The Real Effects of Financial Networks *

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Abstract

Does the direct and indirect access to private interbank liquidity enable banks to extend credit provision to non-financial firms during crises? Does this liquidity insurance also have real effects, e.g. foster longer-term R&D investments? We use a unique data set that combines bank-to-bank credit information with bank-to-firm data on credit exposures and detailed balance sheet information at the firm and bank level for the universe of German banks. Controlling for observed and unobserved firm and bank heterogeneity we show in a difference-in-differences approach that, after the sovereign debt crisis, banks more central in the interbank network–and in particular those that became more central–form more new credit relations with non-financial firms, cut fewer credit relations, and lend larger volumes, especially to firms with more intangible assets. The effect is economically significant: a 10% increase in a bank's indirect access to private liquidity from the pre- to the post-shock period implies provision of 5% more loans to corporate borrowers. In order to establish causality we focus on changes to a bank's centrality resulting from changes in their neighbors' network.

Keywords: Real effects, financial networks, liquidity insurance

JEL Classification: G21, E5, D85

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1 Introduction

The interbank market is the major source of private liquidity for German banks. It can best be described as a network of bilateral lending relationships between banks. A bank's *direct* access to the interbank market depends on the counterparties the bank can borrow from at any given point in time. That is, it depends on the local neighborhood of the bank. Since these lenders can be borrowers on the interbank market themselves, however, a bank's *indirect* access depends on the global structure of the interbank network. Banks with better indirect access borrow from counterparties who have better direct and indirect access to the interbank market themselves. We formalize the notion of indirect access using a bank's network centrality, which is high if the centrality of the banks it borrows from is high.

In this paper we address the question whether the direct and indirect access of banks to private interbank liquidity enables them to extend credit provision to non-financial firms during a crisis. In particular, we are interested whether the liquidity insurance that banks maintain through a central position in the interbank network also has real effects. Do firms obtain more liquidity from banks that have better access to private interbank liquidity? Is the propensity that an existing bank-firm relationship is terminated or a non-existing one created affected by the bank's access to private interbank liquidity? Does a bank's improved access to interbank liquidity foster its corporate borrowers' longer-term R&D investments or their ability to smooth workforce adjustments during crises?

We use a unique data set that combines four sources of data available at Deutsche Bundesbank. First, we obtain bank-to-firm and bank-to-bank credit information from the German large credit registry which records the value of every bank-firm loan at the end of a quarter if the value of the loan is larger than EUR 1.5 million at any point during the quarter. We, second, match this information with detailed firm balance sheet information from Bureau van Dijk. We further augment the data with detailed bank balance sheet information from Bundesbank's monthly balance sheet statistics and banks' security holdings from Bundesbank's quarterly securities holdings statistics. We obtain all these data for the universe of all German banks.

Controlling for observed and unobserved firm and bank heterogeneity, we show in a differences-in-differences approach that after the sovereign debt crisis banks more central to the interbank

lending network, and in particular those that became more central, form more new credit relations with non-financial firms, cut fewer credit relations, and lend larger volumes especially to firms with more intangible assets. In order to establish causality we focus on changes to a banks centrality resulting from changes in their neighbors' network. We use betweenness centrality, which measures the number of shortest paths of liquidity transfer between any two banks in the interbank market, as our main measure of a bank's indirect access to private interbank liquidity. The advantage of using a global network measure like betweenness centrality is that banks have almost no control over their own centrality since they can only influence their local neighborhood.[1]

We find substantive evidence that a bank's direct and indirect access to private interbank liquidity leads to improved liquidity provision to the real economy and hence has measurable real effects. First, we find that an increase in a bank's centrality in the interbank network during the sovereign debt crisis significantly increases the probability that a given firm obtains a loan from the bank for the first time. To ensure that this result is not driven by confounding factors, we include a number of pre-determined bank-specific control variables, including: (i) the bank's equity ratio; (ii) the ratio of provision income to total income as a proxy for how actively a bank is involved in financial markets; (iii) the ratio of business loans to total assets as a measure for how focused a bank is on traditional lending; (iv) the bank's access and actual recourse to central bank liquidity, which might serve as a substitute to interbank liquidity; (v) and the bank's dependency on short-term funding. We furthermore add the change of these control variables from the Pre-Shock to the Post-Shock period to account for the possibility that differences in the cross-sectional impact of the sovereign debt crisis on these bank characteristics might lead to a correlation of a bank's changed network centrality with its lending behavior.

We also study whether banks' access to interbank liquidity is a determinant of their propensity to cut existing lending relationships with corporate borrowers. We find that banks that became less central to the interbank market during the crisis have a significantly higher propensity to cut existing credit relationships in the post-crisis period. Interestingly, we also find that the pre-crisis centrality of a bank has a significant negative effect on its propensity to keep existing credit relations during the crisis. Established interbank credit relationships in the Pre-Shock period matter for the direct and indirect access to interbank funding during the crisis and therefore affect a bank's ability to maintain established lending relationships with non-bank borrowers during the crisis.

[1] See Gabrieli and Georg (2013) for a discussion of the conditions under which banks can control their own centrality.

Finally, we study the effect of banks' direct and indirect access to private interbank liquidity on the amount that they are willing to lend to their corporate borrowers. In order to estimate the intensive margin of bank-firm lending relationships we restrict the sample to firms that obtain a loan before and after the crisis from at least two banks. The effect is economically significant: a 10% increase in a bank's indirect access to private liquidity from the pre- to the post-shock period implies provision of 5% more loans to corporate borrowers. Similarly, a 10% relatively better position in interbank network before the shock implies a 13% increased provision of liquidity to coporate borrowers after the shock. The results for the intensive margin are consistent with our observations for the extensive margin.

In sum, our results on the intensive and extensive margin provide strong evidence that a bank's direct and indirect access to private interbank liquidity is an important determinant of its ability to provide credit to corporate borrowers and to maintain existing credit relationships. Put differently, banks that obtain better liquidity insurance through their centrality in the interbank market can also provide better liquidity insurance to their corporate customers.

Does smoother credit provision to non-banks by banks with better direct and indirect access to interbank funding also entail real economic effects? Access to interbank funding provides banks with better liquidity insurance and enables them to provide more liquidity to their lending business, i.e. provide better liquidity insurance to their corporate customers. This should particularly benefit firms that invest in illiquid assets, such as R&D. Thus, in a first step we analyze whether especially firms with a high share of intangible assets benefit from the credit provision by banks with better indirect access to private liquidity. In a second step, we take a broader perspective on real effects and study whether banks with better direct and indirect access to interbank liquidity provide funding particularly to those firms that increase, in relative terms, their workforce in the aftermath of the sovereign debt crisis. Here the idea is that also the liquidity insurance provided by more central banks to corporate borrowers allows firms to smooth temporary shocks and maintain a more stable workforce in crisis times.

We find that banks which gained better access to interbank liquidity during the crisis (became more central to the interbank network) were more likely to extent a new loan to a firm with a higher share of intangibles. Thus, banks direct and indirect access to interbank liquidity seems to foster its willingness to lend to R&D intensive firms during the crisis, i.e. firms with fewer tangible assets.

Finally, we focus on more explicit real effects of banks' access to interbank liquidity: We analyze whether better liquidity insurance of banks through the interbank market permits them to continue funding particularly firms that maintain a comparatively stable workforce during the crisis. In order to do so, we split the sample into firms that had an increase in employees above the median firm during the crisis and those whose workforce grew by less than the workforce of the median firm. Banks that benefit from an improved access to interbank liquidity during the crisis are significantly more inclined to form a credit relation with a new borrower if this borrower's workforce grew above average. By contrast, for firms that had a below average development of their workforce we do not find that banks with an improved interbank market access show a different lending behavior than other banks. Similarly, we find for banks with strong direct and indirect access to interbank liquidity in the pre-crisis period, a significantly higher propensity to provide a credit to borrowers whose number of employees increases above average, while this effect is not significant for firms with a relatively low increase of their workforce. The results are similar for banks' decisions to terminate existing lending relations.

In sum, our results indicate that banks who benefit from improved direct and indirect access to interbank funding provide funding in particular to R&D intensive firms and firms that maintain a relatively large workforce during the sovereign debt crisis. Thus, banks who benefit from better liquidity insurance through the interbank market also provide better liquidity insurance to their corporate borrowers and thereby enable them to overcome temporary funding shocks.

The crucial contribution of our paper is to show that a bank's direct and indirect access to private interbank liquidity has real effects for the non-financial firms the bank lends to. This provides a novel perspective to the literature on interbank markets as mechanisms to manage liquidity risk (see, among others, Rochet and Tirole (1996), Iyer et al. (2014), and Fecht et al. (2012)). Having a more central position in the interbank network should reduce individual banks' susceptibility to roll-over risks and market dry-ups and at the same time also mitigate risks of financial contagion (e.g. Farhi and Tirole (2010)). Since the interbank market is an OTC market, direct and *indirect* access to interbank lending matters for the efficient allocation of liquidity (see, for example, di Maggio et al. (2015), Li and Schuerhoff (2014), Gabrieli and Georg (2013)). Our contribution to the existing literature on interbank networks, which has mostly studied contagion (e.g. Allen and Gale (2000), Freixas et al. (2000), Elliott et al. (2014), Acemoglu et al. (2015)), is to show that a bank's position in the interbank network does not only matter for the bank's access to liquidity, but has consequences

for firms borrowing from this bank.

Our paper also contributes to the literature on the bank-lending channel. In contrast to the seminal work by Kashyap and Stein (2000), who focus on market liquidity and banks' security holdings, our focus is on funding liquidity. This focus is similar to Khwaja and Mian (2008) who, however, focus on aggregate (international) interbank exposure rather than banks' network position. Our unique focus on banks' direct and indirect access to interbank funding liquidity sets our work also apart from other papers studying the bank-lending channel (see, among others, Jimenez et al. (n.d.), Jimenez et al. (213), Crosignani and Carpinelli (2016)).

2 Data and Variables

We use data from four main sources. First, we use detailed monthly bank balance sheet information from the balance sheet statistics (BISTA) banks are required to report to Bundesbank. Variables are reported by all German banks on a monthly basis. Second, we use bilateral lending information we obtain from the German large credit registry (Millionenkredit-Evidenzzentrale, MiMiK), which records all outstanding loans from bank i to firm j at the end of each quarter, provided the loan volume exceeded EUR 1.5 million at any point during the quarter. Information reported includes a unique bank identifier as well as the type of the bank, which is either a commercial bank, a cooperative bank (Genossenschaftsbank), savings bank (Sparkasse), cooperative central bank (Genossenschaftszentralbank), or savings central bank (Landesbank). The data also includes a unique identifier for each borrower, as well as the name of the borrower and a three digit identifier for the borrower's industry sector. From this dataset we obtain bilateral lending information from banks to firms, as well as bank to bank information used to reconstruct the interbank network structure. Third, we use detailed annual firm information from Bureau van Dijk's DAFNE dataset, matched via the borrower's clear name.[2] Among the positions included are the firm's size, profitability, level of debt and the number of employees. And fourth, we use quarterly information of each bank's security holdings on a security level. These include a unique identifier for each security that we matched with a list of securities eligible as central bank collateral in a given quarter.

[2]Since the firm's clear name in the regulatory reporting does not necessarily match the name in Bureau van Dijk's DAFNE dataset, an extensive name-matching procedure was necessary. We thank colleagues from Bundesbank's Research Data Service Center for providing us with their extensively tested and validated name match.

We use data from Q1/2009 until Q3/2011, which we split into three periods. The Pre-Shock period starts Q1/2009 and ends Q4/2009. The Shock period starts Q1/2010 and ends Q2/2010, while the Post-Shock period starts Q3/2010 and ends Q3/2011. The Shock period was a time of high stress resulting from the euro area sovereign debt crisis, which reached its peak before the agreement among the euro area finance ministers on May 8 2010 to bail out the Greek government which was on the verge of a sovereign default. The threat of this default and the ensuing fear of contagion to other euro area countries provides an exogenous shock to German banks who are differentially affected, depending on their exposure to Greek sovereign debt, Greek banks, and the Greek economy as a whole.

In case the data is available on a monthly basis (as is the case for BISTA) the observation of the first month of the quarter is chosen. In case the data is available only on a yearly basis (as is the case for DAFNE), we impute observations until the next entry, i.e. we use the last available firm balance sheet information and carry it forward.

Based on these datasets we obtain a total of six samples, three samples where we consider all banks, and three sample where we restrict ourselves to commercial banks only. The three samples we obtain each are: One for the intensive margin and two for the extensive margin of the bank-firm credit provision each, where the extensive margin ENTRY sample includes all observations with at least one observation in the Post-Shock period, while the extensive margin EXIT sample includes observations only if there was lending in the Pre-Shock period. Our main results, shown in Tables 6-9 in Appendix B obtain for the sample with all banks. The first sample includes all banks together with an identifier for their type. Our main sample contains 780 banks and $2,714$ firms that all borrow from at least two banks in the sample before and after the shock, but are otherwise randomly drawn. There are $7,120$ bank-firm lending relationships in our sample. We winsorize our data and drop all firms below the five and above the ninety five percent percentile of firm size, measured in the first quarter of the Pre-Shock period. The second set of samples is restricted to commercial banks consisting of large- and regional banks without savings- and cooperative banks. We winsorize the data and drop all firms below the five and above the ninety five percent percentile of firm size, measured in the first quarter of the Pre-Shock period.

The sample for the intensive margin only includes bank-firm relationships, where lending occurs at least once in the Pre-Shock and once in the Post-Shock period. The dependent variable

is the change in the log amount of a loan from bank i to firm j, $\Delta Loan_{ij,t} = \log(Loan)_{ij,t} - \log(Loan)_{ij,t-1}$. The Extensive Margin has to be differentiated between the new creation of a loan in the Post-Shock period that did not exist in the Pre-Shock period (ENTRY), and the termination of a loan in the Post-Shock period which existed in the Pre-Shock period (EXIT). The ENTRY variable equals one if there is no lending in the Pre-Shock period, but at least once lending in the Post-Shock period, and is zero otherwise. Similarly, the EXIT variable is defined as lending at least once in the Pre-Shock period, but no lending in the Post-Shock period. Hence, the EXIT sample does not include observations without lending in the Pre-Shock period. With respect to the randomly drawn sample with all banks included, $8,633$ bank-firm pairs remain, as well as $2,867$ firms and 837 banks for the EXIT sample. For the ENTRY sample, $10,826$ bank-firm pairs from $2,983$ firms to 924 banks remain in our sample.

Our main explanatory variable measures a bank's direct and indirect access to private funding liquidity. Several possibilities how to measure access to private funding liquidity. One could, for example, measure direct access by counting the number of lenders a bank borrows from. But this does not take into account heterogeneity in lending banks' access to funding liquidity. To account for this, we use borrower i's betweenness centrality, defined as the fraction of all shortest paths between any two banks j and k that pass through i:

$$Betweenness_{i,t} = \frac{1}{\alpha} \sum_{j \neq i \neq k} \frac{a_{jk,t|i}}{a_{jk,t}} \tag{1}$$

where $\alpha = (|N| - 1) \times (|N| - 2)$, $a_{jk,t|i}$ denotes the number of shortest paths between j and k that contains i, and $a_{jk,t}$ is the total number of shortest paths between j and k.[3] The sum runs over all pairs (j, k) where both j and k are different from i. The betweenness of bank i is a proxy for how easy it is for this bank to access liquidity in the interbank market, i.e. accessing a random Euro of liquidity flowing between any two banks in the market. It is also a direct measure for a bank i's intermediation function. Banks with high betweenness are in a larger number of intermediation chains. Thus, they are more relevant for financial intermediation, as a shock at such pivotal banks will affect the smooth flow of funds more strongly.

Banks that have a more pivotal position in the interbank market have it easier to obtain private funding liquidity–similar to that banks with more liquid assets, i.e. more securities have it easier

[3]Dividing by $(|N| - 1) \times (|N| - 2)$ obtains a normalized version of betweenness, because this factor represents the maximum number of pairs of banks not including i, hence the maximum value that this indicator can take.

to raise market liquidity.[4] We explicitly control for a bank's access to market liquidity by using $\Delta(Securities_{CB}/Securities$, the change in the ratio of a bank's securities eligible as collateral $Securities_{CB}$ to total securities $Securities$, obtained from the securities holdings statistics. To account for differing market liquidity, we distinguish between securities that are eligible central bank collateral at the end of a given quarter, and those that are not. This specification is an extension of the classic Kashyap and Stein (2000) bank-lending channel.

The dependent variable is the change in the logarithm of the total amount outstanding ($\Delta \log$ Volume). $\Delta \log$ Volumeis on average by -0.053 slightly negative for the selected time period around the sovereign debt crisis. Furthermore, not only the mean and median have a similar size but also the upper and lower one percentile so that the main dependent variable does not show significant skewness. The standard deviation of 1.113, however, indicates sizable variation in the variable. The main independent variable is the change in the network of banks from the Pre-Shock to the Post-Shock period, measured as betweenness centrality ($\Delta \log$ NetPos). Although there is no significant change in the mean of $\Delta \log$ NetPosthere remains sizable variation in the cross section, which is why this variable is suited to study the effect of varying direct and indirect access to private funding liquidity.

Among the level of the banks' network we control for the level and change of certain bank characteristics concerning banks' capital adequacy, size, funding and business model. The capital adequacy (EquityRatio) is defined as the unweighted equity divided by bank balance sheet size which represents on average more than 5 percent of the balance sheet. Size is measured as the logarithm of the balance sheet size ($\log$ BankSize). To capture the funding situation of a bank we control for the maturity of funding as well as the funding received from the Central Bank. The former is the ratio of short term liabilities with a maturity of up to one year to total maturity (stLiab/totalLiab). The latter is the ratio of central bank funding normalised by the bank balance sheet size (CBFundingBankSize). To account for each business model we introduce the ratio of business loans to total loans (BusinessLoansTotalAssets) and the provision income to total income (ProvisionTotalIncome) of a bank.

For the robustness check of changes in the monetary stance of the European Central Bank like the introduction of asset purchase programs or the change in collateral eligibility we introduce a further control. This control is defined as the amount of securities eligible as collateral divided by

[4]This is the original version of the bank-lending channel, described by Kashyap and Stein (2000).

the total amount of securities (CollateralTotalSecurities) held by a bank.

For later real effects analysis sample splits are executed according to the firms' change in number of employees (ΔFirmEmployees) and the ratio of firms' fixed assets to turnover (FirmFixedAssetsFirmSize).

3 Identification

The sovereign debt crisis is an exogenous shock that could possibly affect both banks and firms, by dampening the economic outlook and hence reducing firms' demand for loans. To account for this problem, we follow the methodology of Khwaja and Mian (2008) and collapse our quarterly observations into a single Pre-Shock and Post-Shock sample by averaging the loan values in either period.[5] We then use a difference-in-differences approach and introduce borrowing-firm fixed effects to absorb all firm-specific credit demand shocks. Our main model specification is:

$$\Delta \log \text{Volume}_{ij} = \beta_j + \beta_I + \beta \text{Controls}_i + \beta_1 \log \text{NetPos}_{i,\text{pre}} + \beta_2 \Delta \log \text{NetPos}_i + \epsilon_{ij} \qquad (2)$$

where β_j is a firm fixed-effect, β_I is a fixed effect for the banking group bank i belongs to and Controls_i is a vector of bank-specific controls. These include the equity ratio ($\text{EquityRatio}_{i,\text{pre}}$), the log of the bank size ($\log \text{BankSize}_{i,\text{pre}}$), the ratio of short-term liabilities with a maturity of up to one year to total liabilities ($\text{stLiab/totalLiab}_{i,\text{pre}}$), the ratio of central bank funding to bank size ($\text{CBFundingBankSize}_{i,\text{pre}}$), the ratio of loans to non-banks to total assets ($\text{BusinessLoansTotalAssets}_{i,\text{pre}}$), the ratio of provision income to total income ($\text{ProvisionTotalIncome}_{i,\text{pre}}$), as well as the change of all these variables from the Pre-Shock period to the Post-Shock period.

Our main explanatory variable is $\Delta \log \text{NetPos}_i$, the log of the change in bank i's network position, measured by the betweenness centrality, from the Pre-Shock to the Post-Shock period. Our other explanatory variable is the log of bank i's betweenness centrality in the Pre-Shock period, $\log \text{NetPos}_{i,\text{pre}}$.

[5] According to Bertrand et al. (2004), the collapsing ensures that standard errors are robust to auto-correlation.

4 Results

In this section we present the key results of our empirical analysis. First we focus on the relationship between a bank's centrality in the interbank credit network and its lending behavior, in order to assess whether a bank's direct and indirect access to interbank liquidity is related to its propensity to enter new credit relationships, cut existing relationships, and extend loans of larger volumes. In the second step we address the question whether a bank's centrality (through its lending behavior) also has real effects, in particular whether it lends more to firms with larger investments in intangible assets. Third, we show that there is indeed a casual effect of a bank's centrality on its credit provision in general and on its credit supply to firms with large intangible assets in particular.

4.1 Centrality and Banks' Lending Behavior

Table 6 present the estimation results for our bilateral matching model that allows to study the determinants of newly established credit relations. All regressions include firm fixed effects. The sample is restricted to firms that had a credit relationship with at least one bank in the Post-Shock period, but no credit relationship in the Pre-Shock period.

In our estimates of Model (1) we find that, when controlling only for firm level heterogeneity using firm fixed effects, an increase in a bank's centrality in the interbank network during the sovereign debt crisis significantly increases the probability that a given firm obtains for the first time a loan from the bank. This provides first suggestive evidence that, as a bank direct and indirect access to interbank credit improves, its willingness to establish new credit relationships increases.

Of course, it seems likely that these results are due to confounding factors. A bank's health measured by its equity ratio in the pre-crisis period determines its resilience to the crisis. Healthier banks are less likely rationed in the interbank market and they are less likely forced to deleverage and restrict their loan supply. Therefore, we include as a control variable a bank's pre-crisis equity ratio (EquityRatio). Similarly, banks particularly involved in fixed income markets are likely also be central to the interbank market. They might have lost centrality in the interbank market due to sovereign debt exposure. At the same time they might have deleveraged to compensate losses in their sovereign debt portfolio. We try to control for this by including 1) a bank's provision income to total

income as a proxy for how actively a bank is involved in financial markets (ProvisionTotalIncome) and 2) the ratio of a bank's business loans to total assets as a measure for how focused a bank is on traditional lending (BusinessLoansTotalAssets). Furthermore, a banks access and actual recourse to central bank liquidity might serve as a substitute to interbank liquidity especially in times of fixed rate full allotment that we consider in our analysis. Therefore, we include the credit a bank obtained from the central bank before the crisis relative to its balance sheet total (CBFundingBankSize) as a further control variable. Finally, a bank's dependency on short-term funding in the Pre-Shock period seems also a natural factor influencing in crisis times both a bank's interbank network position as well as its ability to lend to the corporate sector. stLiab/totalLiab proxies this confounding factor.

In Model (2) we include the full set of these control variables capturing bank characteristics before the sovereign debt crisis. In Model (3) we add to this the changes to these control variables during the crisis. In doing so, we not only take into account that bank business models and other characteristics might be confounding factors, but also that differences in the cross-sectional impact of the sovereign debt crisis on these bank characteristics might lead to a correlation of a bank's changed network centrality with its lending behavior.

However, the estimated coefficient for our key variable of interest remains largely unaffected when including these two sets of control variables: An increase in a bank's network centrality during the sovereign debt crisis was associated with a significantly higher probability of obtaining a loan from this bank for a given firm even when controlling for a large set of bank characteristics and changes of them.

In order to further investigate the influence of direct and indirect access to interbank funding on banks' decision to establish new credit relations we next also consider a banks' network position before the crisis as a key determinant. One might be of the opinion that what actually matters for access to interbank liquidity are existing credit links established over a long-term horizon. Thus a better proxy for direct and indirect access to interbank liquidity would be the position of a bank in such a network of long-term established credit, rather than the short-term fluctuations of its centrality. Furthermore, including the pre-crisis centrality of a bank as further explanatory variable allows us to draw some first tentative conclusion about causality: Since a bank's pre-crisis centrality is fairly persistent (see Figure 3) and predetermined reverse causality between a bank's lending behavior after the crisis and its Pre-Shock period access to interbank liquidity can be ruled

out. Finally, including the level of a bank's centrality in addition to changes in centrality, it takes care of the fact that changes in the centrality are truncated: For banks that are very central to the interbank network the centrality can only decline. For banks that are at the periphery a further decline in their centrality cannot occur.

In Model (4) we estimate the probability that a bank lends to a new borrower only based on its Pre-Shock centrality and changes in its centrality during the crisis controlling only for firm fixed effects. In Model (5) we also include the full set of bank level control variables. Our estimates show that first of all the effect of an increase in a bank's centrality on its willingness to form new credit links remains positive and significant if we control for the crisis network position of a bank. This holds also if we include the full set of bank controls. Second, we also find that the pre-crisis network position of a bank is significantly related to its lending behavior. A bank that was more central to the interbank network in the pre-crisis and has therefore better direct and indirect access to interbank funding, is more likely to lend to new non-bank borrowers during the crisis. Also this finding is robust to the inclusion of bank characteristics and of their changes. This suggests that there is not only some correlation between a banks network position and its lending, but that a better access to interbank funding indeed permits banks to continue lending to firms in crisis periods.

Next we investigate whether banks' access to interbank liquidity is also a determinant of its propensity to cut existing lending relationships with corporate borrowers. Table 7 reports our results of a probit model that estimates the probability that an existing bank-firm credit relationship is terminated in the Post-Shock period. Again, all estimates include firm fixed effects to control for observed and unobserved differences across borrowers. For this set of regressions we restrict the sample to firms that had at least with one bank a loan outstanding in the Pre-Shock period and no credit with any bank in the Post-Shock period.

Models (1)-(3) focus again first on the effect of a change in a bank's network position. We find that banks that became less central to the interbank market during the crisis had a significantly higher propensity to cut their existing credit relationships in the post crisis period. This holds not only if we only control for observed and unobserved heterogeneity across firms with fixed effects as in Model (1). Also if we include control variables capturing bank's health (EquityRatio), their business model (BusinessLoansTotalAssets, ProvisionTotalIncome), their on-balance sheet liquidity

risk (stLiab/totalLiab), and dependence on central bank funding (CBFundingBankSize) the drop in a bank's interbank network centrality is associated with a significantly higher propensity to cut existing lending relationship with non-bank corporate borrowers (see Model (2)). This finding also holds if we further account for changes of these control variables during the crisis (see Model (3)).

In order to get a first notion of the causal relation between a bank's direct and indirect access to interbank liquidity and its tendency to cut existing credit relationships Models (4) and (5) consider also a bank's pre-crisis centrality to the interbank network. Our results are consistent with our without the full set of control variables. They show that even when controlling for a bank pre-crisis centrality a drop in its direct and indirect access to interbank liquidity during the crisis remains a significant factor reducing its willingness to maintain credit relations with existing borrowers. More interestingly, we find that also the pre-crisis centrality of a bank has a signficantly negative effect on its propensity not cut existing credit relations during the crisis. Thus established interbank credit relationships pre-crisis seem to matter for the direct and indirect access to interbank funding during the crisis and therefore affect a bank's ability to maintain established lending relationships with non-bank borrowers during the crisis.

In our third set of regressions we study the effect of banks' direct and indirect access to interbank liquidity on the amount that they are willing to lend to its corporate borrowers. In order to estimate the intensive margin of bank-firm lending relationships we restrict the sample to firms that obtained before and after the crisis at least from one bank a loan. Table 8 summarizes our regression results. The results for the intensive margin are consistent with our observations for the extensive margin.

As the results for Model (1)-(3) indicate banks that became more central to the interbank network during the crisis are extending larger loans to their corporate borrowers. This findings is robust to the inclusion of borrower fixed effects only (Model (1)), to further incorporating covariates capturing pre-crisis bank characteristics as well as to adding in addition changes to bank characteristics during the crisis (Model (3)). Thus we also find that better direct and indirect access to interbank liquidity increases the credit volume provided by a bank to its borrowers. Model (4) and (5) show that this result is also robust if we include the pre-crisis network centrality as a further explanatory variable. However, in contrast to our estimates of the extensive margin, we do not find strong evidence that also the pre-crisis network position of a bank matters for its lending behavior.

Only if we include the full set of covariates (Model (5)) we find that a bank's pre-crisis interbank centrality was a weakly statistically significant determinant for the volumes it was willing to lend to its borrowers in the post-crisis period.

In sum, our results on the intensive and extensive margin provide strong evidence that a bank's direct and indirect access to private interbank liquidity is an important determinant of its ability to provide credit to corporate borrowers and to maintain existing credit relationships. Not only is a bank that became more central to the interbank credit network during the crisis more inclined to establish new credit relationships and maintain existing ones while at the same time lending larger volumes, a bank more central to the interbank network before the crisis also ensures better funding access to its non-bank borrowers in the aftermath of the crisis. Put differently banks that obtain better liquidity insurance through their centrality to the interbank market can also provide better liquidity insurance to their corporate customers.

4.2 Centrality and Real Effects

In this section we study whether the more steady credit provision to non-banks by banks with better direct and indirect access to interbank funding also entails real economic effects. Access to interbank funding provides banks with better liquidity insurance and enables them to enter larger liquidity in their lending business, i.e. provide better liquidity insurance to their corporate customers. This should particularly benefit firms that invest is illiquid assets, such as R&D. Thus in a first step we analyze whether especially firms with a high share of intangible assets benefit from the credit provision by bank central to the interbank network.[6] In a second step we take a broader perspective on real effects and study whether banks with better direct and indirect access to interbank liquidity provided funding particularly to those firms that increased in relative terms their workforce in the aftermath of the crisis. Here the idea is that also the liquidity insurance provided by more central banks to corporate borrowers allows firms to smooth temporary shocks and maintain a more stable workforce in crisis times.

In order to assess whether more R&D intensive firms obtain funding from banks with better access to the interbank market, in Table 9 we split our sample into firms with below median

[6]Note: While DAFNE data also contains in general firms' R&D investments, only very few firms actually report it on a constant basis. Thus unfortunately we could not use this better direct measure for our analysis.

share of tangible assets and firms above median share of tangible assets. Then we run on the two samples separately estimations of a banks propensity to form a new credit relation with a borrower ($ENTRY$), its propensity to cut a credit relation with an existing borrower ($EXIT$) and the increase in the volume a bank is willing to lend to its corporate customers ($\Delta logVolume$). We restrict our analysis to regressions with the full set of control variables.

Our estimation results reported in columns (1) and (2) suggest that banks which gained better access to interbank liquidity during the crisis (became more central to the interbank network) were more likely to extent a new loan to a firm with a low ratio of tangible asset, i.e. with a high share of intangibles. Similarly a bank that was already in the pre-crisis period more central to the interbank market and thus had better access to interbank liquidity, also had a somewhat higher tendency to lend to a firm with a large share of intangible assets, i.e. presumable R&D intensive firms. Thus banks direct and indirect access to interbank liquidity seems to foster its willingness to lend to R&D intensive firms during the crisis, i.e. firms with little tangible assets.

In contrast to our results on the formation of new credit relations, our findings on banks propensity to cut existing lending relationships are less conclusive. Changes in a bank's centrality to the interbank network during the crisis do not have a significantly different effect on it propensity to cut lending relations with R&D intensive firms. In fact when splitting the sample the changes in a bank's direct and indirect access to interbank liquidity during the crisis does no longer have any signficant effect on the bank's propensity to cut existing lending relations neither to firms with high nor low tangible asset ratio. Regarding the pre-crisis network position of a bank, we find that actually a bank more central to the network before the sovereign debt crisis is less likely to cut its existing lending relationship to firms with a high tangible asset share, while we do not find such a significant effect for firms with a low ratio of tangible assets.

Columns (5) and (6) report our estimation results for the intensive margin. We do not find that a change in a bank's interbank network centrality affects the amounts it lends to firms with high and low ratio of tangible assets. Thus we can not conclude that banks with an improved direct and indirect access to interbank liquidity during the crisis are willing to extend larger loans to firms with low tangible assets. We also do not find that the pre-crisis network position of a bank has a significant effect on the volume of outstanding loans to firms with more tangible or intangible assets in the aftermath of the crisis. Consequently we also do not find evidence that banks with

better established direct or indirect access to interbank funding in the pre-crisis period were willing to provide more credit to firms with more intangible assets.

In our next set of regressions we focus on more explicit real effects of banks' access to interbank liquidity: We want to analyze whether a better liquidity insurance of banks through the interbank market permits them to continue funding particularly firms that maintain a comparatively stable workforce during the crisis. In order to do so we split the sample into firms that had an increase in employees above the median firm during the crisis and those whose workforce grew by less than the workforce of the median firm. We then estimate 1) the formation of new credit relationships ($ENTRY$), 2) the termination of existing lending relationships ($EXIT$) and 3) the change in loan volumes ($\Delta logVolume$) separately for the two subsamples including firm fixed effects and the full set of control variables at the bank level. Table 10 summarizes the results of this approach.

As the estimation results reported in column (1) and (2) reveal banks that benefited from an improved access to interbank liquidity during the crisis were signficantly more inclined to form a credit relation with a new borrower if this borrower's workforce grew above average. For firms that had a below average development of their workforce we do not find that banks with an improved interbank market access showed a different lending behavior than other banks. Similarly we find for banks that had established strong direct and indirect access to interbank liquidity in the pre-crisis period a significantly higher propensity to provide a credit to borrowers whose number of employees increases above average, while this effect is not significant for firms with a relatively poor development of their workforce.

The results are similar for banks' decision to terminate existing lending relations. Columns (3) and (4) report our estimation results for banks propensity to cut existing lending relations. We find banks that became more central to the interbank network during the crisis hat a weaker tendency to refuse to rollover a loan to an existing borrower no matter whether the borrower increased or decreased his workforce relative to the median firm. However, economically the effect is stronger for firms whose number of employees relatively increased. Banks that had already established a better direct and indirect access to interbank credit before the crisis only had a significantly larger propensity to rollover loans to its borrowers if these borrowers increased their workforce above average, while they had the same propensity to cut existing lending relationships to other firms as banks with poorer access to the interbank market. Thus based on our results on $ENTRY$ and

$EXIT$ of bank-firm credit relationships we can conclude that banks with better direct and indirect access to interbank liquidity seem to have preserved funding to firms that smoothed the adjustment of their workforce during the crisis.

Our findings on the intensive margin are, however, less conclusive (Column (5) and (6)). Here we find that a well established access to interbank liquidity before the crisis as well as an improved access to the interbank market during the crisis significantly increased the volume a bank was willing to lend to its existing borrowers no matter whether these borrowers relatively increased or decreased its workforce. However, economically both effects seem actually somewhat stronger for firms who comparably reduced the number of employees.

In sum, our results indicate that banks that benefited from an improved direct and indirect access to interbank funding provided funding particular to R&D intensive firms and firms that maintained a relatively large workforce during the crisis. Thus banks benefit form a better liquidity insurance through the interbank market provide also liquidity insurance to their corporate borrowers and thereby permit them to overcome temporary funding shocks.

5 Conclusion

We show in this paper that the direct and indirect access of banks to private interbank liquidity enables them to extend credit provision to non-financial firms during crisis. Our unique data set combines bank-firm lending information with bank-to-bank lending information as well as with detailed bank- and firm balance sheet information. This allows us to control for observed and unobserved firm and bank heterogeneity and possible confounding factors in a diff-in-diff setting.

We show that after the sovereign debt crisis banks more central to the interbank lending network, and in particular those that became more central, form more new credit relations with non-financial firms, cut fewer credit relations, and lend larger volumes especially to firms with more intangible assets. We find substantive evidence that a bank's direct and indirect access to private interbank liquidity leads to improved liquidity provision to the real economy and hence has measurable real effects.

Our results have substantial policy implications since the extensive liquidity provision by

central banks in the aftermath of the global financial crisis have substituted a sizable part of the interbank market. We show that this substitution can have unanticipated and subtle consequences for banks' credit provision to the real economy.

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A Figures

Figure 1: Various measures of the interbank network structure. Normalized interbank lending volume (top left). Total number of loans (top right). Number of banks in the interbank market (bottom left). Number of borrowers and lenders in the interbank market (bottom right). All measures are obtained per quarter for the sample containing all German banks.

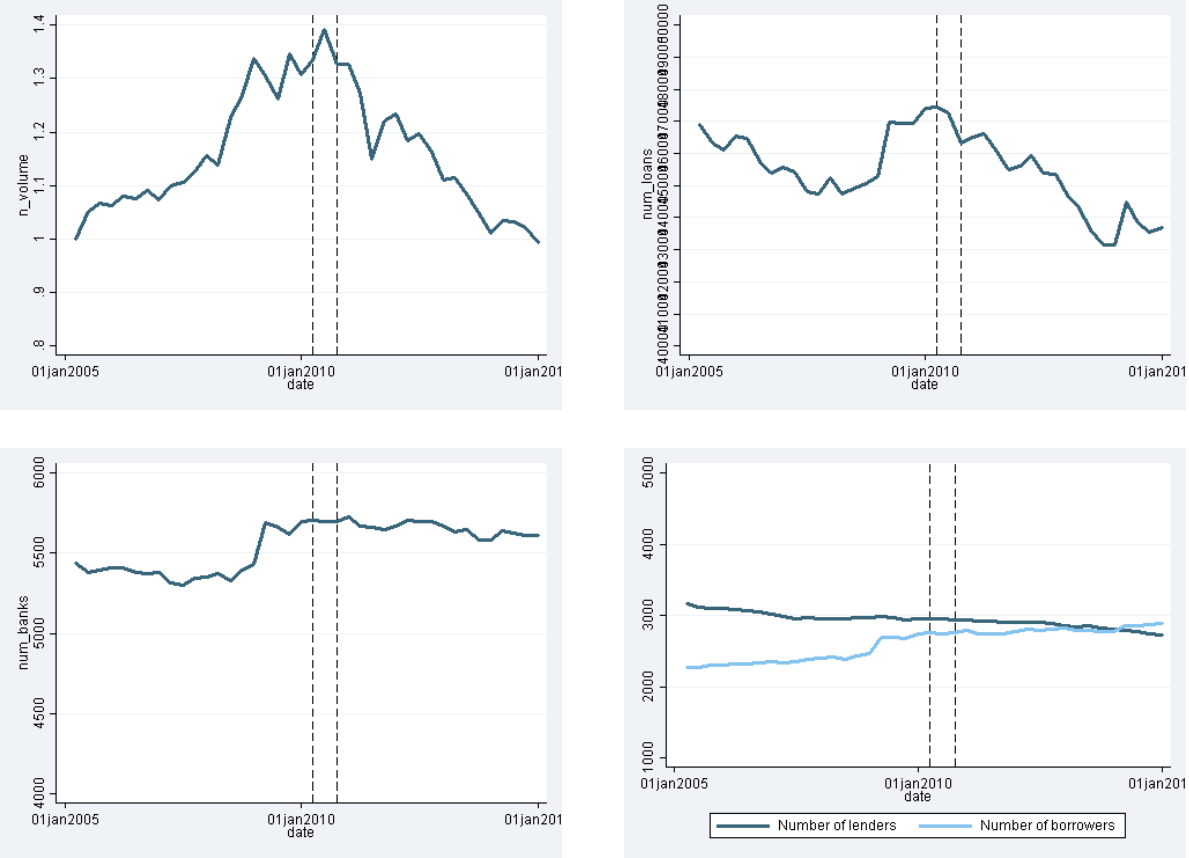


Figure 2: Various measures of the interbank network structure. Density of the interbank market (top left). Average shortest path length (top right). Diameter (bottom left). All measures are obtained per quarter for the sample containing all German banks.

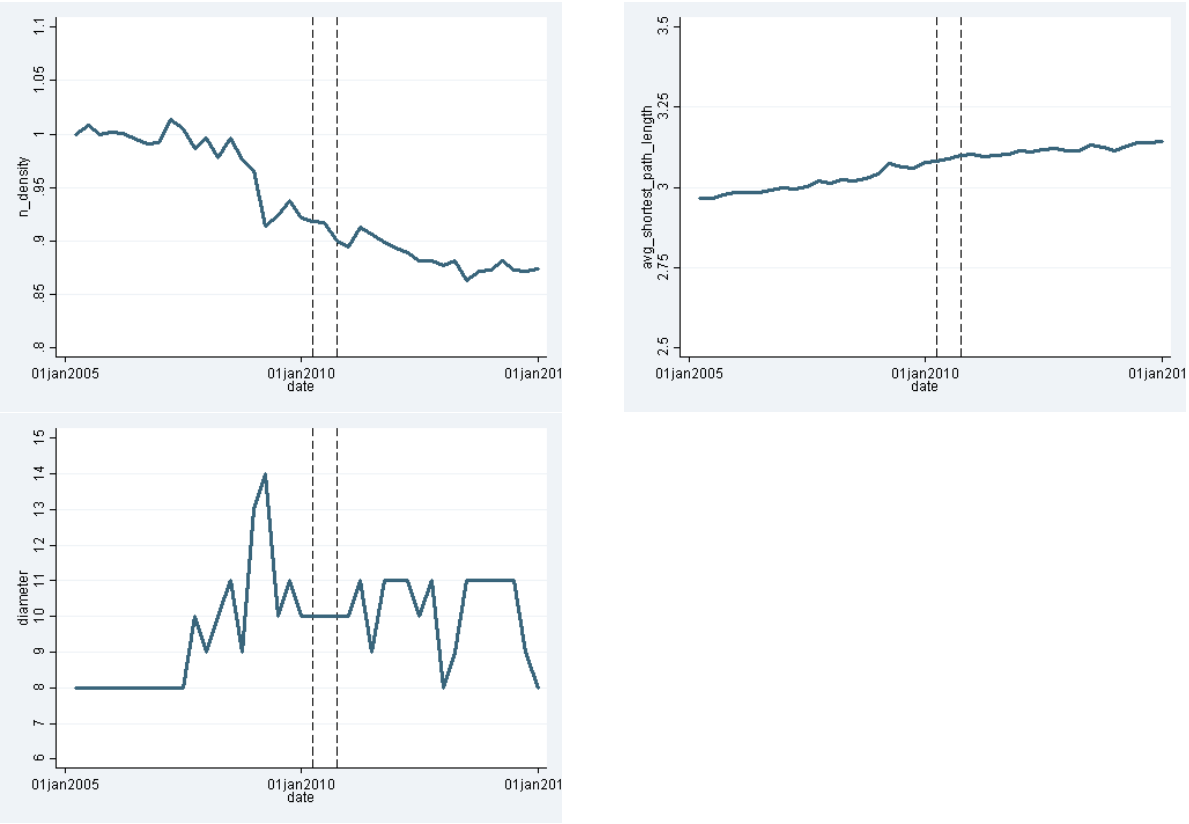


Figure 3: Network measured as betweenness centrality, showing network as mean over the time horizon when Debt Crisis is chosen as shock Q1/2009 - Q3/2011; Sample All Banks (ENTRY dataset)

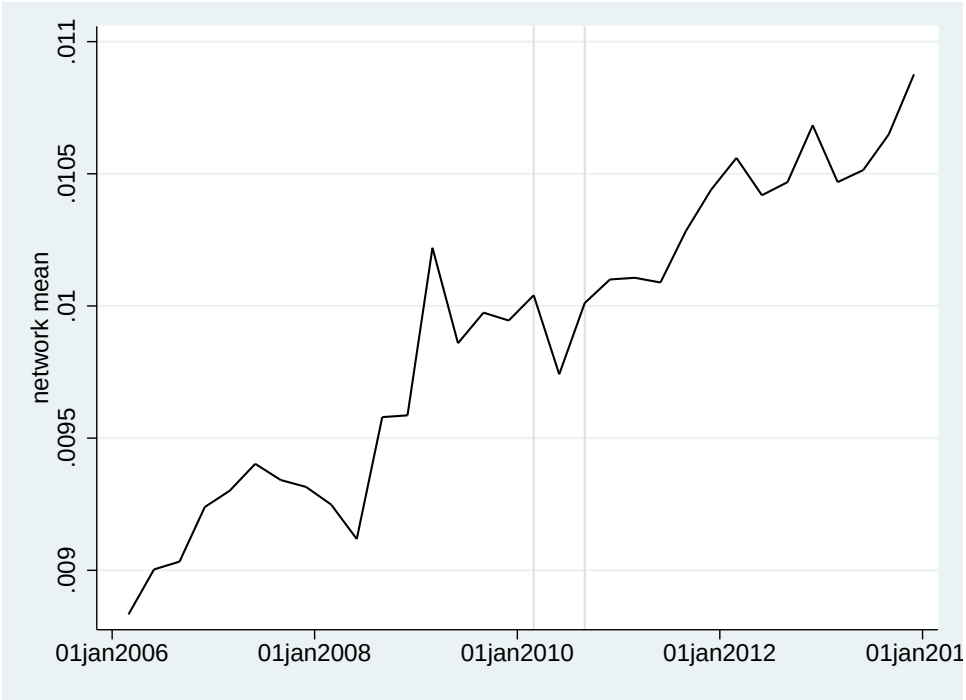
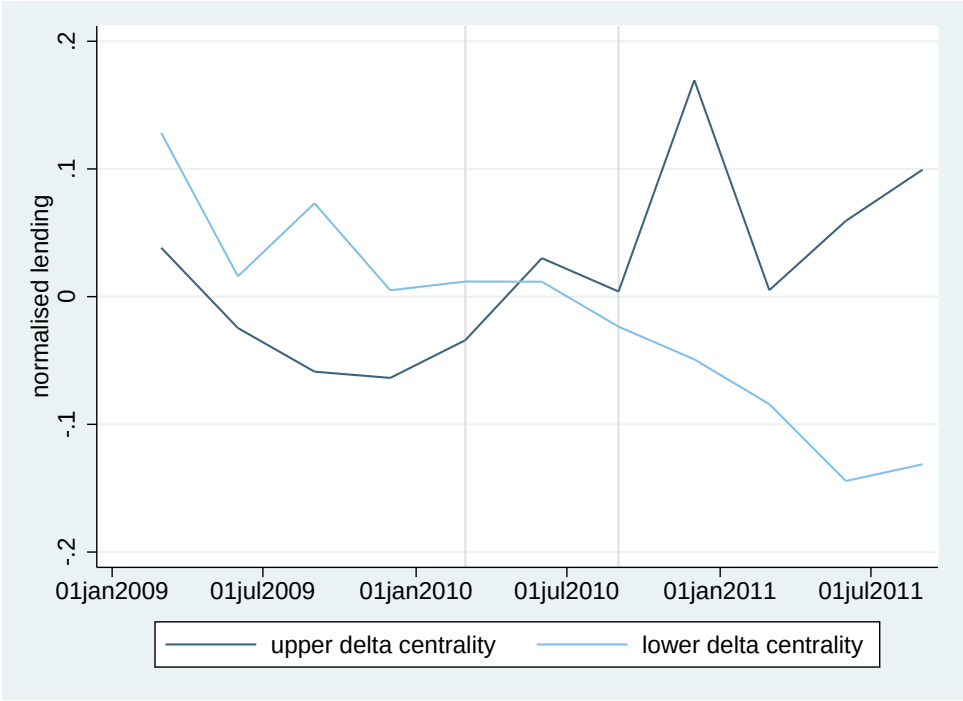


Figure 4: Lending behaviour of more/ less central banks, where the change in centrality from pre to post period is either above or below the median; normalised lending, where the reference period is the mean of shock period; Sample All Banks (ENTRY dataset)



B Tables

Table 1: Definition of Variables. MiMiK denotes the large credit register and P+L a bank's profit and loss report. The form detailing the positions reported in MiMiK and P+L can be downloaded from http://www.bundesbank.de/Redaktion/DE/Standardartikel/Service/Meldewesen/vordrucke_pdf_zur_bankenaufsicht.html (for MiMiK see forms with abbreviation BA; for P+L see forms with abbreviation GVKI). BISTA denotes the monthly balance sheet statistics. The forms detailing the positions reported within BISTA can be found at http://www.bundesbank.de/Redaktion/DE/Standardartikel/Service/Meldewesen/formulare_zur_monatlichen_bilanzstatistik.html. DAFNE denotes Bureau van Dijk's DAFNE dataset.

Variable	**Definition**
Δ log Volume	Change in the logarithm of one plus total loan amount outstanding from Post-Shock to Pre-Shock period per bank-firm observation [MiMiK; BA100]
EquityRatio	Bank equity divided by bank balance sheet size [BISTA; HV21310 / HV11180]
log BankSize	Log of bank balance sheet size [BISTA; log(HV11180)]
stLiab/totalLiab	Short-term liabilities to domestic and foreign banks with a maturity of up to one year, divided by total liabilities to domestic and foreign banks. [BISTA; (a211102 + a211302 + a212002) / (a211102 + a211103 + a211104 + a211302 + a211303 + a211304 + a212002 + a212003 + a212004)]
CBFundingBankSize	Total funding from central bank divided by bank balance sheet size [BISTA; (a211402 + a211403 + a211404) / HV11180]
BusinessLoansTotalAssets	Credit to non-banks divided by bank balance sheet size [BISTA; HV11071 / HV11180]
ProvisionTotalIncome	Provision income divided by total income of the bank [P+L; GV44020 / GV44030]
CollateralTotalSecurities	Securities accepted as Collateral by the ECB divided by total securities held by the bank [WPinvest Securities merged with list of eligible ECB collateral from markets department of Deutsche Bundesbank / Total Securities from WPinvest]

NetPos	Betweenness centrality of the bank [MiMiK; Betwenness centrality is measured on the interbank network obtained from bilateral lending relationships among banks]
log NetPos	Logarithm of one plus betweenness centrality [MiMiK; Betwenness centrality is measured on the interbank network obtained from bilateral lending relationships among banks]
FirmFixedAssetsFirmSize	Firm's fixed Assets divided by firm size [DAFNE; A300009 / A300671]
FirmEmployees	Number of firm's employees [DAFNE;]
Δ of Variables listed above	Difference between the mean of the level variable in the Post-Shock period minus the mean of the level in the Pre-Shock period

Table 2: Descriptive Statistics for relevant independent variables. Sample: All Banks, restricted to Intensive Margin (observations dropped in case of no lending in Pre-Shock or Post-Shock period). There are $7,120$ unique bank-firm pairs from 780 banks to $2,714$ firms. Variables are defined in Table 1.

	mean	p50	p1	p99	sd
Δ log Volume	-0.053	-0.054	-3.515	3.326	1.113
EquityRatio	0.054	0.049	0.008	0.163	0.027
log BankSize	17.088	17.455	12.833	19.770	2.225
stLiab/totalLiab	0.343	0.338	0.000	1.000	0.305
CBFundingBankSize	0.030	0.012	0.000	0.335	0.049
BusinessLoansTotalAssets	0.499	0.492	0.138	0.949	0.212
ProvisionTotalIncome	0.166	0.173	-0.203	0.385	0.136
ΔEquityRatio	-0.005	0.000	-0.056	0.047	0.018
Δ log BankSize	0.117	0.034	-0.344	0.718	0.277
ΔshorttermLiabtotalLiab	-0.062	-0.052	-0.802	0.353	0.158
ΔCBFundingBankSize	-0.021	-0.010	-0.129	0.016	0.034
ΔBusinessLoansTotalAssets	-0.016	-0.012	-0.217	0.264	0.073
ΔProvisionTotalIncome	0.003	0.007	-0.517	0.209	0.102
NetPos	0.014	0.002	0.000	0.188	0.028
ΔNetPos	0.001	0.000	-0.006	0.013	0.004
log NetPos	0.014	0.002	0.000	0.172	0.026
Δ log NetPos	0.001	0.000	-0.005	0.012	0.004

Table 3: Descriptive Statistics for relevant independent variables. Sample: All Banks, restricted to Extensive Margin - EXIT (observations dropped in case of no lending in Pre-Shock period). There are $8,633$ unique bank-firm pairs from 837 banks to $2,867$ firms. Variables are defined in Table 1.

	mean	p50	p1	p99	sd
$\Delta \log$ Volume	-0.053	-0.054	-3.515	3.326	1.113
EquityRatio	0.054	0.050	0.008	0.163	0.027
log BankSize	17.076	17.433	12.767	19.770	2.242
stLiab/totalLiab	0.358	0.338	0.000	1.000	0.313
CBFundingBankSize	0.031	0.011	0.000	0.335	0.053
BusinessLoansTotalAssets	0.497	0.492	0.138	0.949	0.214
ProvisionTotalIncome	0.167	0.173	-0.203	0.413	0.136
ΔEquityRatio	-0.005	0.000	-0.056	0.050	0.018
$\Delta \log$ BankSize	0.113	0.034	-0.344	0.718	0.283
ΔshorttermLiabtotalLiab	-0.070	-0.052	-0.880	0.318	0.170
ΔCBFundingBankSize	-0.021	-0.009	-0.129	0.016	0.037
ΔBusinessLoansTotalAssets	-0.018	-0.014	-0.233	0.264	0.077
ΔProvisionTotalIncome	0.002	0.007	-0.517	0.209	0.104
NetPos	0.014	0.002	0.000	0.188	0.027
ΔNetPos	0.001	0.000	-0.006	0.013	0.004
log NetPos	0.014	0.002	0.000	0.172	0.026
$\Delta \log$ NetPos	0.001	0.000	-0.005	0.012	0.004

Table 4: Descriptive Statistics for relevant independent variables. Sample: All Banks, restricted to Extensive Margin - ENTRY (observations dropped in case of no lending in Post-Shock period). There are 10,826 unique bank-firm pairs from 924 banks to 2,983 firms. Variables are defined in Table 1.

	mean	p50	p1	p99	sd
Δ log Volume	-0.053	-0.054	-3.515	3.326	1.113
EquityRatio	0.056	0.051	0.008	0.163	0.028
log BankSize	17.022	17.334	12.658	19.770	2.292
stLiab/totalLiab	0.362	0.369	0.000	1.000	0.316
CBFundingBankSize	0.030	0.012	0.000	0.335	0.051
BusinessLoansTotalAssets	0.499	0.492	0.138	0.949	0.219
ProvisionTotalIncome	0.172	0.178	-0.203	0.413	0.136
ΔEquityRatio	-0.006	-0.000	-0.056	0.050	0.019
Δ log BankSizee	0.133	0.037	-0.348	0.718	0.300
ΔshorttermLiabtotalLiab	-0.070	-0.052	-0.880	0.312	0.171
ΔCBFundingBankSize	-0.021	-0.009	-0.129	0.016	0.037
ΔBusinessLoansTotalAssets	-0.019	-0.014	-0.233	0.264	0.076
ΔProvisionTotalIncome	0.002	0.006	-0.517	0.209	0.099
NetPos	0.014	0.002	0.000	0.188	0.028
ΔNetPos	0.001	0.000	-0.006	0.013	0.004
log NetPos	0.014	0.002	0.000	0.172	0.026
Δ log NetPos	0.001	0.000	-0.005	0.012	0.004

Table 5: Correlation Matrix for all relevant variables. Sample: All Banks, restricted to Intensive Margin (observations dropped in case of no lending in Pre-Shock or Post-Shock period). There are 7,120 unique bank-firm pairs from 780 banks to 2,714 firms. Variables are defined in Table 1.

	Δ log Volume	EquityRatio	log BankSize	stLiab/totalLiab	CBFundingBankSize	BusinessLoansTotalAssets	ProvisionTotalIncome	ΔEquityRatio	Δ log BankSize	ΔshorttermLiabtotalLiab	ΔCBFundingBankSize	ΔBusinessLoansTotalAssets	ΔProvisionTotalIncome	NetPos	ΔNetPos	log NetPos	Δ log NetPos
Δ log Volume	1.00																
EquityRatio	0.01	1.00															
log BankSize	-0.01	-0.10	1.00														
stLiab/totalLiab	-0.04	0.02	0.55	1.00													
CBFundingBankSize	-0.04	-0.25	-0.01	0.01	1.00												
BusinessLoansTotalAssets	0.01	0.20	-0.60	-0.47	0.01	1.00											
ProvisionTotalIncome	0.03	0.12	-0.01	0.14	-0.30	-0.39	1.00										
ΔEquityRatio	-0.05	-0.52	-0.35	-0.19	0.13	0.18	-0.20	1.00									
Δ log BankSize	0.07	0.37	0.33	0.28	-0.27	-0.26	0.41	-0.77	1.00								
ΔshorttermLiabtotalLiab	0.04	-0.22	-0.24	-0.54	0.00	0.09	0.05	0.02	0.03	1.00							
ΔCBFundingBankSize	0.03	0.23	0.04	-0.00	-0.87	0.01	0.24	-0.08	0.21	-0.01	1.00						
ΔBusinessLoansTotalAssets	0.01	-0.43	-0.24	-0.34	0.39	0.04	-0.15	0.55	-0.60	0.21	-0.27	1.00					
ΔProvisionTotalIncome	0.03	-0.04	0.00	0.10	0.10	-0.03	-0.10	-0.03	0.09	-0.06	-0.09	-0.04	1.00				
NetPos	0.01	-0.13	0.50	0.25	-0.15	-0.47	0.03	-0.11	0.10	-0.09	0.15	-0.18	0.02	1.00			
ΔNetPos	0.05	0.23	0.15	0.15	0.01	-0.22	0.40	-0.58	0.61	0.05	-0.09	-0.18	0.01	0.04	1.00		
log NetPos	0.01	-0.12	0.52	0.26	-0.16	-0.49	0.03	-0.12	0.11	-0.10	0.15	-0.19	0.02	1.00	0.04	1.00	
Δ log NetPos	0.05	0.23	0.15	0.15	0.01	-0.22	0.40	-0.59	0.62	0.05	-0.09	-0.19	0.01	0.02	1.00	0.02	1.00

Table 6: Extensive Margin – ENTRY (no lending in Pre-Shock period, lending at least once in Post-Shock period). Sample: All Banks, restricted to Extensive Margin – ENTRY. Main explanatory variables are log NetPos measured as the log of one plus the betweenness centrality of bank i in the Pre-Shock period, which is defined as the fraction of shortest paths of liquidity transfer between any two banks in the Pre-Shock interbank network that pass through bank i (for a formal definition, see Equation 2), and Δ log NetPos the change of the log of betweenness centrality from the Pre-Shock to the Post-Shock period. All variables are defined in Table 1.

ENTRY	(1)	(2)	(3)	(4)	(5)	(6)
Δ log NetPos	12.15***	6.281***	4.690**		13.68***	11.46***
	(1.132)	(1.803)	(1.960)		(1.240)	(2.503)
log NetPos				1.157*	1.720***	3.376***
				(0.609)	(0.573)	(0.778)
ΔEquityRatio		-1.154*	-2.686***	-3.683***		-1.359*
		(0.650)	(0.719)	(0.594)		(0.781)
Δ log BankSize		0.114***	0.0927**	0.124***		0.0857**
		(0.0358)	(0.0361)	(0.0352)		(0.0361)
ΔshorttermLiabtotalLiab		-0.0193	-0.0580	-0.0629*		-0.0862**
		(0.0331)	(0.0378)	(0.0380)		(0.0383)
ΔCBFundingBankSize		0.155	-0.511	-0.842**		-0.563
		(0.185)	(0.345)	(0.340)		(0.345)
ΔBusinessLoansTotalAssets		0.568***	0.683***	0.799***		0.638***
		(0.0996)	(0.107)	(0.101)		(0.107)
ΔProvisionTotalIncome		-0.129**	-0.131**	-0.0923		-0.0979
		(0.0599)	(0.0630)	(0.0634)		(0.0634)
EquityRatio			-1.267***	-1.285***		-1.432***
			(0.314)	(0.315)		(0.316)
log BankSize			-0.0180***	-0.0214***		-0.0287***
			(0.00483)	(0.00519)		(0.00542)
stLiab/totalLiab			0.0192	0.0230		0.0103
			(0.0292)	(0.0292)		(0.0292)
CBFundingBankSize			-0.626***	-0.754***		-0.582***
			(0.207)	(0.204)		(0.207)
BusinessLoansTotalAssets			0.0141	0.0228		-0.000377
			(0.0400)	(0.0398)		(0.0401)
ProvisionTotalIncome			0.0179	0.0538		-0.0659
			(0.0542)	(0.0513)		(0.0575)
Constant	-0.0449	-0.0401	0.354	0.375	-0.0831	0.532**
	(0.212)	(0.211)	(0.236)	(0.237)	(0.212)	(0.239)
Firm fixed-effects	yes	yes	yes	yes	yes	yes
Bank-type fixed-effect	yes	yes	yes	yes	yes	yes
N	11116	10575	10575	10575	11116	10575
R^2	0.356	0.373	0.376	0.376	0.357	0.378
R^2 (adjusted)	0.117	0.123	0.127	0.127	0.118	0.129

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Extensive Margin – EXIT (lending at least once in Pre-Shock period, but not in Post-Shock period). Sample: All Banks, restricted to Extensive Margin – EXIT. Main explanatory variables are log NetPos measured as the log of one plus the betweenness centrality of bank i in the Pre-Shock period, which is defined as the fraction of shortest paths of liquidity transfer between any two banks in the Pre-Shock interbank network that pass through bank i (for a formal definition, see Equation 2), and $\Delta \log$ NetPos the change of the log of betweenness centrality from the Pre-Shock to the Post-Shock period. All variables are defined in Table 1.

EXIT	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log$ NetPos	-6.312***	-3.421*	-4.882**		-7.936***	-9.507***
	(1.333)	(2.066)	(2.296)		(1.476)	(2.954)
log NetPos				-0.393	-1.607**	-2.128**
				(0.665)	(0.628)	(0.856)
ΔEquityRatio		0.564	0.104	1.120		-0.829
		(0.737)	(0.833)	(0.684)		(0.913)
$\Delta \log$ BankSize		-0.0571	-0.0667	-0.0989**		-0.0597
		(0.0418)	(0.0423)	(0.0406)		(0.0423)
ΔshorttermLiabtotalLiab		-0.178***	-0.184***	-0.185***		-0.166***
		(0.0382)	(0.0433)	(0.0435)		(0.0439)
ΔCBFundingBankSize		-0.526***	-0.404	-0.138		-0.355
		(0.202)	(0.380)	(0.375)		(0.380)
ΔBusinessLoansTotalAssets		-0.214*	-0.327***	-0.436***		-0.286**
		(0.111)	(0.124)	(0.116)		(0.125)
ΔProvisionTotalIncome		-0.0364	-0.0261	-0.0532		-0.0446
		(0.0640)	(0.0677)	(0.0681)		(0.0681)
EquityRatio			0.0608	0.0587		0.129
			(0.342)	(0.343)		(0.343)
log BankSize			-0.00356	-0.00174		0.00302
			(0.00540)	(0.00583)		(0.00601)
stLiab/totalLiab			-0.000447	-0.00736		0.00688
			(0.0334)	(0.0333)		(0.0336)
CBFundingBankSize			0.127	0.254		0.0992
			(0.224)	(0.219)		(0.224)
BusinessLoansTotalAssets			-0.148***	-0.159***		-0.137***
			(0.0444)	(0.0441)		(0.0446)
ProvisionTotalIncome			0.0427	0.00139		0.0967
			(0.0592)	(0.0557)		(0.0631)
Constant	0.335	0.304	0.391*	0.392*	0.371*	0.281
	(0.205)	(0.203)	(0.235)	(0.237)	(0.205)	(0.239)
Firm fixed-effects	yes	yes	yes	yes	yes	yes
Bank-type fixed-effect	yes	yes	yes	yes	yes	yes
N	8928	8532	8532	8532	8928	8532
R^2	0.398	0.418	0.420	0.420	0.399	0.421
R^2 (adjusted)	0.107	0.121	0.123	0.123	0.108	0.124

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Intensive Margin (lending at least once in Pre-Shock and Post-Shock period). Sample: All Banks, restricted to Intensive Margin. Main explanatory variables are log NetPos measured as the log of one plus the betweenness centrality of bank i in the Pre-Shock period, which is defined as the fraction of shortest paths of liquidity transfer between any two banks in the Pre-Shock interbank network that pass through bank i (for a formal definition, see Equation 2), and $\Delta \log$ NetPos the change of the log of betweenness centrality from the Pre-Shock to the Post-Shock period. All variables are defined in Table 1.

$\Delta \log$ Volume	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log$ NetPos	23.32***	15.87**	15.56**		25.80***	26.56***
	(4.365)	(6.867)	(7.650)		(4.815)	(9.853)
log NetPos				0.201	2.478	4.959*
				(2.175)	(2.030)	(2.800)
ΔEquityRatio		-0.627	-2.371	-5.670**		-0.123
		(2.449)	(2.800)	(2.285)		(3.074)
$\Delta \log$ BankSize		0.298**	0.254*	0.345**		0.233
		(0.142)	(0.143)	(0.138)		(0.144)
ΔshorttermLiabtotalLiab		0.0763	-0.0249	-0.00400		-0.0733
		(0.132)	(0.147)	(0.148)		(0.150)
ΔCBFundingBankSize		1.754***	2.489**	1.792		2.387*
		(0.664)	(1.248)	(1.230)		(1.249)
ΔBusinessLoansTotalAssets		0.320	0.324	0.667*		0.202
		(0.379)	(0.418)	(0.387)		(0.424)
ΔProvisionTotalIncome		0.284	0.193	0.265		0.244
		(0.216)	(0.228)	(0.230)		(0.230)
EquityRatio			-1.763	-1.785		-1.869*
			(1.121)	(1.123)		(1.123)
log BankSize			-0.0465***	-0.0490**		-0.0624***
			(0.0179)	(0.0194)		(0.0200)
stLiab/totalLiab			-0.0872	-0.0597		-0.109
			(0.111)	(0.110)		(0.112)
CBFundingBankSize			0.336	-0.0175		0.416
			(0.742)	(0.726)		(0.743)
BusinessLoansTotalAssets			0.0329	0.0709		0.00493
			(0.146)	(0.145)		(0.147)
ProvisionTotalIncome			-0.0111	0.126		-0.135
			(0.196)	(0.184)		(0.208)
Constant	-0.220	-0.254	0.784	0.732	-0.286	1.031
	(0.725)	(0.720)	(0.820)	(0.825)	(0.727)	(0.832)
Firm fixed-effects	yes	yes	yes	yes	yes	yes
Bank-type fixed-effect	yes	yes	yes	yes	yes	yes
N	7420	7126	7126	7126	7420	7126
R^2	0.482	0.489	0.491	0.490	0.483	0.491
R^2 (adjusted)	0.174	0.176	0.176	0.176	0.174	0.177

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Intensive and Extensive Margin with sample split for above (1) (3) (5) or below (2) (4) (6) median according to ratio of fixed assets to firm size. Sample: All Banks, restricted to Extensive Margin – ENTRY (no lending in Pre-Shock period, lending at least once in Post-Shock period; Used in models (1) + (2)), Extensive Margin – EXIT (lending at least once in Pre-Shock period, but not in Post-Shock period; Used in models (3) + (4)), and Intensive Margin (lending at least once in Pre-Shock and Post-Shock period; Used in models (5) + (6)). Main explanatory variables are log NetPos measured as the log of one plus the betweenness centrality of bank i in the Pre-Shock period, which is defined as the fraction of shortest paths of liquidity transfer between any two banks in the Pre-Shock interbank network that pass through bank i (for a formal definition, see Equation 2), and Δ log NetPos the change of the log of betweenness centrality from the Pre-Shock to the Post-Shock period. All variables are defined in Table 1.

	(1)	(2)	(3)	(4)	(5)	(6)
	ENTRY [above p50]	ENTRY [below p50]	EXIT [above p50]	EXIT [below p50]	Δ log Volume [above p50]	Δ log Volume [below p50]
Δ log NetPos	5.548**	6.775***	-3.449	-1.303	11.63	17.73
	(2.214)	(2.590)	(2.486)	(3.004)	(7.513)	(11.01)
log NetPos	0.530*	0.631**	-0.643**	-0.266	0.721	-1.291
	(0.272)	(0.321)	(0.305)	(0.369)	(0.910)	(1.336)
ΔEquityRatio	-0.337	-2.198**	0.0302	0.686	-2.332	0.855
	(0.892)	(0.874)	(1.033)	(0.994)	(3.133)	(3.680)
Δ log BankSize	0.117***	0.126***	-0.142***	-0.0177	0.350**	0.145
	(0.0430)	(0.0480)	(0.0497)	(0.0564)	(0.159)	(0.206)
ΔshorttermLiabtotalLiab	-0.0572	-0.0390	-0.181***	-0.167**	0.104	-0.255
	(0.0473)	(0.0576)	(0.0538)	(0.0669)	(0.168)	(0.251)
ΔCBFundingBankSize	-0.457	-1.046*	0.285	-0.344	1.190	3.578
	(0.380)	(0.597)	(0.421)	(0.662)	(1.275)	(2.450)
ΔBusinessLoansTotalAssets	0.393***	0.742***	-0.332**	-0.308	0.857*	-0.451
	(0.130)	(0.162)	(0.145)	(0.195)	(0.439)	(0.736)
ΔProvisionTotalIncome	-0.00146	-0.146*	-0.137**	-0.0846	0.401**	-0.290
	(0.0500)	(0.0766)	(0.0534)	(0.0835)	(0.170)	(0.307)
EquityRatio	-0.745**	-1.110**	-0.0962	-0.972	-0.498	-0.708
	(0.329)	(0.525)	(0.362)	(0.592)	(1.072)	(2.205)
log BankSize	-0.0184***	-0.0186***	0.00319	-0.0182***	-0.0546***	0.0117
	(0.00422)	(0.00553)	(0.00472)	(0.00659)	(0.0142)	(0.0248)
stLiab/totalLiab	0.0313	0.108***	0.0295	0.0137	0.0629	-0.273
	(0.0287)	(0.0367)	(0.0322)	(0.0444)	(0.0972)	(0.169)
CBFundingBankSize	-0.433*	-0.848*	0.521**	-0.181	-0.517	2.617
	(0.221)	(0.475)	(0.241)	(0.523)	(0.735)	(1.995)
BusinessLoansTotalAssets	0.0587	0.0432	-0.111**	-0.193***	0.0547	-0.0299
	(0.0398)	(0.0573)	(0.0437)	(0.0655)	(0.130)	(0.246)
ProvisionTotalIncome	-0.00146	-0.0868	0.0616	-0.221**	-0.121	0.238
	(0.0520)	(0.0853)	(0.0570)	(0.0978)	(0.172)	(0.372)
Constant	0.290	0.339	0.310	0.480	0.754	0.770
	(0.207)	(0.306)	(0.209)	(0.301)	(0.681)	(0.988)
Firm fixed-effects	yes	yes	yes	yes	yes	yes
Bank-type fixed-effect	yes	yes	yes	yes	yes	yes
N	5377	5198	4564	3968	3927	3199
R^2	0.345	0.385	0.365	0.465	0.433	0.533
R^2 (adjusted)	0.130	0.0904	0.113	0.107	0.167	0.141

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Intensive and Extensive Margin with sample split for above (1) (3) (5) or below (2) (4) (6) median according to change in the number of firm employees. Sample: All Banks, restricted to Extensive Margin – ENTRY (no lending in Pre-Shock period, lending at least once in Post-Shock period; Used in models (1) + (2)), Extensive Margin – EXIT (lending at least once in Pre-Shock period, but not in Post-Shock period; Used in models (3) + (4)), and Intensive Margin (lending at least once in Pre-Shock and Post-Shock period; Used in models (5) + (6)). Main explanatory variables are log NetPos measured as the log of one plus the betweenness centrality of bank i in the Pre-Shock period, which is defined as the fraction of shortest paths of liquidity transfer between any two banks in the Pre-Shock interbank network that pass through bank i (for a formal definition, see Equation 2), and Δ log NetPos the change of the log of betweenness centrality from the Pre-Shock to the Post-Shock period. All variables are defined in Table 1.

	(1)	(2)	(3)	(4)	(5)	(6)
	ENTRY [above p50]	ENTRY [below p50]	EXIT [above p50]	EXIT [below p50]	Δ log Volume [above p50]	Δ log Volume [below p50]
Δ log NetPos	11.92***	2.271	-11.72***	-9.904*	30.80***	43.89**
	(3.125)	(4.414)	(3.534)	(5.645)	(11.27)	(17.75)
log NetPos	2.453**	-0.0951	-2.942***	-0.487	9.033***	14.19***
	(1.009)	(1.339)	(1.092)	(1.616)	(3.427)	(5.026)
ΔEquityRatio	-1.169	-3.699***	-1.650*	0.279	-0.945	2.362
	(0.898)	(1.411)	(0.988)	(1.730)	(3.092)	(5.486)
Δ log BankSize	0.0715	0.0592	-0.0361	-0.0179	0.0309	-0.0312
	(0.0460)	(0.0595)	(0.0531)	(0.0727)	(0.174)	(0.241)
ΔshorttermLiabtotalLiab	-0.0222	-0.0642	-0.129**	-0.164**	-0.199	-0.249
	(0.0471)	(0.0605)	(0.0532)	(0.0749)	(0.180)	(0.239)
ΔCBFundingBankSize	-0.402	-1.073*	-0.703	0.134	3.153**	2.493
	(0.439)	(0.570)	(0.479)	(0.674)	(1.477)	(2.084)
ΔBusinessLoansTotalAssets	0.427***	0.941***	-0.0333	-0.129	0.193	-0.194
	(0.134)	(0.190)	(0.150)	(0.238)	(0.481)	(0.761)
ΔProvisionTotalIncome	-0.0298	-0.132	-0.150*	-0.155	0.147	0.710*
	(0.0804)	(0.114)	(0.0837)	(0.132)	(0.256)	(0.420)
EquityRatio	-0.794*	-0.482	0.539	0.464	-3.832***	-2.757
	(0.411)	(0.538)	(0.438)	(0.635)	(1.382)	(2.010)
log BankSize	-0.0248***	-0.0346***	0.0106	-0.0297***	-0.0942***	0.00206
	(0.00693)	(0.00937)	(0.00768)	(0.0112)	(0.0246)	(0.0357)
stLiab/totalLiab	0.0168	-0.0182	0.0715*	-0.0387	-0.0281	-0.444**
	(0.0365)	(0.0493)	(0.0416)	(0.0617)	(0.134)	(0.198)
CBFundingBankSize	-0.467*	-0.921***	0.0451	0.569	1.197	-0.570
	(0.267)	(0.331)	(0.288)	(0.384)	(0.902)	(1.189)
BusinessLoansTotalAssets	-0.0471	0.0387	-0.0869	-0.314***	0.297*	-0.195
	(0.0510)	(0.0685)	(0.0560)	(0.0821)	(0.176)	(0.258)
ProvisionTotalIncome	-0.168**	-0.0697	0.198**	0.0615	-0.451*	-0.479
	(0.0741)	(0.0991)	(0.0803)	(0.118)	(0.258)	(0.363)
Constant	0.480**	0.732**	0.0166	1.135***	2.007***	-0.0738
	(0.236)	(0.331)	(0.238)	(0.366)	(0.761)	(1.300)
Firm fixed-effects	yes	yes	yes	yes	yes	yes
Bank-type fixed-effect	yes	yes	yes	yes	yes	yes
N	6776	3447	5408	2808	4522	2290
R^2	0.397	0.362	0.453	0.394	0.532	0.517
R^2 (adjusted)	0.130	0.116	0.138	0.0980	0.209	0.222

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Online Appendix

Figure 5: Lending behaviour of more/ less central banks, where the change in centrality from pre to post period is either above or below the median; normalised lending, where the reference period is the mean of shock period; Sample Commercial Banks (ENTRY dataset)

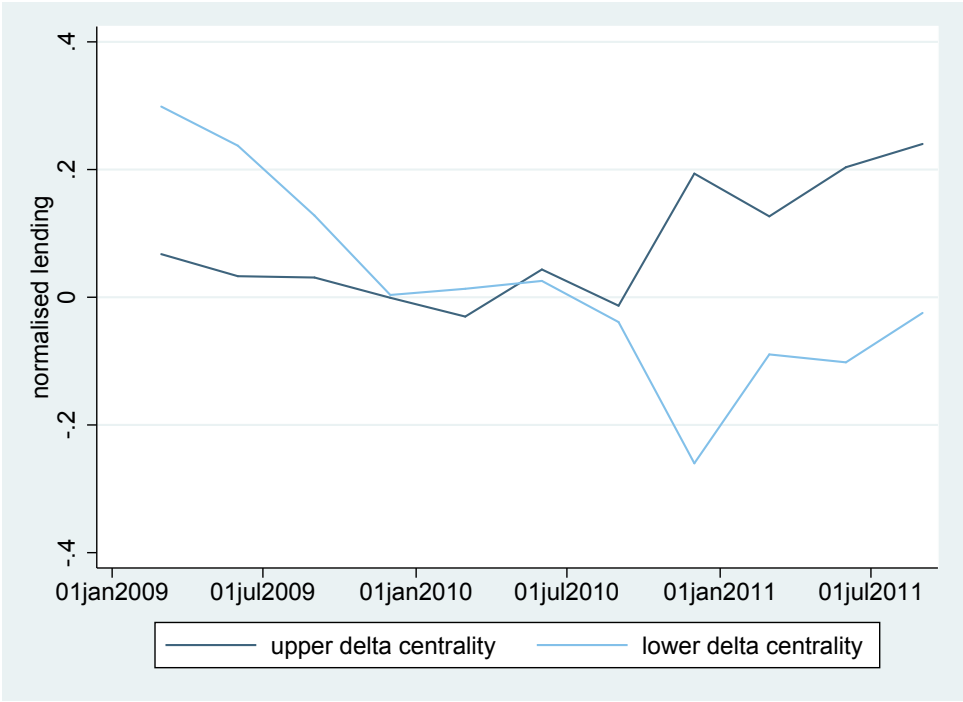


Figure 6: Histogram of percentage change in network position from Pre-Shock to Post-Shock shock period for various sample restrictions. The only difference between the panels is the definition of what 'same neighbors' means. Top left: A bank has the same neighbors if it has the exact same neighbors in the Pre-Shock and Post-Shock period ($4,433$ of out $6,101$ banks). Top right: A bank has the same neighbors in both periods if it has at least two neighbors and all neighbors are exactly the same in the Pre-Shock and Post-Shock period (504 banks). Bottom left: A bank has the same neighbors in both periods if it has more than five neighbors and all neighbors are exactly the same in the Pre-Shock and Post-Shock period (26 banks). Bottom right: A bank has the same neighbors in both periods if it has at least two neighbors in the Pre-Shock period and at least 90% of its neighbors are identical in the Pre-Shock and Post-Shock period (514 banks).

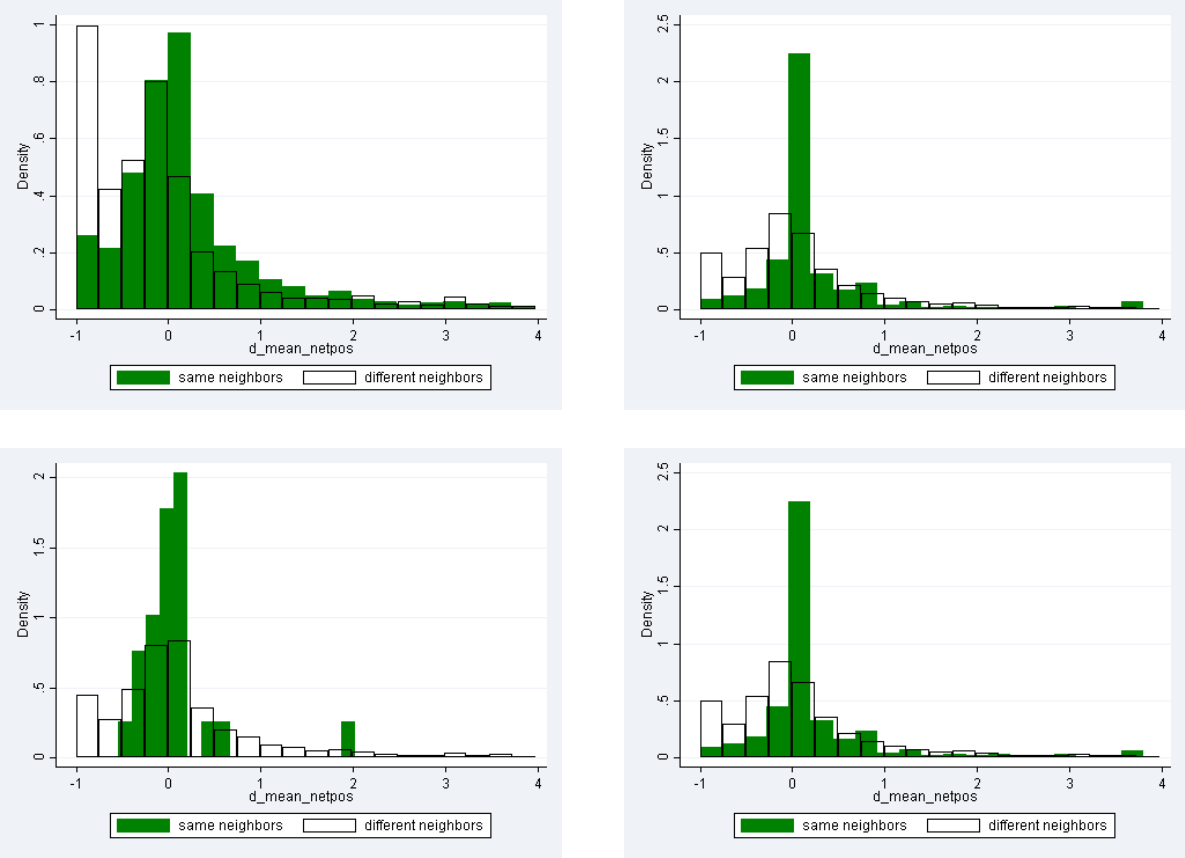


Table 11: Intensive Margin (PRE at least once lending, POST at least once lending), controlling for collateral to total securities, Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to All Banks (1-2) and Commercial Banks(3-4), where a dummy for the type of bank is included; firm fixed effects and type of bank dummies included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)
	delta_log_volume	delta_log_volume	delta_log_volume	delta_log_volume
B_EquityRatio_pre	-1.869*	-0.977	-3.752	0.209
	(1.123)	(1.200)	(4.582)	(5.263)
B_LogBankSize_pre	-0.0624***	-0.0598***	-0.0331	-0.0327
	(0.0200)	(0.0207)	(0.0865)	(0.0910)
B_shorttermLiabtotalLiab_pre	-0.109	-0.0876	-0.723**	-0.249
	(0.112)	(0.122)	(0.293)	(0.377)
B_CBFunding_BankSize_pre	0.416	0.621	2.861	-2.316
	(0.743)	(0.766)	(2.547)	(3.444)
B_BusinessLoans_TotalAssets_pre	0.00493	0.00359	0.205	0.509
	(0.147)	(0.157)	(0.685)	(0.793)
B_Provision_TotalIncome_pre	-0.135	-0.101	-0.325	-1.017
	(0.208)	(0.220)	(0.934)	(1.014)
delta_EquityRatio	-0.123	0.578	15.47*	17.26
	(3.074)	(3.353)	(8.666)	(10.53)
delta_LBankSize	0.233	0.400**	-0.0476	0.0456
	(0.144)	(0.166)	(0.298)	(0.395)
delta_stTOtotalliabilities	-0.0733	-0.0913	-0.526	-0.768
	(0.150)	(0.187)	(0.425)	(0.830)
delta_CBFunding_Size	2.387*	2.780**	4.149	1.878
	(1.249)	(1.288)	(5.530)	(6.495)
delta_BLoansTOtotalAssets	0.202	0.481	0.926	0.950
	(0.424)	(0.452)	(1.512)	(1.660)
delta_provisionTOtotalIncome	0.244	0.167	-1.627	-1.197
	(0.230)	(0.241)	(1.472)	(1.778)
ln_network_B_pre	4.959*	5.401*	54.46**	38.68
	(2.800)	(3.066)	(21.91)	(23.86)
ln_delta_network_B	26.56***	16.37	81.20**	93.00*
	(9.853)	(11.95)	(31.78)	(48.61)
B_collateralsecurity_pre		0.247		0.484
		(0.243)		(0.469)
delta_collateralTOsecurities		0.722**		0.254
		(0.305)		(0.904)
_cons	1.031	0.676	-4.206*	-4.703**
	(0.832)	(0.879)	(2.193)	(2.347)
N	7126	6974	2347	2233
r2	0.491	0.492	0.710	0.717
r2_a	0.177	0.175	0.114	0.119

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Extensive Margin EXIT (PRE at least once lending, POST always no lending), controlling for collateral to total securities, Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to All Banks (1-2) and Commercial Banks(3-4), where a dummy for the type of bank is included; firm fixed effects and type of bank dummies included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)
	EXIT3	EXIT3	EXIT3	EXIT3
B_EquityRatio_pre	0.129	0.0619	0.330	0.327
	(0.343)	(0.364)	(1.171)	(1.306)
B_LogBankSize_pre	0.00302	0.00515	-0.0579***	-0.0365
	(0.00601)	(0.00625)	(0.0218)	(0.0234)
B_shorttermLiabtotalLiab_pre	0.00688	-0.00897	0.0723	0.203**
	(0.0336)	(0.0370)	(0.0725)	(0.0952)
B_CBFunding_BankSize_pre	0.0992	0.131	0.0256	-0.637
	(0.224)	(0.231)	(0.636)	(0.856)
B_BusinessLoans_TotalAssets_pre	-0.137***	-0.169***	-0.484***	-0.341*
	(0.0446)	(0.0475)	(0.161)	(0.189)
B_Provision_TotalIncome_pre	0.0967	0.137**	-0.196	-0.0493
	(0.0631)	(0.0671)	(0.236)	(0.253)
delta_EquityRatio	-0.829	-1.668*	0.878	-4.059
	(0.913)	(0.996)	(2.195)	(2.682)
delta_LBankSize	-0.0597	-0.0967**	0.00278	-0.00600
	(0.0423)	(0.0484)	(0.0764)	(0.101)
delta_stTOtotalliabilities	-0.166***	-0.0359	-0.404***	0.236
	(0.0439)	(0.0551)	(0.102)	(0.218)
delta_CBFunding_Size	-0.355	-0.221	-1.960	-2.542
	(0.380)	(0.391)	(1.348)	(1.571)
delta_BLoansTOtotalAssets	-0.286**	-0.330**	-0.421	-0.599
	(0.125)	(0.133)	(0.368)	(0.396)
delta_provisionTOtotalIncome	-0.0446	0.00352	0.312	-0.126
	(0.0681)	(0.0713)	(0.373)	(0.447)
ln_network_B_pre	-2.128**	-2.248**	-1.419	-5.606
	(0.856)	(0.936)	(5.571)	(5.961)
ln_delta_network_B	-9.507***	-10.31***	-3.903	-21.81*
	(2.954)	(3.587)	(8.122)	(12.39)
B_collateralsecurity_pre		0.0773		0.280**
		(0.0741)		(0.118)
delta_collateralTOsecurities		-0.0258		0.0184
		(0.0898)		(0.241)
_cons	0.281	0.221	1.281**	0.633
	(0.239)	(0.254)	(0.579)	(0.616)
N	8532	8336	2801	2647
r2	0.421	0.427	0.689	0.702
r2_a	0.124	0.129	0.146	0.157

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Extensive Margin ENTRY (PRE no lending, POST at least once lending), controlling for collateral to total securities, Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to All Banks (1-2) and Commercial Banks(3-4), where a dummy for the type of bank is included; firm fixed effects and type of bank dummies included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)
	ENTRY3	ENTRY3	ENTRY3	ENTRY3
B_EquityRatio_pre	-1.432***	-1.582***	-3.841***	-5.145***
	(0.316)	(0.335)	(1.095)	(1.292)
B_LogBankSize_pre	-0.0287***	-0.0233***	-0.0694***	-0.0639***
	(0.00542)	(0.00560)	(0.0189)	(0.0207)
B_shorttermLiabtotalLiab_pre	0.0103	-0.0355	0.0812	0.0460
	(0.0292)	(0.0338)	(0.0583)	(0.0894)
B_CBFunding_BankSize_pre	-0.582***	-0.484**	-1.522***	-0.849
	(0.207)	(0.213)	(0.566)	(0.795)
B_BusinessLoans_TotalAssets_pre	-0.000377	-0.0516	-0.261*	-0.371**
	(0.0401)	(0.0431)	(0.152)	(0.185)
B_Provision_TotalIncome_pre	-0.0659	-0.0189	-0.732***	-0.688***
	(0.0575)	(0.0610)	(0.216)	(0.236)
delta_EquityRatio	-1.359*	-1.274	-1.459	-2.665
	(0.781)	(0.883)	(1.719)	(2.397)
delta_LBankSize	0.0857**	0.0732*	0.0430	0.146*
	(0.0361)	(0.0399)	(0.0656)	(0.0815)
delta_stTOtotalliabilities	-0.0862**	-0.0507	-0.106	0.179
	(0.0383)	(0.0498)	(0.0856)	(0.186)
delta_CBFunding_Size	-0.563	-0.465	-2.186*	-1.804
	(0.345)	(0.355)	(1.197)	(1.427)
delta_BLoansTOtotalAssets	0.638***	0.524***	-0.237	-0.561
	(0.107)	(0.117)	(0.357)	(0.395)
delta_provisionTOtotalIncome	-0.0979	-0.0695	-1.150***	-1.553***
	(0.0634)	(0.0660)	(0.356)	(0.409)
ln_network_B_pre	3.376***	3.582***	6.409	4.357
	(0.778)	(0.849)	(4.993)	(5.645)
ln_delta_network_B	11.46***	11.26***	15.94**	-2.282
	(2.503)	(3.090)	(6.428)	(10.74)
B_collateralsecurity_pre		0.0938		-0.0303
		(0.0627)		(0.107)
delta_collateralTOsecurities		0.0635		0.480**
		(0.0748)		(0.194)
_cons	0.532**	0.402	1.459**	1.517**
	(0.239)	(0.248)	(0.573)	(0.610)
N	10575	10279	3693	3448
r2	0.378	0.388	0.624	0.658
r2_a	0.129	0.136	0.129	0.168

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Intensive Margin (PRE at least once lending, POST at least once lending), Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to Commercial Banks; firm fixed effects included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)	(5)	(6)
	delta_log_volume	delta_log_volume	delta_log_volume	delta_log_volume	delta_log_volume	delta_log_volume
ln_delta_network_B	15.85***	31.04**	53.19***		22.85***	71.93***
	(3.529)	(12.05)	(14.68)		(4.152)	(16.35)
delta_EquityRatio		-0.720	0.460	-7.761***		3.649
		(3.222)	(3.692)	(2.906)		(3.888)
delta_LBankSize		-0.284**	-0.506***	-0.203		-0.455***
		(0.142)	(0.163)	(0.154)		(0.164)
delta_stTOtotalliabilities		0.0511	-0.172	-0.0108		-0.369*
		(0.149)	(0.211)	(0.210)		(0.224)
delta_CBFunding_Size		0.108	7.043**	2.269		5.949**
		(1.503)	(2.799)	(2.710)		(2.828)
delta_BLoansTOtotalAssets		-1.236*	-2.271**	-0.413		-1.387
		(0.701)	(0.944)	(0.981)		(1.003)
delta_provisionTOtotalIncome		1.528**	0.204	-0.966		-0.730
		(0.662)	(0.766)	(0.847)		(0.846)
B_EquityRatio_pre			-2.679	0.211		-6.128**
			(2.217)	(2.152)		(2.584)
B_LogBankSize_pre			0.0237	0.0763*		-0.0233
			(0.0437)	(0.0416)		(0.0472)
B_shorttermLiabtotalLiab_pre			-0.273*	-0.273*		-0.336**
			(0.143)	(0.144)		(0.144)
B_CBFunding_BankSize_pre			2.273*	2.500*		2.132
			(1.341)	(1.342)		(1.341)
B_BusinessLoans_TotalAssets_pre			-0.374	-0.164		-0.393
			(0.349)	(0.345)		(0.348)
B_Provision_TotalIncome_pre			-1.073**	-0.525		-1.382***
			(0.462)	(0.437)		(0.477)
ln_network_B_pre				7.593	16.71***	30.39***
				(10.55)	(5.248)	(11.73)
_cons	-0.542	-0.722	-0.287	-1.975	-0.964	0.342
	(1.220)	(1.180)	(1.551)	(1.482)	(1.226)	(1.568)
N	6853	6413	6413	6413	6853	6413
r2	0.633	0.656	0.660	0.658	0.634	0.660
r2_a	0.167	0.213	0.219	0.216	0.170	0.221

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Extensive Margin EXIT (PRE at least once lending, POST always no lending), Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to Commercial Banks; firm fixed effects included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)	(5)	(6)
	EXIT3	EXIT3	EXIT3	EXIT3	EXIT3	EXIT3
ln_delta_network_B	-8.080***	1.917	-4.153		-9.579***	-7.183*
	(0.940)	(3.029)	(3.641)		(1.104)	(3.996)
delta_EquityRatio		3.404***	2.278***	2.885***		1.822**
		(0.787)	(0.879)	(0.696)		(0.913)
delta_LBankSize		-0.0450	0.00232	-0.0330		-0.00552
		(0.0365)	(0.0414)	(0.0388)		(0.0417)
delta_stTOtotalliabilities		-0.0908**	-0.156***	-0.151***		-0.121**
		(0.0372)	(0.0532)	(0.0538)		(0.0564)
delta_CBFunding_Size		0.532	-1.197*	-0.563		-0.961
		(0.382)	(0.674)	(0.650)		(0.686)
delta_BLoansTOtotalAssets		-0.197	-0.129	-0.358		-0.259
		(0.169)	(0.221)	(0.226)		(0.232)
delta_provisionTOtotalIncome		-0.179	0.0951	0.286		0.241
		(0.172)	(0.194)	(0.208)		(0.210)
B_EquityRatio_pre			0.549	0.499		1.111*
			(0.527)	(0.506)		(0.609)
B_LogBankSize_pre			-0.0224**	-0.0227**		-0.0135
			(0.0101)	(0.0100)		(0.0112)
B_shorttermLiabtotalLiab_pre			0.0360	0.0423		0.0449
			(0.0364)	(0.0367)		(0.0367)
B_CBFunding_BankSize_pre			-0.129	-0.137		-0.101
			(0.347)	(0.346)		(0.347)
B_BusinessLoans_TotalAssets_pre			-0.233***	-0.243***		-0.220**
			(0.0851)	(0.0844)		(0.0854)
B_Provision_TotalIncome_pre			0.0660	0.0368		0.123
			(0.116)	(0.110)		(0.120)
ln_network_B_pre				-3.037	-3.506***	-5.098*
				(2.529)	(1.354)	(2.776)
_cons	0.493*	0.536**	0.876**	0.966***	0.577**	0.750**
	(0.263)	(0.260)	(0.350)	(0.335)	(0.265)	(0.356)
N	8399	7836	7836	7836	8399	7836
r2	0.536	0.552	0.558	0.558	0.537	0.558
r2_a	0.0784	0.0982	0.109	0.109	0.0797	0.109

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Extensive Margin ENTRY (PRE no lending, POST at least once lending), Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to Commercial Banks; firm fixed effects included as well as bank controls as amount of the pre period and changes from pre to post period

	(1) ENTRY3	(2) ENTRY3	(3) ENTRY3	(4) ENTRY3	(5) ENTRY3	(6) ENTRY3
ln_delta_network_B	12.65***	-2.272	7.390***		10.94***	11.73***
	(0.794)	(2.304)	(2.831)		(0.917)	(3.157)
delta_EquityRatio		-4.029***	-3.613***	-4.696***		-3.031***
		(0.619)	(0.723)	(0.597)		(0.746)
delta_LBankSize		0.0256	-0.0134	0.0284		-0.00814
		(0.0308)	(0.0337)	(0.0323)		(0.0338)
delta_stTOtotalliabilities		-0.0211	-0.0676	-0.0677		-0.114**
		(0.0305)	(0.0422)	(0.0430)		(0.0448)
delta_CBFunding_Size		-1.057***	-1.001*	-1.880***		-1.269**
		(0.329)	(0.563)	(0.545)		(0.569)
delta_BLoansTOtotalAssets		0.601***	-0.000235	0.301		0.195
		(0.143)	(0.186)	(0.195)		(0.196)
delta_provisionTOtotalIncome		-0.481***	-0.542***	-0.818***		-0.756***
		(0.148)	(0.169)	(0.182)		(0.182)
B_EquityRatio_pre			-2.117***	-1.860***		-2.961***
			(0.451)	(0.436)		(0.526)
B_LogBankSize_pre			-0.0398***	-0.0345***		-0.0514***
			(0.00840)	(0.00799)		(0.00919)
B_shorttermLiabtotalLiab_pre			0.0527*	0.0446		0.0451
			(0.0292)	(0.0293)		(0.0293)
B_CBFunding_BankSize_pre			-0.735**	-0.669**		-0.765***
			(0.293)	(0.292)		(0.293)
B_BusinessLoans_TotalAssets_pre			-0.113	-0.0886		-0.119
			(0.0741)	(0.0737)		(0.0741)
B_Provision_TotalIncome_pre			-0.343***	-0.269***		-0.416***
			(0.101)	(0.0961)		(0.104)
ln_network_B_pre				3.443	-4.347***	7.352***
				(2.130)	(1.169)	(2.374)
_cons	-0.0724	-0.0619	0.922***	0.690**	0.0316	1.075***
	(0.284)	(0.277)	(0.340)	(0.328)	(0.285)	(0.343)
N	11187	10315	10315	10315	11187	10315
r2	0.459	0.493	0.496	0.496	0.460	0.497
r2_a	0.103	0.134	0.139	0.138	0.105	0.140

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Intensive Margin and Extensive Margin with sample split for above (1) (3) (5) or below (2) (4) (6) median according to change in employees, Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to Commercial Banks; firm fixed effects and type of bank dummies are included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)	(5)	(6)
	ENTRY [above p50]	ENTRY [below p50]	EXIT [above p50]	EXIT [below p50]	Δ log Volume [above p50]	Δ log Volume [below p50]
Δ log NetPos	15.21***	-0.372	-14.86**	-3.433	21.73	37.19
	(4.785)	(5.861)	(6.699)	(7.241)	(25.05)	(31.67)
log NetPos	6.220**	0.707	-4.445	-2.944	3.411	20.66
	(2.888)	(3.364)	(3.433)	(3.861)	(12.50)	(16.81)
ΔEquityRatio	-2.190**	-4.568***	-0.874	2.433	-2.137	-5.561
	(1.117)	(1.310)	(1.488)	(1.596)	(5.166)	(8.009)
Δ log BankSize	-0.0422	0.0910	0.0946	-0.0339	0.0288	-0.130
	(0.0527)	(0.0626)	(0.0677)	(0.0767)	(0.246)	(0.284)
ΔshorttermLiabtotalLiab	-0.0639	0.0328	-0.0421	0.00493	0.640*	-0.804**
	(0.0673)	(0.0860)	(0.0882)	(0.108)	(0.341)	(0.395)
ΔCBFundingBankSize	-1.412	-1.782*	-2.291**	-1.767	-3.150	1.454
	(0.859)	(1.036)	(1.066)	(1.220)	(4.169)	(4.649)
ΔBusinessLoansTotalAssets	0.223	0.504	0.0548	-1.165***	-1.065	-0.377
	(0.307)	(0.354)	(0.381)	(0.404)	(1.404)	(1.919)
ΔProvisionTotalIncome	-0.644***	-0.695**	0.329	-1.123***	-1.604	0.885
	(0.239)	(0.284)	(0.281)	(0.322)	(1.022)	(1.248)
EquityRatio	-2.990***	-1.605*	0.608	-0.658	-0.996	-8.361**
	(0.772)	(0.919)	(0.933)	(1.048)	(3.600)	(4.241)
log BankSize	-0.0671***	-0.0322*	-0.0158	-0.0448**	-0.0636	-0.139*
	(0.0138)	(0.0171)	(0.0173)	(0.0207)	(0.0697)	(0.0835)
stLiab/totalLiab	0.0576	0.0519	0.169***	0.164**	0.517**	-0.428
	(0.0453)	(0.0563)	(0.0616)	(0.0728)	(0.229)	(0.275)
CBFundingBankSize	-0.732	-1.689***	-0.935	-1.755**	-5.076**	0.628
	(0.476)	(0.573)	(0.589)	(0.688)	(2.182)	(2.583)
BusinessLoansTotalAssets	-0.168	0.206	-0.141	-0.359**	0.265	-0.523
	(0.110)	(0.137)	(0.130)	(0.154)	(0.540)	(0.625)
ProvisionTotalIncome	-0.484***	-0.138	0.0678	-0.520**	-1.716**	-1.332
	(0.152)	(0.191)	(0.184)	(0.218)	(0.699)	(0.867)
Constant	1.443***	0.642	0.170	1.579***	1.748	2.880
	(0.363)	(0.469)	(0.417)	(0.516)	(1.611)	(2.142)
N	5023	2830	3755	2173	3077	1775
R^2	0.495	0.517	0.571	0.594	0.674	0.698
R^2 (adjusted)	0.111	0.160	0.0839	0.163	0.197	0.286

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Intensive Margin and Extensive Margin with sample split for above (1) (3) (5) or below (2) (4) (6) median according to the ratio of fixed assets to firm size, Sovereign Debt Crisis: Pre Period Q1/2009 - Q4/2009 [Q1/2010 - Q3/2010] Post Period Q4/2010 - Q3/2011, restricted to Commercial Banks; firm fixed effects and type of bank dummies are included as well as bank controls as amount of the pre period and changes from pre to post period

	(1)	(2)	(3)	(4)	(5)	(6)
	ENTRY3	ENTRY3	EXIT3	EXIT3	delta_log_volume	delta_log_volume
B_EquityRatio_pre	-1.901***	-3.471***	2.308***	-0.609	-4.297	-3.373
	(0.676)	(0.809)	(0.771)	(0.967)	(3.402)	(3.889)
B_LogBankSize_pre	-0.0422***	-0.0736***	-0.0158	-0.000580	-0.0267	-0.0272
	(0.0118)	(0.0148)	(0.0138)	(0.0194)	(0.0571)	(0.0835)
B_shorttermLiabtotalLiab_pre	0.0606	0.0276	0.0258	0.0622	0.148	-0.565***
	(0.0413)	(0.0437)	(0.0556)	(0.0553)	(0.225)	(0.212)
B_CBFunding_BankSize_pre	-0.591	-1.207***	-0.832*	0.542	-1.487	4.312**
	(0.397)	(0.457)	(0.504)	(0.524)	(2.051)	(1.978)
B_BusinessLoans_TotalAssets_pre	0.0315	-0.203*	-0.288***	-0.179	0.208	0.107
	(0.0931)	(0.116)	(0.111)	(0.139)	(0.453)	(0.590)
B_Provision_TotalIncome_pre	-0.217*	-0.523***	-0.0194	0.00335	-1.197**	-0.246
	(0.127)	(0.162)	(0.147)	(0.200)	(0.604)	(0.815)
delta_EquityRatio	-2.287**	-2.943***	1.913	2.353*	-5.282	11.57**
	(1.062)	(1.062)	(1.403)	(1.277)	(6.645)	(5.259)
delta_LBankSize	0.0166	-0.0642	0.00733	0.0133	-0.328	-0.476*
	(0.0436)	(0.0587)	(0.0553)	(0.0719)	(0.225)	(0.274)
delta_stTOtotalliabilities	0.00677	-0.182***	0.0423	-0.248***	0.343	-0.565
	(0.0642)	(0.0652)	(0.0827)	(0.0845)	(0.335)	(0.345)
delta_CBFunding_Size	-0.563	-1.693*	-2.343**	0.395	0.638	10.66**
	(0.749)	(0.884)	(0.931)	(1.071)	(4.109)	(4.215)
delta_BLoansTOtotalAssets	0.336	-0.230	-0.136	-0.523	-1.052	-1.757
	(0.259)	(0.305)	(0.321)	(0.349)	(1.430)	(1.430)
delta_provisionTOtotalIncome	-0.450**	-0.763***	-0.246	0.417	-0.967	1.232
	(0.206)	(0.273)	(0.243)	(0.317)	(0.993)	(1.234)
ln_network_B_pre	1.660	4.943	-2.365	-4.504	3.116	28.99*
	(2.555)	(3.018)	(3.047)	(3.545)	(13.11)	(15.08)
ln_delta_network_B	8.029*	15.92***	-9.900*	-1.718	25.06	97.16***
	(4.465)	(4.672)	(5.969)	(5.824)	(25.94)	(23.53)
_cons	0.899**	2.597***	0.797**	0.115	0.429	0.828
	(0.370)	(0.432)	(0.392)	(0.465)	(1.700)	(1.892)
N	5350	4965	4228	3608	3500	2913
r2	0.480	0.508	0.551	0.573	0.619	0.704
r2_a	0.134	0.131	0.141	0.0739	0.187	0.246

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$