1}^{N} \beta_{3n} Bank_{ijtn} + \sigma z_t + \varepsilon_{ijt}, \quad (7)$$

where *Degree of Asymmetry*$_{jt}$ captures the degree of asymmetry for firm *j* at time *t*, which is measured both by the Herfindahl-Hirschman Index (*HHI*) and by the Comprehensive Industrial Concentration Index (*CCI*).[12] *Firm*$_{jt}$ captures firm-specific characteristics. *Largest Lender*$_{jt}$ denotes the characteristics of the largest lender (the largest lender is defined as a lender with the largest share of financing). *Bank*$_{ijt}$ captures bank-specific characteristics of all banks in the sample. 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 et al., 2000 and Guiso and Minetti, 2004). We leave the two stage empirical specification reflecting this two-step decision process to the robustness part. In

this section we take the dependent variable as continuous varying between 0 and 1, where 1 presents the choice of one single creditor.

Table 6 presents the main results in explaining creditor 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.

Panel A explains the degree of concentration with only firm-specific variables. The three specifications are estimated both with the *HHI* and the *CCI* as the dependent variable. Probability of Default, Financial Debt and ROA proxy for the quality of the firm alternatively and these variables are included in different specifications to avoid multicollinearity.

Probability of Default is significantly negative in all specifications indicating that firms with a higher probability of default are expected to have a lower degree of creditor concentration. This is in line with the model of Bris and Welch (2005) in which creditor concentration increases the bargaining power of creditors and as a result only high quality firms want more concentrated credit. On the other hand our finding 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 is higher for the *HHI* than the one obtained with the *CCI*, i.e. a decrease of 2.11 percentage points and 1.34 percentage points respectively. This implies that for larger shares in financing, a change in Probability of Default matters more, since *HHI* attaches greater weights to larger shares.

---

[12] We cannot calculate the third alternative measure for asymmetry here, i.e. the Share of Inequality Index *(SII)* that is the residual term obtained by regressing the *HHI* on $1/N_{jt}$. The reason is that the *HHI* is calculated under the assumption of an infinite number of banks in the main part.

As expected the size of the firm has a negative impact on concentration. Thus, larger firms tend to diversify their creditors. The coefficient is not statistically significant in the specifications with the *CCI* though. Both Illiquid Assets and Intangible Assets are proxies for the redeployability of assets. Illiquid Assets is inversely related to the *HHI* measure, a result also found by Guiso and Minetti (2004). However, it is statistically significant in only one specification in Panel A and at a ten percent level. Intangible Assets included in the third specification in Panel A is positively but not significantly related to the dependent variable. Therefore, we exclude this variable in the rest of the analysis and continue with only two main specifications.

Financial Debt is computed as the total financial debt to total assets, and it is inversely related to the degree of concentration. This is plausible since the higher the bank indebtedness of a firm, the lower might be the degree of concentration also depending on the need for an increased number of creditors. Moreover, Financial Debt is often used as a proxy for risk as well. In this respect the result does not contradict with the finding for Probability of Default. Profitability of the firm (ROA) has a positive impact on creditor concentration. This finding is in line with the predictions of the model by Detragiache et al. (2000) where profitable firms do not need to establish multiple relationships since they can easily borrow from transactional lenders in case their single relationship lender has liquidity problems. For the dummy variable indicating the legal form of the firm whether it is a corporation or a partnership, we do not find any evidence that corporations differ systematically from partnerships in concentration of borrowing.

In Panel B, we include the characteristics of the creditor with the largest share in financing. The coefficients of the firm-specific variables do not differ from the ones in Panel A. The profitability of the relationship lender (measured as the bank with the largest financing share) is positively and significantly related to the dependent variable. This

finding again is in line with the predictions of Detragiache et al. (2000) related to 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 degree of concentration by 2.62 percentage points, since the firms might not need to look for other creditors in this case. Liquid Assets has a negative coefficient contrary to the expectations, but it is statistically insignificant however. Risk Provisions is positively significant in one specification that can be interpreted as a bank's tendency to concentrate on one safe borrower that in turn might increase the degree for the borrower as well. The negative coefficient for Capital Adequacy possibly captures the credit availability to total assets instead of the quality of the bank. Thus, the firm borrows from other creditors, which decreases the degree of concentration. The size of the relationship bank is positively related to the degree of concentration but not statistically significant.

In Panel C, we test the impact of firm and bank characteristics for the sample of all banks and we only find evidence for ROA with a positive coefficient. Other bank characteristics do not seem to matter for the degree of concentration. On the other hand, the coefficient on the profitability of the firm (ROA) is no longer significant when we include bank variables for the sample of all banks.

To summarize, risky, illiquid, large, leveraged, and unprofitable firms engaged with an unprofitable but highly capitalized relationship bank borrow in more equal shares from multiple lenders. We find these results overall in line with predictions in Detragiache et al. (2000) and Bris and Welch (2005).

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:

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

where $Bank\ Exposure_{ijt}$ denotes bank lending of all banks in the sample except of the bank with the largest exposure (these banks are called, therefore, further in the text "the other lenders") and $Largest\ Exposure_{jt}$ captures the exposure of the largest lender towards a firm *j* at time *t*. In comparison to the specification (7) this specification reflects how the lending behavior of other lenders is 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, and by firm characteristics. We take the absolute values of exposures since the total exposures to a firm measured as financing shares in percentages sum up to one.

Table 7 reports the estimation results for the impact of the Largest Exposure on the Other Exposures. The specification (8) is also estimated with fixed effects estimation techniques. The panel variable in these estimations is presented by a combined firm-bank-level dimension. 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 6.5 percent. Hence the other lenders seem to follow the decisions of the lender with the largest exposure. Capital Adequacy for other lenders has a negative coefficient, similar to the estimated coefficients in the previous models, possibly implying that the other lenders tie up funds in capital decreasing their willingness to extend credit.

Among the characteristics of relationship lender, only the coefficient on size (measured by Log of Assets) is statistically significant and negative. As hypothesized in the previous section, the ability of the relationship lender to extract rents may increase in its size, decreasing the willingness of the other lenders to extend credit.

In the second specification we include interaction terms of the Largest Exposure with the bank characteristics. To assess the significance of the relevant variables we test the significance of the sum of the variable coefficient itself and the coefficient of the interaction term. The estimated coefficients on the variables Largest Exposure and Capital Adequacy for other lenders are no longer significant. Instead, the interaction term of the Largest Exposure with Capital Adequacy is negatively significant at ten percent level. The impact of the "availability of funds" is also captured by the interaction term with the size variable of other lenders with a positive coefficient throughout the rest of the specifications. In other words, smaller banks tend to follow the credit decision of the relationship lender as long as their size allows them to extend more credit. The size of the relationship lender itself also continues to be significant with a negative partial effect of 0.07 standard deviations from the mean.

The third and fourth specifications include firm characteristics in the model. The negative coefficient of the interaction term of the largest exposure with the profitability of the relationship lender in specification 3 may also capture hold-up (as did the size of the relationship lender in the first specification). The interaction term of the Largest Exposure with the size variable of other lenders is positive and significant in the specifications 3 and 4. The interaction term of the Largest Exposure with Capital Adequacy is negative and significant in the specification 4. These findings largely support the findings in the specification 1. In specification 4, the interaction terms with the profitability of the

relationship lender and with the capital adequacy for smaller lenders remain negative, but the partial effects become positive.

The size of the firm (Log of Assets) is positively related to the size of the Other Exposures as expected. Probability of Default is positively related to the dependent variable, in other words as predicted by Bris and Welch (2005), low quality firms do not prefer to concentrate their borrowing, which would decrease their bargaining power in case of default. Also financial leverage is positively related to the size of the Other Exposures, in line with the previous estimations. The dummy variable for the legal form of the firm has a negative coefficient but significant at ten percent level, implying that if the firm is a corporation (rather than a partnership) other lenders will tend to lower their financing shares.

Summarizing, other banks seem more reluctant to extend credit the larger the exposure of a relationship lender that is large and profitable; in particular if the other banks are small or well capitalized. Distressed, large or leveraged firms borrow more from the other banks.

V. Robustness

To check the robustness of our results we compute the degree of concentration assuming that the unobserved part of credit is concentrated in one bank with a maximum amount of 1.499 million Euros (see 3.2.1, equation 6). We measure the degree of concentration by the Herfindahl-Hirschman Index (*HHI*), by the Comprehensive Industrial Concentration Index (*CCI*) and by the Share of Inequality Index *(SII),* alternatively. Remember that the *SII* is computed by regressing the *HHI* on $1/N_{jt}$ and by taking the residual. The *SII* proxies for share of inequality after the removal of the direct impact of the number of shares.

Table 8 presents the same specifications that were reported in Table 6, now with the alternative measurement of the *HHI* and *CCI* and in addition we include the *SII*. The bottom-line: working under the second assumption for the unobserved loans in the credit register does not affect our estimation results. The signs and statistical significance for Probability of Default, Log Assets, Illiquid Assets and Financial Debt remain virtually unchanged. We note, however, that the coefficient on the size of the firm variable is never significant when the dependent variable is the share of inequality (except for one specification in Panel B but then only at the ten percent level). This finding may indicate that both *HHI* and *CCI* are more sensitive to the impact of the number of banks compared to the asymmetry in financing.

The outcomes of Panel B and C including bank-specific variables deviate slightly from Table 6. Liquid Assets has a negative coefficient in Panel B presenting the relationship lender characteristics, whereas it is positively significant in Panel C including all banks. This exactly the opposite outcome of what we would expect. On the other hand, the parameter for Capital Adequacy turns to be positive when explaining the *SII*, which makes sense for Panel C where the average number of banks would lend less if their capital is higher.

A. Two Stage Estimation

In this subsection, we follow the methodology by Detragiache et al. (2000) and Guiso and Minetti (2004) by applying a two stage empirical specification. The first and third columns in all panels of Table 9 present the estimation results for the first stage probit for the probability of multiple banking, and 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 region. As the identification variable, we choose firm

size, a variable that was insignificant in the concentration estimations using the share inequality of the previous subsection. The variable is positively related to the probability of multiple banking as expected (given previous work and straightforward intuition). 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 8. Illiquid Assets is not statistically significant when explaining the degree of concentration, but in three specifications it is positively and significantly related to the probability of multiple banking as predicted by 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 positive and significant in the second stage, however only at a ten percent level. Risk Provisions has a negative impact on the probability of multiple banking but not on the degree of asymmetry at a five percent level. The size of the bank is positively related to the *SII*. In Panel C, the probability of multiple banking decreases in the share of risk provisions of banks as predicted by Detragiache et al. (2000) that the probability of multiple banking decreases in bank fragility. However there is little evidence for a relationship between Risk Provisions and the *SII*.

To summarize, large and leveraged firms and firms with less liquid assets prefer multiple banking, however size and asset liquidity do not have an impact on the degree of asymmetry. Risky and leveraged firms with a small and unprofitable relationship lender choose to have lower asymmetry in borrowing.

B. Other Robustness Tests

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 a next 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 any further results). The significance of the parameters is unchanged and even stronger for firm-specific variables. Moreover, there is an increase in the magnitudes of those parameters.

One may argue on the direction of causality between some bank-specific variables, such as Liquid Assets and Capital Adequacy, and the degree of asymmetry. When a bank extends credit, this definitely has an impact on its liquidity and capital ratios. Considering the possibility of an endogeneity problem, we re-estimate our regressions by excluding these two variables. The results confirm our previous findings. As an alternative specification we also include lagged bank-specific variables. The results remain unchanged except for bank profitability. The coefficient turns to be negative when including all banks in the sample.

Another concern may be the choice of the econometric model since the HHI and CCI proxying for the degree of asymmetry cannot take on values smaller than zero and greater than one. For that reason, we estimate a Tobit model left and right censored at zero and one respectively, and alternatively only right censored at one. We also re-estimate our regressions by taking out the observations where the dependent variable equals to one. Estimation results seem robust to these extensions. However, two coefficients that proxy for firm asset specificity change here. The coefficient for Illiquid Assets is still negative when explaining the HHI but positive when explaining the CCI. The other parameter, namely Illiquid Assets for which we did not find any evidence for an impact on the dependent variable before, becomes positive and statistically significant in the last

estimations. These findings imply that it is difficult to conclude that there exists a strong relationship between the asset specificity of a firm and its degree of concentration in borrowing.

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 borrowing by firms from different banks. We use three alternative measures of asymmetry and conduct a variety of other robustness exercises.

We find that firm quality is positively related to the degree of asymmetry. Firm size, on the other hand, positively affects the number of creditors but not the asymmetry. We also uncover some evidence for a positive relationship between redeployability of assets and our proxies for asymmetry. The degree of concentration further increases when the relationship lender has higher profits, an increased level of risk provisions and a lower degree of capital adequacy ratio. We also find that other smaller lenders tend to follow the relationship lender's credit decisions as long as their size allows for this or if they are not well capitalized. However they are reluctant to extend credit if the relationship lender is too large and profitable. Another important finding of this study is that relationship lending is also relevant for larger firms and not only for smaller firms, considering the structure of the data used in the analysis.

Overall, our study confirms hypotheses in Detragiache et al (2000) and Bris and Welch (2005) about the positive effect of firm quality on creditor concentration. However our study also indicates that firm size does not determine creditor asymmetry but only the number of creditors. Profitability and capitalization of the relationship lender and size of

the other lenders also play an important role. More theoretical and empirical work on this issue seems warranted.

References

Biais, B., and C. Gollier, 1997, "Trade Credit and Credit Rationing," *Review of Financial Studies*, 10, 903-937.

Bikker, J.A., and K. Haaf, 2002a, "Measures of Competition and Concentration in the Banking Industry: a Review of the Literature," *Economic and Financial Modeling* 9, 53–98.

Bolton, P., and D.S. Scharfstein, 1990, A Theory of Predation Based on Agency Problems in Financial Contracting, *American Economic Review* 80, 93-106.

Bolton, P., and D.S. Scharfstein, 1996, Optimal Debt Structure and the Number of Creditors, *Journal of Political Economy* 104, 1-25.

Bris, A., and I. Welch, 2005, The Optimal Concentration of Creditors, *Journal of Finance* 60 (5), 2193-2212.

Brunner, A. and J. P. Krahnen, 2001, Corporate Debt Restructuring: Evidence on Lending Coordination in Financial Distress, CEPR Discussion Paper No. 3030.

Carletti, E., 2004, The Structure of Bank Relationships, Endogenous Monitoring, and Loan Rates, *Journal of Financial Intermediation* 13, 58-86.

Carletti, E., V. Cerasi, and S. Daltung, 2004, Multiple-Bank Lending: Diversification and Free-Riding in Monitoring, (Center for Financial Studies, Frankfurt).

Detragiache, E., P. G. Garella, and L. Guiso, 2000, Multiple versus Single Banking Relationships: Theory and Evidence, *Journal of Finance* 55, 1133-1161.

Deutsche Bundesbank (1998), Instruction sheet for the reporting of large exposures and loans of 3 million deutsche mark or more pursuant to sections 13 to 14 of the banking act, in: Banking Regulations 7.

Deutsche Bundesbank (2001), Banking Act, in: Banking Regulations 2.

Dewatripont, M., and E. Maskin, 1995, Credit and Efficiency in Centralized and Decentralized Economies, *Review of Economic Studies* 62, 541-555.

Elsas, R., J. P. Krahnen, 1998, Is Relationship Lending Special? Evidence from Credit-File Data in Germany, *Journal of Banking and Finance* 22, 1283-1316.

Elsas, R., F. Heinemann, and M. Tyrell, 2004, Multiple but Asymmetric Bank Financing: The Case of Relationship Lending, (University of Frankfurt, Frankfurt).

Elsas, R., 2005, Empirical Determinants of Relationship Lending, *Journal of Financial Intermediation* 14, S. 32-57.

Guiso, L. and R. Minetti, 2004, Multiple Creditors and Information Rights: Theory and Evidence from US Firms, CEPR Discussion Paper No. 4278.

Hannan, T. H., 1997, Market Share Inequality, the Number of Competitors, and the HHI: An Examination of Bank Pricing, *Review of Industrial Organization* 12, 23-35.

Harhoff, D., and T. Körting, 1998, How Many Creditors Does it Take to Tango?, (Wissenschaftszentrum Berlin, Berlin).

Hart, O. D., 1995. *Firms, Contracts, and Financial Structure* (Oxford University Press, Oxford).

Hart, O. D. and J. Moore, 1989, Default and Renegotiation: A Dynamic Model of Debt, Manuscript. Cambridge: MIT, Dept. Econ.

Horvath, J., 1970, Suggestion for a Comprehensive Measure of Concentration, *Southern Economic Journal* April, 446–452.

Houston, J. and C. James, Bank Information Monopolies and the Mix of Private and Public Debt Claims, 1996, *Journal of Finance*, 51, (5), 1863-1889.

Jean-Baptiste, E. L., 2005, Information Monopoly and Commitment in Intermediary-Firm Relationships, *Journal of Financial Services Research* 27, 5-26.

Machauer, A., and M. Weber, 2000, Number of Bank Relationships: an Indicator of Competition, Borrower Quality, or just Size, (Center for Financial Studies, Frankfurt).

Ongena, S., and D. C. Smith, 2000, What Determines the Number of Bank Relationships? Cross-Country Evidence, *Journal of Financial Intermediation* 9, 26-56.

Petersen, M., and R. Rajan, 1994, The Benefits of Lending Relationships: Evidence from Small Business Data, *Journal of Finance* 49, S. 3-37.

Rajan, R., 1992, Insiders and Outsiders: The Choice between Relationship and Arms Length Debt, *Journal of Finance* 47, 1367-1400.

Schüle, T., 2006, Forbearance Lending and Soft Budget Constraints in a Model of Multiple Heterogeneous Bank Financing, Tübinger Diskussionsbeitrag 303.

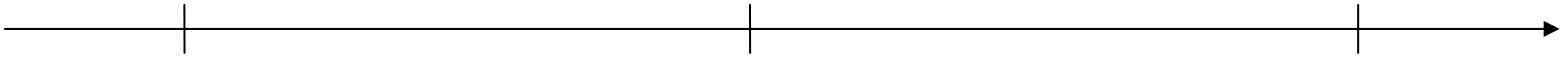
Stordal, S., 2004, Impacts of the European Economic Area Agreement on the Structure and Concentration of Roundwood Sales in Norway, *Forest Policy and Economics* 6, 49-62.

Takeda, F. and K. Takeda, 2006, Refinancing and Coordination among Multiple Creditors and a Debtor Firm, *Global Business and Economics Review*, 7, No. 2/3, 234-246.

Volpin, P. F., 2001, Ownership Structure, Banks, and Private Benefits of Control, (London Business School, London).

von Thadden, E. L., 1992, The Commitment of Finance, Duplicated monitoring and the Investment Horizon, (ESF-CEPR, London).

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



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

Table 1: Implications of Models

	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 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 of decreasing 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 possible, no need for multiple relationship banking.	- Banking fragility, efficient loan enforcement and profitability of the investment project affect the choice.	- **Multiple banking** more likely with **less efficient loan enforcement**, when **banks are less fragile** and when **investment projects** of the firm are **not profitable**. - In the multiple region, 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: Relationships with and without the Part of Loans below the Threshold

This table summarizes the structure of credit relations for German firms for the time period between 1993 and 2003. The number of observations is 6,891 firm-years and the sample constitutes an unbalanced panel. 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 the 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	0.77				0.77	≠	1.00
2	0.21	0.63	0.21			0.84	≠	1.00
3	0.10	0.56	0.21	0.08		0.85	≠	1.00
Greater than 3	0.14	0.40	0.20	0.12	0.03	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	*0.15*	*1*
2	*0.41*	*0.73*
3	*0.18*	*0.58*
Greater than 3	*0.25*	*0.42*

Table 3: Summary Statistics for the Number of Relationships and the Degree of Concentration with the Observable Number and with Two Opposing Assumptions

The table presents summary statistics for the number and the degree of concentration for German firms for 6,891 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 unobserved part of loans to be diversified among 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. Share of Inequality Index *(SII)* is computed for Panel C by regressing the *HHI* on *1/Njt* and by taking the residual.

Variable	*No. Obs.*	*Mean*	*25th Quantile*	*Median*	*75th Quantile*	*Max*
PANEL A: Number of creditors observable in the Credit Register						
N	6,846	2.29	1	1	2	109
Panel B: Unobserved part of loans is assumed to be diversified among an infinite number of banks						
HHI	6,846	0.55	0.28	0.51	0.91	1
CCI	6,846	0.72	0.56	0.77	0.95	1
PANEL C: Unobserved part of loans is assumed to be concentrated						
*N**	*6,846*	*4.90*	*2*	*2*	*4*	*792*
HHI	*6,846*	*0.63*	*0.42*	*0.58*	*0.92*	*1*
CCI	*6,846*	*0.83*	*0.75*	*0.86*	*0.97*	*1*
SII	*6,846*	*0.01*	*(0.14)*	*(0.05)*	*0.11*	*0.71*

Table 4: Definition of Variables

Proxy for Variables	*Variable Name*	*Description*	*Source*
	Firm-specific variables		
Financial Leverage	**Financial Debt Firm**	Total Financial Debt to Total Assets	*Jalys* / *Ustan*
Profitability	**ROA Firm**	Return on Assets	*Jalys* / *Ustan*
Quality	**Probability of Default Firm**		Credit Register
Size	**Log Assets Firm**	Log of Total Assets	*Jalys* / *Ustan*
Asset Specificity	**Illiquid Assets Firm**	(Fixed Assets + Intangible Assets) / Total Assets	*Jalys* / *Ustan*
	Intangible Assets Firm	Intangible Assets / Total Assets	
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	*BAKIS*
Fragility	**Risk Provisions Bank (1)**	Risk Provisions / Credit Exposure	*BAKIS*
	Risk Provisions Bank (2)	Risk Provisions / Capital	*BAKIS*
	Liquid Assets Bank	Liquid Assets / Total Assets	*BiSta*
	Capital Adequacy Bank		*BAKIS*
Size	**Log Assets Bank**	Log of Total Assets	BAKIS

Table 5: Descriptive Statistics

The table presents descriptive statistics for both firm-specific and bank-specific variables. The number of observations is 6,846 firm-years and the sample constitutes an unbalanced panel. 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	0.20	0.38	0.55	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	56.94	3.81	7.79	21.02	0.07	9,429.66
Illiquid Assets Firm	Share	0.26	0.06	0.20	0.40	0.00	1.00
Intangible Assets Firm	Share	0.01	0.00	0.00	0.00	0.00	0.83
Legal Form Firm	dummy	0.92	1	1	1	0	1
Bank-specific variables							
Total Assets Bank	Mln Euros	14,443	529	1,320	5,302	5.21	742,401
ROA Bank	Share	0.01	0.00	0.00	0.01	(0.07)	0.14
Risk Provisions Bank (1)	Share	0.02	0.01	0.02	0.03	-	0.50
Risk Provisions Bank (2)	Share	0.33	0.17	0.29	0.43	(7.97)	7.91
Liquid Assets Bank	Share	0.43	0.34	0.40	0.49	0.00	1.00
Capital Adequacy Bank	Share	0.11	0.09	0.10	0.12	(0.01)	1.03

Table 6: Estimation Results for the Degree of Concentration

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 infinite number of banks. Panel A includes only firm-specific variables. Panel B includes the characteristics of the largest lender (largest financing share) in addition to firm characteristics. Panel C reports the results for all banks. In Panel A and Panel B our panel variable is determined by the firm-level dimension. In Panel C our panel variable is determined by a combined firm-bank-level (exposure-level) dimension. We include 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***			***PANEL C***							
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Dependent Variable	**(*HHI*)**	**(*HHI*)**	**(*HHI*)**	**(*CCI*)**	**(*CCI*)**	**(*CCI*)**	**(*HHI*)**	**(*HHI*)**	**(*CCI*)**	**(*CCI*)**	**(*HHI*)**	**(*HHI*)**	**(*CCI*)**	**(*CCI*)**
Constant	0.692[a]	0.766[a]	0.753[a]	0.747[a]	0.778[a]	0.773[a]	0.757[a]	0.812[a]	0.816[a]	0.832[a]	0.800[a]	0.892[a]	0.847[a]	0.939[a]
	(0.052)	(0.054)	(0.052)	(0.043)	(0.046)	(0.044)	(0.075)	(0.075)	(0.063)	(0.063)	(0.263)	(0.236)	(0.217)	(0.213)
Firm-specific variables														
Probability of Default Firm	-2.113[a]			-1.338[a]			-2.156[a]		-1.417[a]		-2.583[a]		-1.861[b]	
	(0.592)			(0.500)			(0.626)		(0.546)		(0.649)		(0.777)	
Log Assets Firm	-0.043[b]	-0.035[b]	-0.035[b]	-0.005	-0.002	-0.003	-0.048[b]	-0.039[b]	-0.007	-0.004	-0.060[a]	-0.061[a]	-0.036[b]	-0.046[b]
	(0.018)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)	(0.019)	(0.018)	(0.016)	(0.016)	(0.018)	(0.018)	(0.018)	(0.019)
Illiquid Assets Firm	-0.097[c]	-0.055		-0.038	-0.021		-0.119[b]	-0.0841	-0.055	-0.042	-0.123[b]	-0.091[c]	-0.075	-0.063
	(0.055)	(0.054)		(0.047)	(0.046)		(0.057)	(0.057)	(0.049)	(0.050)	(0.053)	(0.053)	(0.049)	(0.052)
Intangible Assets Firm			0.238			0.196								
			(0.226)			(0.190)								
Financial Debt Firm		-0.261[a]	-0.264[a]		-0.120[a]	-0.121[a]		-0.249[a]		-0.108[a]		-0.327[a]		-0.214[a]
		(0.042)	(0.042)		(0.037)	(0.037)		(0.044)		(0.039)		(0.042)		(0.042)
ROA Firm		0.068[c]	0.070[c]		0.059[c]	0.060[c]		0.067[c]		0.059[c]		-0.002		-0.006
		(0.040)	(0.040)		(0.034)	(0.034)		(0.041)		(0.035)		(0.030)		(0.029)
Legal Form Firm	0.002	-0.012	-0.013	0.006	0.001	0.001	-0.001	-0.001	-0.001	-0.002	0.013	0.016	0.015	0.029
	(0.031)	(0.030)	(0.030)	(0.025)	(0.025)	(0.025)	(0.031)	(0.031)	(0.025)	(0.024)	(0.029)	(0.031)	(0.023)	(0.028)

Table 6 continued:

	PANEL A						***PANEL B***				***PANEL C***			
Dependent Variable	**1 (*HHI*)**	**2 (*HHI*)**	**3 (*HHI*)**	**1 (*CCI*)**	**2 (*CCI*)**	**3 (*CCI*)**	**1 (*HHI*)**	**2 (*HHI*)**	**1 (*CCI*)**	**2 (*CCI*)**	**1 (*HHI*)**	**2 (*HHI*)**	**1 (*CCI*)**	**2 (*CCI*)**
Bank-specific variables							***Characteristics of the bank with the largest share***				***All banks***			
ROA Bank							2.622[b]	2.560[a]	2.115[b]	2.040[b]	0.935[b]	0.639	0.465	0.319
							(1.046)	(0.988)	(0.970)	(0.918)	(0.474)	(0.437)	(0.448)	(0.417)
Risk Provisions Bank							0.585	0.687[c]	0.354	0.476	0.222	0.173	0.237	0.188
							(0.410)	(0.404)	(0.367)	(0.362)	(0.405)	(0.366)	(0.365)	(0.336)
Log Assets Bank							0.003	0.004	0.001	0.002	-0.015	-0.013	-0.008	-0.008
							(0.004)	(0.004)	(0.004)	(0.004)	(0.027)	(0.024)	(0.022)	(0.021)
Liquid Assets Bank							-0.070	-0.063	-0.042	-0.042	0.032	-0.008	0.012	-0.019
							(0.056)	(0.055)	(0.051)	(0.050)	(0.066)	(0.060)	(0.059)	(0.054)
Capital Adequacy Bank							-0.791[a]	-0.868[a]	-0.649[a]	-0.705[a]	-0.120	-0.120	-0.097	-0.053
							(0.285)	(0.279)	(0.245)	(0.241)	(0.174)	(0.161)	(0.159)	(0.149)
Observations	5,968	6,180	6,180	5,968	6,180	6,180	5,659	5,862	5,659	5,862	11,408	12,201	11,408	12,201
Hausman test: prob > chi-squared	0.09	0.24	0.30	0.03	0.08	0.08	0.10	0.15	0.05	0.08	0.11	0.02	0.02	0.00
R-squared	0.01	0.03	0.03	0.01	0.01	0.01	0.02	0.03	0.01	0.02	0.02	0.05	0.02	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. Our panel variable is presented by a combined firm-bank-level dimension. We include 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)	(4)
	(Log) Other Exposures	(Log) Other Exposures	(Log) Other Exposures	(Log) Other Exposures
Constant	-1.901	0.929	-0.387	-2.632
	(2.222)	(2.545)	(3.229)	(3.000)
(Log) Largest Exposure	0.651[a]	-0.304	-0.036	-0.635
	(0.071)	(0.463)	(0.638)	(0.608)
ROA Bank *(L)*	-3.478	4.868	11.622	15.237[c]
	(5.396)	(8.564)	(8.783)	(8.490)
Risk Provisions Bank *(L)*	-2.696	-3.152	-0.380	2.401
	(3.637)	(5.707)	(7.243)	(6.963)
(Log) Assets Bank *(L)*	-0.053[b]	-0.079[c]	-0.067	-0.053
	(0.027)	(0.042)	(0.049)	(0.046)
Capital Adequacy Bank *(L)*	0.237	1.650	2.722	0.373
	(0.596)	(2.224)	(3.111)	(2.594)
ROA Bank	-7.777	-11.421	-7.891	-8.269
	(4.787)	(7.946)	(9.869)	(8.650)
Risk Provisions Bank	-0.987	-5.263	-4.498	-7.106
	(3.607)	(5.528)	(6.477)	(6.767)
(Log) Assets Bank	0.203	-0.110	-0.174	-0.143
	(0.226)	(0.249)	(0.301)	(0.269)
Capital Adequacy Bank	-2.660[c]	2.070	3.647	4.614[c]
	(1.610)	(2.346)	(3.266)	(2.696)
(Log) Largest Exposure * ROA Bank *(L)*		-5.305	-9.516[c]	-11.769[b]
		(4.476)	(5.459)	(4.736)
(Log) Largest Exposure * Risk Provisions Bank (*L*)		0.332	-0.165	-1.082
		(2.421)	(3.916)	(3.591)
(Log) Largest Exposure * Log Assets Bank *(L)*		0.014	0.006	0.010
		(0.018)	(0.029)	(0.025)
(Log) Largest Exposure * Capital Adequacy Bank *(L)*		-0.359	-0.733	0.254
		(0.475)	(1.013)	(0.844)
(Log) Largest Exposure * ROA Bank		1.710	-1.153	-0.224
		(2.144)	(3.406)	(2.729)
(Log) Largest Exposure * Risk Provisions Bank		1.987	1.124	2.601
		(1.637)	(2.345)	(2.337)
(Log) Largest Exposure * Log Assets Bank		0.095[a]	0.081[b]	0.095[b]
		(0.034)	(0.039)	(0.037)
(Log) Largest Exposure * Capital Adequacy Bank		-1.393[c]	-1.738	-2.036[b]
		(0.806)	(1.209)	(0.801)
Probability of Default Firm			22.918[a]	
			(5.829)	
Log Assets Firm			0.567[a]	0.908[a]
			(0.181)	(0.172)
Illiquid Assets Firm			-0.066	-0.208
			(0.449)	(0.433)
Financial Debt Firm				2.920[a]
				(0.482)
ROA Firm				-0.242
				(0.309)
Legal Form Firm			-0.746[c]	-0.580
			(0.435)	(0.383)
Observations	6,355	6,355	4,286	4,702
R-squared	0.09	0.10	0.12	0.15

Table 8: Robustness Tests / Assuming the Unobserved Part of the Loans Concentrated

The table reports the fixed effects estimation results explaining the degree of concentration measured by the Herfindahl-Hirschman Index (*HHI*), the Comprehensive Industrial Concentration Index (*CCI*) and the Share of Inequality Index *(SII)* under the assumption that the unobserved part of loans are concentrated in one bank with a maximum amount of 1.499 million Euros. Panel A includes only firm-specific variables. Panel B (following page) includes the characteristics of the largest lender (largest financing share) in addition to firm characteristics. Panel C (following page) reports the results for all banks. In Panel A and in Panel B the panel variable is defined by firm-level dimension and in Panel C the panel variable is defined by firm-bank-level dimension. We include 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

Dependent Variable	**1 (*HHI*)**	**2 (*HHI*)**	**3 (*HHI*)**	**1 (*CCI*)**	**2 (*CCI*)**	**3 (*CCI*)**	**1 (*SII*)**	**2 (*SII*)**	**3 (*SII*)**
Constant	0.901[a]	1.032[a]	1.025[a]	1.009[a]	1.102[a]	1.109[a]	0.061[c]	0.101[a]	0.094[a]
	(0.041)	(0.040)	(0.039)	(0.026)	(0.025)	(0.024)	(0.033)	(0.034)	(0.033)
Probability of Default Firm	-2.280[a]			-1.395[a]			-1.187[a]		
	(0.448)			(0.260)			(0.450)		
Log Assets Firm	-0.108[a]	-0.096[a]	-0.096[a]	-0.080[a]	-0.074[a]	-0.074[a]	-0.02	-0.016	-0.016
	(0.014)	(0.013)	(0.013)	(0.009)	(0.008)	(0.008)	(0.012)	(0.012)	(0.012)
Illiquid Assets Firm	-0.090[b]	-0.022		-0.009	0.035		-0.05	-0.028	
	(0.042)	(0.040)		(0.027)	(0.024)		(0.042)	(0.04)	
Intangible Assets Firm			0.274			0.205[c]			-0.027
			(0.174)			(0.110)			(0.113)
Financial Debt Firm		-0.412[a]	-0.413[a]		-0.283[a]	-0.28[a]		-0.119[a]	-0.121[a]
		(0.028)	(0.028)		(0.018)	(0.018)		(0.025)	(0.025)
ROA Firm		0.011	0.012		-0.004	-0.005		-0.009	-0.008
		(0.023)	(0.023)		(0.013)	(0.013)		(0.025)	(0.025)
Legal Form Firm	0.006	-0.019	-0.019	0.008	-0.009	-0.008	-0.004	-0.019	-0.019
	(0.025)	(0.024)	(0.024)	(0.017)	(0.015)	(0.015)	(0.023)	(0.023)	(0.023)
Observations	5,968	6,180	6,180	5,968	6,180	6,180	5,968	6,180	6,180
R-squared	0.05	0.11	0.11	0.06	0.15	0.15	0.02	0.03	0.03

Table 8 : Panel B and C

	PANEL B						*PANEL C*					
Dependent Variable	**1 (*HHI*)**	**2 (*HHI*)**	**1 (*CCI*)**	**2 (*CCI*)**	**1 (*SII*)**	**2 (*SII*)**	**1 (*HHI*)**	**2 (*HHI*)**	**1 (*CCI*)**	**2 (*CCI*)**	**1 (*SII*)**	**2 (*SII*)**
Constant	0.939[a]	1.047[a]	1.052[a]	1.126[a]	0.073	0.105[b]	0.863[a]	0.997[a]	0.952[a]	1.091[a]	0.365[c]	0.448[b]
	(0.058)	(0.055)	(0.035)	(0.034)	(0.047)	(0.047)	(0.227)	(0.197)	(0.158)	(0.152)	(0.200)	(0.187)
Firm-specific variables												
Probability of Default Firm	-2.240[a]		-1.341[a]		-1.110[b]		-3.150[a]		-2.282[a]		-2.157[a]	
	(0.459)		(0.271)		(0.472)		(0.506)		(0.519)		(0.430)	
Log Assets Firm	-0.114[a]	-0.100[a]	-0.083[a]	-0.075[a]	-0.022[c]	-0.017	-0.098[a]	-0.093[a]	-0.082[a]	-0.085[a]	-0.020	-0.020
	(0.015)	(0.014)	(0.009)	(0.008)	(0.013)	(0.012)	(0.016)	(0.015)	(0.013)	(0.014)	(0.013)	(0.013)
Illiquid Assets Firm	-0.105[b]	-0.041	-0.018	0.024	-0.059	-0.039	-0.077	-0.029	-0.000	0.028	-0.041	-0.020
	(0.043)	(0.042)	(0.028)	(0.026)	(0.044)	(0.043)	(0.051)	(0.043)	(0.042)	(0.034)	(0.041)	(0.037)
Financial Debt Firm		-0.406[a]		-0.276[a]		-0.125[a]		-0.436[a]		-0.335[a]		-0.209[a]
		(0.029)		(0.019)		(0.026)		(0.036)		(0.032)		(0.032)
ROA Firm		0.006		-0.008		-0.014		-0.008		-0.011		-0.007
		(0.024)		(0.013)		(0.025)		(0.026)		(0.021)		(0.026)
Legal Form Firm	0.004	-0.016	0.002	-0.011	-0.005	-0.018	0.009	0.007	0.004	0.011	0.009	-0.006
	(0.025)	(0.025)	(0.016)	(0.015)	(0.024)	(0.024)	(0.025)	(0.028)	(0.017)	(0.023)	(0.030)	(0.032)
Bank-specific variables		***Characteristics of the bank with the largest share***							***All banks***			
ROA Bank	1.755[b]	1.834[a]	0.738[c]	0.861[b]	0.241	0.620	0.768[b]	0.467	0.320	0.174	0.410	0.402
	(0.687)	(0.640)	(0.432)	(0.406)	(0.668)	(0.660)	(0.374)	(0.341)	(0.279)	(0.258)	(0.394)	(0.385)
Risk Provisions Bank	0.384	0.439	0.082	0.140	-0.285	-0.165	0.294	0.217	0.282	0.199	0.060	0.085
	(0.292)	(0.276)	(0.189)	(0.177)	(0.293)	(0.288)	(0.302)	(0.271)	(0.217)	(0.188)	(0.291)	(0.280)
Log Assets Bank	0.002	0.003	-0.001	-0.000	0.002	0.003	-0.009	-0.008	-0.001	-0.003	-0.038[c]	-0.037[b]
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.023)	(0.020)	(0.016)	(0.014)	(0.020)	(0.018)
Liquid Assets Bank	-0.066	-0.053	-0.042	-0.036	-0.107[a]	-0.107[a]	0.091[c]	0.043	0.077[b]	0.038	0.080[c]	0.044
	(0.044)	(0.041)	(0.028)	(0.027)	(0.039)	(0.038)	(0.052)	(0.045)	(0.037)	(0.032)	(0.046)	(0.042)
Capital Adequacy Bank	-0.340	-0.402[b]	-0.063	-0.097	0.317[c]	0.265	0.029	0.030	0.082	0.127	0.300[b]	0.263[b]
	(0.208)	(0.200)	(0.135)	(0.130)	(0.187)	(0.181)	(0.140)	(0.128)	(0.105)	(0.100)	(0.135)	(0.127)
Observations	5,659	5,862	5,659	5,862	5,659	5,862	11,408	12,201	11,408	12,201	11,408	12,201
R-squared	0.06	0.12	0.07	0.15	0.03	0.03	0.05	0.12	0.06	0.16	0.03	0.04

Table 9: Two Stage Estimation

The table reports the two stage estimation results; first and third columns of each panel the first stage probit results for the probability of multiple banking, second and fourth columns of the panels 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. Panel A includes only firm-specific variables. Panel B includes the characteristics of the largest lender (largest financing share) in addition to firm characteristics. Panel C reports the results for all banks. We include 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***				***PANEL C***			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Dependent Variable	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***
Constant	0.483[a]	0.010	-0.094	0.171[a]	0.807[a]	0.021	0.304	0.147[a]	0.771[a]	0.017	0.057	0.158
	(0.128)	(0.036)	(0.140)	(0.039)	(0.235)	(0.044)	(0.246)	(0.045)	(0.206)	(0.172)	(0.219)	(0.156)
Firm-specific variables												
Probability of Default Firm	-2.488	-1.696[a]			1.143	-1.255[b]			3.556	-2.133[a]		
	(3.250)	(0.516)			(2.924)	(0.514)			(3.015)	(0.417)		
Log Assets Firm	0.212[a]		0.254[a]		0.217[a]		0.251[a]		0.282[a]		0.328[a]	
	(0.025)		(0.023)		(0.026)		(0.024)		(0.028)		(0.023)	
Illiquid Assets Firm	0.274[c]	-0.012	0.063	-0.016	0.332[b]	-0.013	0.103	-0.024	0.313[b]	0.008	0.028	0.009
	(0.148)	(0.044)	(0.145)	(0.042)	(0.147)	(0.047)	(0.146)	(0.044)	(0.145)	(0.043)	(0.141)	(0.037)
Financial Debt Firm			1.075[a]	-0.196[a]			1.041[a]	-0.184[a]			1.386[a]	-0.263[a]
			(0.149)	(0.034)			(0.154)	(0.034)			(0.161)	(0.040)
ROA Firm			0.189	-0.017			0.051	-0.016			0.009	-0.026
			(0.209)	(0.038)			(0.149)	(0.039)			(0.155)	(0.029)
Legal Form Firm	-0.136	-0.038[c]	-0.008	-0.039[b]	-0.117	-0.039[c]	0.006	-0.037[c]	-0.109	-0.030[c]	0.050	-0.036[b]
	(0.107)	(0.020)	(0.107)	(0.019)	(0.104)	(0.021)	(0.104)	(0.020)	(0.101)	(0.018)	(0.110)	(0.018)

Table 9 continued:

	PANEL A				*PANEL B*				*PANEL C*			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Dependent Variable	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***	**Prob**	***SII***
Bank-specific variables					***Characteristics of the bank with the largest share***				***All banks***			
ROA Bank					8.147	1.220[c]	6.900	0.856	6.045	0.526	4.314	0.236
					(5.244)	(0.739)	(5.447)	(0.704)	(4.324)	(0.373)	(4.398)	(0.359)
Risk Provisions Bank					-5.211[b]	-0.604[c]	-5.946[a]	-0.107	-3.932[b]	0.130	-4.324[a]	0.225
					(2.063)	(0.337)	(2.088)	(0.321)	(1.559)	(0.268)	(1.635)	(0.243)
Log Assets Bank					-0.012	0.005[c]	-0.007	0.006[b]	-0.015	-0.005	-0.007	-0.003
					(0.015)	(0.003)	(0.015)	(0.003)	(0.012)	(0.017)	(0.012)	(0.016)
Liquid Assets Bank					-0.165	-0.125[a]	-0.171	-0.110[a]	-0.180	0.062	-0.152	0.031
					(0.270)	(0.038)	(0.267)	(0.037)	(0.209)	(0.044)	(0.207)	(0.040)
Capital Adequacy Bank					-1.342	-0.026	-1.598	0.010	-0.351	0.084	-0.585	0.071
					(1.569)	(0.194)	(1.522)	(0.182)	(0.836)	(0.123)	(0.818)	(0.114)
Mills Ratio		0.178[b]		-0.077		0.202[b]		-0.046		0.137		-0.094
		(0.088)		(0.063)		(0.085)		(0.061)		(0.085)		(0.063)
Observations	5,968	5,053	6,180	5,224	5,659	4,790	5,862	4,955	11,408	10,408	12,201	11,150
R-squared		0.01		0.03		0.02		0.03		0.02		0.05

Appendix

A Treatment of Bank Mergers

During the sample period around hundred bank mergers take place. There are different approaches to handle mergers. First, one could exclude the banks that were involved in mergers. However this procedure will lead to a considerable loss of information. The second approach deals with the merged bank as one institution during the whole time period. This assumes aggregation of banks to one institution before the merger takes place. It is also unlikely that the second approach helps to avoid data breaks since the aggregated data before the merger and the data of the merged bank mostly do not suit well. For these reasons, we choose another approach where we separate the pre-merger banks from the merged bank. In the end, we have three banks, which are treated independently from each other. We repeat this procedure as often as a merger takes place. Each time, a new merged bank receives a new identification number, and we drop target banks in that year (or quarter). As a consequence, the number of banks in the sample increases, since we create a new additional bank with its own identification number in the case of each merger. This procedure has obvious drawbacks if one uses dynamic panel estimation techniques.

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

We have matched the information on the firm exposures from the credit register with the information on the firm balance sheets from the *Jalys/Ustan* database. To match we use two different components of the credit register, i.e. the information on the exposures at the

level of firms and the exposures at the level of borrower units.[1] It is necessary to include the latter information as well because some large firms are only included at the level of borrower units in the database.

In order to carry out the match we use firm-specific information in the credit register and in the *Jalys/Ustan.* Information such as firm identity, location, industry and legal form allows us to identify the correct matches. Both databases cover the entire available time period.[2] At the level of firms we can identify 3,433 matches, at the level of borrower units 1,086 matches and in total 4,429 matches.

Using the correct matches, we merge the data from the credit register with the data from the *Jalys/Ustan.* The data in the credit register is available on a quarterly basis, and the data from the *Jalys/Ustan* is 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 which 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. First, since we have both firms and borrower units in the dataset we exclude those firms, which belong to the borrower units in the current dataset to avoid double counting. We prefer to leave the borrower units in the dataset because the borrower units often play a role of a guarantor for their firms in receiving credits. Second, we exclude all GBRs and their partners from the dataset in order to avoid the double counting of the exposures.[3] Third, we compute a coverage ratio

---

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

[2] The data in the credit register is available since 1993 and the data in the Jalys/Ustan is available since 1989.

[3] The information on GBRs and their partners is only available for 2004/Q4 and not for the entire time period.

between the two databases and exclude observations with a coverage ratio above 120 percent.[4] The coverage ratio is calculated as follows:

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

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

Table A1: The coverage ratio

variable	p10	p25	p50	p75	p90
Coverage ratio	48.90	76.52	98.73	111.83	215.48

Table A2: The number of firms in the dataset with data adjustments

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	**Total**
The dataset after the match												
Firms	1,228	1,119	1,192	1,163	1,122	912	835	834	770	614	259	**2,268**
Borrower units	91	88	105	116	124	122	75	140	151	147	84	**295**
First step (correction for borrower units)												
Firms	1,208	1,099	1,167	1,142	1,099	889	807	804	737	584	247	**2,225**
Borrower units	91	88	105	116	124	122	75	140	151	147	84	**295**
Second step (correction for GBRs and their partners)												
Firms	1,033	933	994	952	914	727	647	636	589	459	191	**1,900**
Borrower units	91	88	105	116	124	122	75	140	151	147	84	**295**
Third step (correction for coverage ratio above 120 per cent)												
Firms	767	694	723	768	740	567	512	500	474	365	145	**1,697**
Borrower units	45	36	46	54	65	63	42	84	83	72	46	**191**

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 the firms diminishes over time. This is explained with the regulatory changes related to the Euro. Before the introduction of

[4] The aim is to exclude the observations with a coverage ratio above 100 percent to clean the data failures. However we choose a tolerance level of 120 percent and correct the data for the degree of asymmetry measure.

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.