Local competition, innovation, and firms' bank relationships

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ABSTRACT

With firms searching for secured external funding by engaging in multiple bank relationships on the one hand and banks for profit maximization on the other hand, conflicts of interests may arise when firms' banks demand access to corporate private information. This information can help banks to gauge the creditworthiness of borrowers, but also exposes the latter to losses of secrecy. Thus, firms which are dependant on informative secrecy – especially innovative firms – might incur difficulties when trying to get access to external funding. As rival firms prevail within firms' own industries, a special focus is on effects of local industry specialization and competition when investigating the quantity of firms' bank connections.

Analysing German firm level and county specific industry data, I find evidence that the number of bank relationships decreases for the cross-section of firms with local industry diversification. The effects of the indicators of industry-specific and overall competition are twofold with the former being positively related to the probability of using multi-bank relationships and the latter negative. Concluding, firms located in industrially specialized areas might rather refrain from relationship lending, due to potential loss of external funding, while innovative firms seem to rely on transaction-based banking. Contrarily, firms located in areas that are diversified w.r.t. industries, firm sizes and corporate landscape engage in relationship banking.

JEL Classification: G32, O16, R11, R51, G21

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1. INTRODUCTION

With banks being a major source of external funding for most firms in continental Europe, the choice of the number of banking relationships is crucial for enterprises' existence.

At the early stage of a firm's life, there might be obstacles to engaging in a large variety of lending relationships, such as informational opacity or lack of collateral. Often, maintaining a single close banking connection is the only option for firms to gain external funding. While a single close bank relationship creates a familiar atmosphere between creditor and borrower on the one hand, it submits the firm to bank's interest rate policy and hold-up problems

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on the other hand (Foglia, 1998).[1] Links to a single bank are commonly regarded as indicator of relationship lending, whereas a multitude of relationships is seen as sign of transaction-based banking. The choice on which relationship type a firm should engage in is influenced by a variety of factors, such as firm's size, solvency or banking competition, and is thus hard to determine ex ante. Additionally, the number of bank relationships may not be stable over time. Firm growth might require additional external funding that cannot be provided by the initially affiliated institute.

The composition of the local industries and resulting firm level competition is a feature that might help at explaining banking relationships. On the one hand, more local industry specialization could result in stronger competition and recoverability of ideas and innovations, thus higher need for secrecy. This could scare off innovative firms to disclose their information to a multitude of banks, aware of the danger that private information might as well be accessed by rivals. With private information being highly relevant for external finance, firms' bank relationships are likely to be affected. On the other hand, banks located in specialized areas could try to diversify their portfolio, thereby credit-constraining firms of the lead industry. Furthermore, specialized environments could help banks to better assess firms' projects and to customize their products for high quality firms only. This in turn would induce firms to engage in multiple bank relationships. The quantity of firms' banking relationships could thus point to whether competitive aspects of local specialization outweigh potential benefits of externalities and concluding strategies in external funding in the eyes of an average enterprise. As a consequence, there might be a trade-off between transaction-based banking, i.e. not sharing private information and avoiding hold-up costs versus forming close ties with one bank only and thus reducing coordination costs on the one hand and easing the access to funding for small and opaque firms on the other hand.

The paper contributes to existing research in several ways: Although there is a large body of research of the implications of banking competition on firm financing and firm establishments or innovations (e.g. Aghion et al., 2005; Boot and Thakor, 2000; Cornaggia et al., 2015; Petersen and Rajan, 1995; Rice and Strahan, 2010), potential effects of firm level competition on banking relationships have been neglected so far. Hence, there is no empirical evidence on whether the benefits and disadvantages of sharing information and knowledge in specialized areas affect firms' choice of bank relationships. Using evidence form German firms, I find local industry level specialization as measure of relative competition does not affect firms' number of banking relationships significantly, while the distribution if industries and firm sizes, competition as embodied by new established firms and industries' concentration have a negative impact on the number of bank relationships.

Considering financing of innovative firms, the paper contributes to existing studies as e.g. Benfratello et al. (2006), Cornaggia et al. (2015) or Micucci and Rossi (2013). Besides analysing the impact of innovative activity on firms' bank relationships, I also provide evidence on the impact of specialized and competitive environments on innovative firms' funding. Furthermore, to the best of my knowledge, previous studies have not analysed neighbourhood effects in external funding, i.e. the impact of competing firms' bank relationship quantity on firms' external funding. This yields additional evidence on the impact of spatially close competitors' bank relationships on firms' external funding.

There are several potential implications for the economy: If firms in competitive environments prefer relationship banking over a multitude of banking relationships, the vanishing of small banks and the reduction of bank branches[2] that enable banks to process soft information adequately, has a great impact on firm financing. Small innovative firms might either no longer be able to gain external funds or locate in areas with a higher prevalence of small banks, mostly rural areas.

[1] Yet, e.g. Harhoff (1998) did not find the number of banking relationships to matter for the interest paid in data on German firms.

[2] According to the German *Bundesbank*, the number of banks in Germany has reduced from 2,912 to 1,783 between 2000 and 2018 while the number of branch offices has decreased from 56,936 to 27,887 within this period.

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Contrarily, banking competition will be affected in competitive areas if firms are more prone to relationship banking. Local banks' attempts to diversify could cause firms to engage in more bank relationships in specialized locations.

The paper proceeds as follows: The second part of the paper will discuss several factors affecting the number of banking relationships, which have already been identified in literature. Theoretical arguments for trade-off effects of local industry specialization and its effects on firms' choice of its number of banking relationships are laid out in that section as well. Section three introduces the data and summary statistics. Empirical analyses are performed in section four. Section five concludes.

2. LITERATURE REVIEW AND HYPOTHESES

Several studies investigate the number of firms' bank relationships under a variety of aspects, as e.g. lending: Ongena et al. (2012) find that the number of banking relationships and creditor concentration are not determined by the same factors. The higher the share of total loan amount granted by a firm's most important lender, the larger is the creditor's informational advantage over other lenders. Also, the strength of relationships (Neuberger et al., 2006) has been considered, where an increase in the number of bank connections can be interpreted as decrease of relationship lending of a firm (Gianetti, 2009). Although a linear relationship between the strength and the number of banking relationships is supposed, many of the existing studies only distinguish between a single and some banking relationships but not as many as observed empirically (Cosci and Meliciani, 2002).

Theoretical predictions are mixed: While borrowers engaging in multiple banking relationships must coordinate the concentration of loan amounts between creditors on the one hand, they can avoid hold-up problems on the other hand (Gianetti, 2009; Guiso and Minetti, 2010; see also Stein (2015) for empirical evidence). Besides avoiding hold-up costs, multiple banking relationships also allow firms to lend from one bank when payments towards another bank are due (Foglia et al., 1998), decrease credit crunches, especially for small firms (Detragiache et al., 2000), and offer access to a variety of financial services (Neuberger et al., 2008).

Several empirical investigations find that the number of banking relationships increases along with firm size and age (Farinha and Santos, 2002; Neuberger et al., 2006; Neuberger et al., 2008; Ongena and Smith, 2000; Ongena et al., 2012). The former might impact the number of banking relationships in various ways: As larger firms tend to choose larger banks (Berger et al., 2005), the number of banking relationships cannot be expected to grow steadily with firm size. Instead, one could expect firms to switch banks when the desired loan amounts become too high for small initial banks. As costs to found a new banking relationship are constant, they are lower for large firms (Detragiache et al., 2000), which might favour new bank connections over replacement of existing ones.

Furthermore, small firms are rather in need of bank based financing due to a lack of alternative external funding (Prantl et al., 2008). Therefore, especially small firms might seek to decrease their probabilities of financial distress by multiple lending (Carmignani and Omiccioli, 2007). Additionally, firms' creditworthiness can impact the number of bank relationships (see e.g. Cosci and Meliciani, 2002): Farinha and Santos (2002) argue that low quality borrowers might want to establish multiple banking relationships in the beginning of their funding, as those firms are granted only lower loan amounts and hence are in need of additional funding sources. Indeed, the authors find that firms of low creditworthiness establish multiple banking relationships to avoid credit crunches, while good quality borrowers do so to avoid a hold-up by their bank. A similar result was obtained by Ongena et al. (2012) and Foglia et al. (1998).

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Besides low quality firms demanding for credit from multiple institutions, banks themselves might be interested in not acting as single lender towards riskier enterprises. Harhoff and Koerting (1998) suspect that high quality firms have long lasting relationships with few lenders while firms of minor quality engage in multiple relationships as banks do not want to bear the borrower's default risk alone.

Highly related to the creditworthiness is the impact of collateral: According to soft budget constraint, firms with a high liquidation value of their assets will decide on less lenders (Guiso and Minetti, 2010). There is a body of literature on the number of firms' bank relationships in the light of coordination in case of default, e.g. Bolton and Scharfstein (1996), Foglia et al. (1998), Guiso and Minetti (2010), and Harhoff and Koerting (1998). The results of these studies suggest a high relevance of controlling for industry specific effects, especially, since specific assets in case of liquidation often can only be sold to competitors.

The duration of a banking relationship is one of the most commonly used measures for assessing its strength and indicates besides exclusivity, whether the firm relies on relationship lending (Gianetti, 2009). Long-lasting firm-bank relationships foster the reduction of informational asymmetries between firms and banks (Cenni et al., 2015; Harhoff and Koerting, 1998.), leading to potential benefits for the firm, as e.g. reduction of banks' demand for collateral (Jiménez et al., 2009). Furthermore, they enable banks to customize products for the firm (Berger and Udell, 1995). Yet, such long lasting relationships give some power to the bank and can threaten the firm to stop loan payments or demand hold-up related extra costs from the firm. Thus, firms have to pay additional premia to new outside creditors, with the hold-up problem aggravating with the duration of the relationship. As the informational asymmetry between lending and outside banks is especially large for small and opaque firms, the latter should try to establish multiple banking relationships quickly (Farinha and Santos, 2002).

The number of banking relationships might increase with the intensity of local banking competition, as well as the spatial coverage of the local banking market. This holds true as long as relationship lending is not completely substituted by transaction-based lending and banks located farther away are of minor importance (Neuberger et al., 2008). Besides avoiding hold-up costs, a multitude of banking relationships due to stronger banking competition might include c.p. lower interest rates compared to less competitive markets (Rheinbaben and Ruckes, 2004). Thus, besides being enabled to compare loan conditions between banks, firms might be exposed to lower pressure to disclose private information in the presence of stronger banking competition (Foglia et al. 1998).

2.1. Local Industry Specialization and Competition

Additionally to banking competition, firm level competition supposedly has a high impact on firms' ability to obtain stable external funding. Besides the establishment of new firms, local industry composition often is a highly relevant factor when assessing firm level competition and innovative activity.[3] It might on the one hand contribute to firms' innovations and increase their productivity, and on the other hand also increase banks' industry-specific knowledge and thus improve banks' offer of industry-specific products as well as its ability to assess firms' success.

Considering firm-level competition, a common motivation for the existence of industrially specialized areas are location advantages for firms which are reflected in firms' higher productivity. These so called Marshall-Arrow-Romer (MAR) Externalities include sharing of knowledge (including involuntary access to secret firm information), labour markets and infrastructure

[3] Note, that we distinguish between industry concentration and local specialization in order to gauge effects of industry localization on the number of banking relationships appropriately. While concentration describes the geographical settlement pattern of a single industry within multiple locations (e.g. within a country), specialization applies to the industry mix of a single location.

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and should thus ease availability to and quality of a variety of production factors.[4] Regarding innovative activity besides productivity effects of specialization are not clear: Strong competition will reduce innovation according to MAR-theory, as neighbouring firms could copy innovations very quickly (Carlino, 2001). As a consequence, monopolist competition will maximize profits from innovations most (Feldman and Audretsch, 1999). Contrarily, Fritsch and Slavtchev (2010) argue that innovations could rather take place in specialized areas, as there is more infrastructure that is customized for the industry and locally bound knowledge, i.e. more workers with industry-specific abilities.

If an environment of diversified industries fosters firms' innovations and growth, Jacobs-Externalities are present (Shuai, 2013). Thus, local diversification externalities can be described as gains in productivity by a more diverse surrounding, where ideas from different industries come together. This competition among firms and industries enables market entries of new firms (Feldman and Audretsch, 1999).

With analyses having different focuses, there are no final results, which of the two externalities ultimately fosters innovation. On the one hand, firms that are still in a development phase might rather be in need of a industry-diversified environment while elder and more established firms could favour a specialized surrounding (Duranton and Puga, 2004). But on the other hand, established industries might rather be in need of impulses and input for innovations from diversified environments. MAR externalities have a high importance when transferring industry specific knowledge. Firms willing to innovate should have such industry specific knowledge as new information is easier to gain for persons having already some experience and knowledge (Einem, 2011; Shuai 2013). Thus, innovations of competitors could be absorbed more easily. This is aggravated by firm size: due to their better access to external funds, large firms can produce innovations easier than small rivals (Rogers, 2004). Turning to different industries, research has often documented different impacts of specialization on high and low tech industries. There is empirical evidence that MAR externalities are more frequent for non-technology-intense industries whereas high-tech and service industries firms benefit from a diversified environment (Beaudry and Schiffauerova, 2009; Paci and Usai, 1999).

Yet, an unlimited flow of knowledge, as it is often assumed in studies, must be doubted, as knowledge only is advantageous, as long as it is not shared (Einem, 2011). Thus, as secrecy and non-disclosure of firm specific knowledge between firms is crucial for their existence, similar information asymmetries could occur or even be requested between firms and external funders.

2.2. Competition and Funding of Innovative Firms

For externally funded firms, long-term access to funds frequently is a substantial prerequisite for innovations. This holds not only true for purchasing fixed and working assets, but also creative personnel, who could switch jobs from credit constrained employers to non-credit constrained (Hombert and Mataray, 2017). Similarly, Mina et al. (2013) point out that long-term capital is needed in order to 'smooth' investments in research and development and to be able to retain key employees. Thus, stronger competition among firms, implying high turnover of management and key employees, will decrease the possibility of forming close long-term relationships with banks.

While banking competition might not impact firms' propensity to innovate (as in Gianetti, 2009), it might be relevant when it comes to local banking conditions: If banking competition eases access to finance, corporate innovative output should increase c.p. (Cornaggia et al., 2015). Empirical results with mixed evidence have been provided by Benfratello et al. (2006), Cornaggia et al. (2015), Farinha and Santos (2002), and Neuberger et al. (2008).

[4] A review of empirical insights into the effects of specialization in Europe can be found in Fritsch and Slavtchev (2010).

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Trade credit is another possibility to obtain external funding, but is not a perfect substitute of bank based financing. Firms with higher market power can on the hand demand more trade credit and can even demand higher rates than those paid by themselves for bank based funding (Shenoy and Williams, 2017). Additionally, trade credit is an even higher threat for firms' private information (Petersen and Rajan, 1997). This has a high relevance for innovative firms looking for access to finance and secrecy of their private information at the same time. The protection of innovations can be be difficult if firms maintain close relationships to other firms, as Hussinger (2004) points out: The protection of innovations using patents requires the initial publication of the new technology or product, which allows rival firms for reverse engineering. Hussinger (2004) finds that firms rather tend to protect their ideas by patents if their innovations will have a dominant position within markets, while early stage innovations are secured by secrecy (see also Bittelmeyer, 2007). As firms relying on trade credit will have close relationships to their suppliers and recipients, keeping information completely secret is difficult and a fragile method of protecting powerful inventions from being adopted. Therefore, we can assume that firms in specialized areas, where rival firms can adopt inventions easily and innovative firms in general will rely c.p. less on trade credit.

Concluding, we can build the following hypotheses:

H1: a) Innovative firms have a c.p. higher share of long-term financial debt.

b) Innovative firms and those located in specialized areas have a c.p. lower share of trade credit.

c) As competition hinders firms from building up close relationships with external funders that provide such debt, stronger competition among firms will affect their long-term financial debt negatively.

2.3. Competition and Bank Relationships

A frequently named way of getting access to long-term funding by banks is relationship lending, i.e. forming a close and long lasting relationship with the lending bank. Gianetti (2009) argues that relationship lending is beneficial for innovative firms as it allows individual features of loan contracts, access to long-term external funding and a higher level of secrecy of firms' ideas. The key feature of long lasting bank relationships that allow for these benefits is the resulting reduction of information asymmetries. If a firm engages in research and development processes, whose outcome is not clear ex ante and cannot be assessed robustly by outside investors, lending to those firms is considered risky. Especially small and medium enterprises (SMEs), which frequently are informationally opaque, might rather be in need of forming close ties to related banks, as future returns from projects can only be estimated by outside investors with some difficulties (Gianetti, 2009). Ways of overcoming the opacity of firms, as e.g. patents, where innovations are laid down for record, allow firms to become more transparent (Mina et al., 2013). Mann (2018) provides empirical evidence that the employment of patents as collateral facilitates external funding for innovative firms and that higher collateral patent values increased firms' external funding. Therefore, the use of relationship lending or exclusive banking relationships could decline with an increase in the use of patents.

Empirical studies found that besides long lasting firm-bank relationships, banking competition promotes innovative output of firms as well (Micucci and Rossi, 2013). Besides more favourable loan conditions, banking market competition might foster innovation by banking market entrants financing riskier projects to gain market shares (Benfratello et al., 2006). Additionally to banking competition, local firm level competition could determine the quantity of firms' bank relationships. Local competition and industry specialization could foster banks' acquisition of industry-specific knowledge, which enables local banks to offer tailored products to firms of the lead industry. Thus, multiple bank relationships not only include higher transaction costs for firms, but also

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their broader variety of financial services and products (see Aristei and Gallo, 2017) could be a lower competitive advantage in industrially specialized areas. Therefore, in order to obtain all desired financial services, firms are possibly not in need of seeking additional bank relationships, but stick to less and possibly local banks. This could be reinforced by stronger competition for funds. As banks have industry specific knowledge and can compare competitors to each other, they could try to optimize an diversify their portfolio by lending only to high quality firms of the lead industry. Obtaining funds hence could depend on relationship banking with a lender who is interest in a long lasting relationship with a borrower. Funding of competitors thus only can be considered as diversification strategy to a limited degree.

Furthermore, thorough screening and monitoring of loan applicants and borrowers should rather take place if firms act in a competitive environment. Incentives to put a lot of effort into screening are reduced if an enterprise is funded by multiple lenders (Aristei and Gallo, 2017). This favours relationship lending in competitive areas where firms have on average lower market power. Therefore, hypothesis two is

H2: Local competition and industry specialization have a negative impact on firms' probability to engage in transaction-based banking.

The above considerations are expected to hold even more for innovative firms in competitive and specialized areas where information asymmetries between firms and banks are greater.

In line with theoretical predictions, Gianetti (2009) finds the number of banking relationships to have a negative impact on the probability to innovate for firms that strongly rely on external funding. This is closely related to Hypothesis 1b): Innovative firms that depend on external funding should rather stick to relationship banking. Thus, less bank relationships could c.p. enable them to obtain the funds needed to become notably innovative. Cornaggia et al. (2015) find that the number and quality of firms' patents of U.S. firms is positively affected by state-level specialization, thus strongly indicating MAR-externalities, affecting innovation.

Yet, banks' expertise and the quality of its financial advice have high relevance to German innovative firms with most of them being externally funded to a high degree (Bittelmeyer, 2007, p. 313). Hence,

H3: Firms located in competitive areas will maintain significantly less bank relationships if they are innovative.

2.4. Effects of Competitors' Bank Relationships

Local industry specialization and the use of multiple banks seems to be beneficial for firms, as industry specific knowledge can increase banks' service and consulting quality. Yet, from borrowers' perspective, banks' industry expertise might come at a cost, as it is mostly gained by consulting competitors (Rheinbaben and Ruckes, 2004). This could impede close affiliations with a variety of banks in a competitive area, as firms might be unwilling to disclose private information to a multitude of banks with a large number of (regionally) competing firms being affiliated with the same banks. If a firm discloses information more often to a bank, the probability increases that it is obtained by a competitor (Rheinbaben and Ruckes, 2004). Therefore, (innovative) firms must disclose private information very deliberately. Although bank-financed firms are not confronted with sharing information with capital markets, disclosing private information with only a few outside investors could harm firms nevertheless severely: Banks could use firms' private information, obtained e.g. in a lending relationship, to increase its own profits, possibly in opposition to the borrower. Unless they cannot determine the intensity of their banking relationships, innovative firms thus should avoid engaging in multiple banking relationships (Guiso and Minetti, 2010), which then again exposes them to hold-up problems.

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A way to overcome this problem is the use of lending techniques that reduce information asymmetries between borrower and lender or allow external funders to assess the profitability of projects without disclosing private information. Using e.g. collateral (including patents), allows firms to disclose only non-sensitive information to outside investors or banks and enables them to engage in multiple banking relationships (Rheinbaben and Ruckes, 2004).[5] Thus we should not only consider different methods of keeping information secret, but also when which kind of protection of ideas will be applied (e.g. use of secrecy vs. patents, see Hussinger, 2004). Therefore, qualities of firm innovations matter as well for bank relationships: According to Rheinbaben and Ruckes (2004), firms only disclose information to more than one bank if the loss of innovative advantage and the loss resulting from the reaction of competitors having obtained private information is outweighed by better loan conditions. Contrarily, if the innovative lead of the new firm is large, private information will not be disclosed. As a consequence, new firms first decide on the amount of private information they share with banks and on a second stage, how many banking relations they desire.

Furthermore, the distribution of firm sizes could contribute significantly to the problems associated with a loss of secrecy of private information: E.g., if local competitors' sizes vary substantially, large firms might buy small enterprises to sell their innovations (Almeida and Kogut, 1997).

A multitude of bank relationships therefore is not a clear indicator of a low level of private information, as firms might use techniques associated with transaction-based banking, thus withholding private information. However, those techniques are rarely employed by small firms, which often are unable to provide sufficient collateral (e.g. Paul, 2007). Innovative firms thus could disclose private information in relationship banking, with the latter reducing information asymmetries and banks' demand for collateral (Jiménez et al., 2009).

Additionally, the number of chosen banking relationships is publicly observable by rival firms, enabling them to conclude whether firm has a high innovative potential. If competitors observe a rival's engagement in a single-bank relationship, this could lead the former to assume that the firm tries to hide a good innovation as illustrated by Yosha (1995).

Therefore, the fourth hypothesis to be analysed is

H4: Firms' number of bank relationships is affected by neighbour firms' bank relationship quantity.

3. DATA AND VARIABLES

3.1 Data Sources

Firm level data are obtained from Bureau van Dijk's *Amadeus* database. The data contain the names of banks firms are affiliated with, i.e. similar to Neuberger et al. (2008) all types of bank relationships are included. Firm information includes balance sheet data, patent quantity, trademarks and information on management. As e.g. Neuberger et al. (2008) find firm level variables to have more explanatory power on firms' decision on single or multiple banking relationship than bank characteristics, I focus on the former.

After correcting for missing values, the initial sample of about 90,000 firm observations is reduced to 25,031 firm specific observations in 2015 (summary statistics can be found in table 1).

Data for industry specialization as a measure of firm competition on county level is obtained from the German Federal Office of Statistics (destatis). As in most regional studies and as suggested by e.g. Cetorelli and Strahan (2006), industry composition is measured using data on

[5] If more firm information is publicly available, the risk of hold-up is much smaller (Guiso and Minetti, 2010).

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employment. A mere use of the number of firms in a region, as employed in Benfratello et al. (2006) as a proxy of measuring the possibility for externalities, is not regarded as appropriate.

Data on firms' locations from *Amadeus* was matched with the denomination of communities in German counties of the Federal Statistical Office to assign county-specific information on local industries to each firm. Data on bank addresses was obtained by the Yellow Pages by TVG; distance calculation was conducted by converting bank branches' ZIP Codes into decimal coordinates using OpenGeoDB, and then calculating (non-spherical) distances of each branch towards the investigated firms. This information is used in the following empirical investigation to calculate a measure of local banking competition.

Data on patents is provided by Bureau van Dijk based on European Patent Office's PATSTAT Database. 1,119 firms can be identified as innovative using patent applications as basis for the resulting variable (see Cornaggia et al., 2015).

3.2 Variables Definition

Besides local specialization, measured as Herfindahl-index of county employment of eleven industries, spatial industry concentration (as Herfindahl-index over all German counties) was calculated as well.[6] Industry concentration thus grasps industry specific competition rather than local competition and might be well suited to explain effects, that have been subsumed by current research using dummy variables on industries. This concentration also controls for asset specificity: Higher concentration on average decreases asset heterogeneity due to less different locations and as firms with assets that can be redeployed easily will prefer a single lender (Bolton and Scharfstein, 1996), a negative coefficient is expected from the concentration variable.

Innovative ideas fostering competition are embodied by people rather than spaces (see also Feldman and Audretsch, 1999). In line with that, Hombert and Matray (2017) link funding of firms to their workers, as credit-constrained firms' inventors might be hired by competitors, who face only little financial constraints. As the opportunity of innovative workers to switch employees could be higher in specialized areas[7], firms there might be more in need to guarantee external funding. This is another hint for the necessity of firms located in specialized areas to engage in multiple bank relationships.

For each firm I calculate the share of the local employment in its own main industry. E.g. Cetorelli and Strahan (2006) use the employment share to control for the importance of an industry for a region when investigating the effects of increased banking competition. Additionally, following Paci and Usai (1999) as well as van der Panne (2004), the specialization index PS_{ij}, indicating the share of industry i in county j is used to grasp MAR externalities

$$PS_{ij} = \frac{E_{ij} / \sum_i E_{ij}}{\sum_j E_{ij} / \sum_i \sum_j E_{ij}} \tag{1}$$

where E_{ij} is employment in industry i in county j. Thus, the more elaborate measurement of specialization adjusts the above mentioned regional share of employees in a firm's industry to industry size.

Besides the aforementioned Herfindahl-Index on local industry composition, the competition of firms within a certain industry within a also country is captured by the variable $COMP_{ij}$ following van der Panne (2004).

[6] An overview with all variables used and their description can be found in the appendix

[7] Hombert and Matray (2017) find only weak evidence of inter-industry mobility of inventors.

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$$COMP_{ij} = \frac{firms_{ij} / E_{ij}}{\sum_i \sum_j firms_{ij} / \sum_i \sum_j E_{ij}} \tag{2}$$

where $firms_{ij}$ is the number of firms in county j in industry i. Although the variable was initially designed to grasp firm level competition on employees, it is used as competition measure for all input factors.

Overall industry structure can be used, on the other hand, to grasp Jacobs externalities. The variable employed thus resembles the Herfindahl-index.

$$PD_j = \frac{2}{(n_j - 1) \cdot \sum_i E_j} \sum_{i=1}^{n-1} \sum_i E_j \tag{3}$$

n_j is the number of firms residing in county j and E is employment ordered ascendingly by industry size. Thus, the cumulative sum of employment is used, similar to a Gini-Index.

The Lerner-Index as used e.g. in Aghion et al. (2005) would not be appropriate here, as the competition of industries would be reflected only by firms in the sample and thus might be biased. In contrast, the introduced measures allow for specification of competition using data of the whole population.

As Almeida and Kogut (1997) notice, not only firm sizes are relevant in a location when investigating the financial situation of innovative firms, but also their distribution in terms of size. If firm sizes are distributed unequally, large firms might buy innovative small firms, incorporating and selling the innovations of the latter. Therefore, a Herfindahl-index on firm sizes was calculated. As firm size data by employee number on county level are only provided in categories, the Herfindahl was calculated using the latter. The categories indicate the numbers of firms with 0–9, 10–49, 50–249 and 250 or more employees.

Additionally, the number of firms' establishments and close-downs within a county can be obtained from data of the German Federal Office of Statistics. Firm foundations relative to all existing firms within the county are used to grasp the attractiveness of the location towards firm founders. If the opportunities of positive location externalities outweigh the negative impact of higher difficulties to maintain secrecy, we should observe a positive coefficient in the latter estimations.

Rather than firm close-downs, I use a ratio of acquisitions to newly registered firms to grasp the prevalence of established firms obtaining new innovations by buying other enterprises. A higher share of acquisitions thus presents a higher risk for innovative firms to be integrated into large companies, what could be the consequence of loss of secrecy on their innovations. A positive coefficient could indicate that large firms acquired small firms that have more widespread distribution of banking relationships and thus possibly lower secrecy. The ratio between the number of actual and former managers was included to grasp effects of frequent turnover of managers an hence the ability of building up long lasting (personal) relationships.

Innovation is frequently measured as firms' numbers of patents. While previous studies used firms' number of patents to quantify their innovative power[8], the outcome here is not clear ex ante. On the one hand, firms having more patents can be considered more innovative and thus rather sensitive to new ideas. On the other hand, if firms are able to protect their innovations with patents, they might be less prone to a loss of secrecy and not be as careful about their number of banking relationships. Therefore, patents are not perfectly reliable to describe firms' innovations (see Carlino, 2001; Hombert and Matray, 2017). To have yet an indicator of whether

[8] e.g. Cornaggia et al. (2015) propose the number of patent applications of a firm per year as measure of innovative activity and gauge the quality of the patents by the number of their citations, as in Aghion et al. (2005).

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firms are innovative or not, firms with patent applications between 2010 and 2015 are considered as innovative. Furthermore, the quality of innovations is included in additional regressions similar to Cornaggia et al. (2015) as the average number of patent citations received for patents that were granted between 2010 and 2015.

Ongena et al. (2012) define asset specificity as the share of the firms' illiquid assets ($\frac{Fixed + Intangible\ Assets}{Total\ Assets}$). This might play a major role when firms default and creditors cannot rely on liquid stocks of the firm but have to sell a number of assets to a limited number of firms (e.g. it is not reasonable to assume that a retailer could have use of a steel firm's machines).

Firms with a higher share of intangible assets (as proxy for asset opacity) could try to establish multiple banking relationships at an early stage of their life to avoid lock-in (Farinha and Santos, 2002). Additionally to asset opacity, *Intangible* is employed to consider firms' ability to offer collateral. As banks could have difficulties when estimating the actual and future value of intangible assets, relationship lending might be rather in use when the portion of intangibles is high for fixed assets.

To additionally control for the effects collateral, dummies for firms' legal forms and industries (1-digit) are employed[9] which might as well grasp overall industry-specific effects, as e.g. the need for external funding (Gianetti, 2009). Besides, as e.g. Neuberger et al. (2006) find legal form only to approximate firms' credit risk for small firms, the expected effects of the inclusion is thus mixed. Loosely following Rheinbaben and Ruckes (2004), I include the number of bank branches within a distance of 25 km from the firm in the analyses to control for local banking competition. As Alessandrini et al. (2010) find the probability of product innovations to be lower for SMEs in the presence of a high density of bank branches, the results on the coefficient could have a positive sign.

4. EMPIRICAL INVESTIGATION

4.1. Empirical Strategy and Summary Statistics

Due to the different research questions formulated in the hypotheses, I employ various empirical methods. First, multiple regressions will be in use as to determine the impact of innovative activity and local competition on firm financing.

The determination of which banking type will be in use is done by using exclusive bank relationships as indicator for relationship lending. First, I will use Probit analyses to investigate the impacts on the probability whether relationship lending is in use. Additionally, I will gauge the number of bank relationships after separating relationship borrowers from transaction-based borrowers using Heckman sample selection estimation (similar to Aristei and Gallo, 2017), which takes into account that the sample of firms engaged in multiple bank relationships is not randomly drawn from the population.

As the number of bank relationships is discrete, I use Poisson estimations to analyse hypothesis three, i.e. the impact of local competition on the number of bank relationships. Turning to the relevance of disclosure of private information and the danger of rivals obtaining access to it, I check whether the number of other firms' bank relationships in the vicinity of the firm has an additional impact on firms' choice of its number of bank relationships besides firm-level and local variables.

As can be seen from the summary statistics in table 1, it is firm specific variables that are unevenly distributed, while the gaps between mean and median for the local variables are smaller.

[9] German classification system (WZ 2008)

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They as well span between wide numbers, e.g. between zero and 829 when it comes to the number of bank branches in a circumference of 25 km from the firm's location.

Table 1
Summary statistics for explanatory variables

	Min	Median	Mean	Max
Trademarks	0	0	3.153	3890
Age	0	3.219	3.248	6.405
Manager act/form	0.0556	2	2.7794	54
Equity ratio	0	0.3678	0.3885	1
Patents	0	0	31.47	187286
Locations	0	0	2.404	283
Tradecredit	0	0.0739	0.1342	1
Act Managers	0	7	9.198	394
Intangible	0	0.0027	0.0234	5.5531
Total assets	4.32	9.601	9.85	19.761
$Banks_{25}$	0	203	261	829
$HHI_{Firm_{Size}}$	0.6984	0.8113	0.8088	0.8825
COMP	0.0163	1.3605	1.6886	41.2349
PS	0.0352	1.0682	1.1704	10.2543
PD	0.0847	0.1423	0.14	0.1994
$HHI_{Concentration}$	0.0053	0.0081	0.0096	0.0254
$Share_{Industry}$	0.0030	0.2020	0.1881	0.5767
$HHI_{Specialization}$	0.1566	0.1933	0.1992	0.3766
Firms est.	0.7714	0.9845	0.9927	1.2209
Firms acq.	0.0107	0.0761	0.0769	0.3386

Source: Author's calculation based on data from the German Federal office of Statistics, Yellow Pages, and Amadeus.

4.2. Funding of Innovative Firms

Analysing hypothesis one, I test whether firms' innovative activity and local competition have effects on funding. As dependent variables, I use long-term debt and trade credit with the latter as indicator for lower relevance for banks and higher reliance on other enterprises. Both variables are set in relation to all liabilities and total assets respectively. The results are displayed in table 2.

Regressions (3)–(6) yield that the use of trade credit decreases with an increase in local own industry specialization as well as in patents' quality gauged by the number of citations. The importance of protection of private information's secrecy might increase with its value and the opportunities of others to obtain and classify this information. Thus, relationships towards other firms are reduced. H1 b) thus can be confirmed to some extent: Firms having high quality innovations that could provide some market power to firms (see Hussinger, 2004) seem to avoid close contact to other firms.

The use of long-term financial debt (estimations (1), (2) and (5)) increases with local industry specialization, firm size competition and the share of intangible assets. Yet, there is a significant

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negative effect of innovative activity on firms' share of long-term financial debt. Therefore, Hypothesis 1 a) must be rejected. This partly is in line with Gianetti (2009), who finds banks to play a crucial role in the early stages of innovations for technology-intense working firms, while small firms and those with high leverage have problems at funding innovations. This could be evidence that innovative firms are e.g. funded by equity, thus relying on bank based finance to a lower degree.

Using long-term financial debt as indicator for relationship lending, the results suggest that forming close bank relationships is important for opaque (measured by *Intangible*) firms which are not able to engage in transaction-based banking and those that are confronted with a more unequal firm size distribution. Concluding, firms could rather engage in close bank relationships to avoid loss of secrecy and secure long-term access to external funding in the presence of high competition and credit constraints, while closer relationships to other firms can be found in more diversified areas. Stronger overall diversification has a positive effect on the share of trade credit as well as industry specific competition and competition measured by market entrants (*Firms est.*). This suggests that firms in diversified areas have less private information, allowing them to replace bank relationships with financial relationships to other firms.

Thus, we must be consider that firms rather replace bank relationships with trade credit in the presence of a diversified industrial environment, higher competitive pressure by market entrants and more unequally distributed firm sizes. High quality innovative firms seem to refrain from external funding by other firms, while innovative firms have c.p. less long-term financial debt. With respect to hypotheses two and three, this would suggest that innovative firms fund by engaging in transaction-based banking, possibly protecting their ideas by means of patents or not disclosing private information to banks. Considering long-term financial debt as indicator for close bank relationships, firms in specialized areas rather seem to engage in relationship lending. A more detailed analysis of relationship vs. transaction-based banking will be performed in the next section.

4.3. Type and Number of Bank Relationships

Innovative firms seem to make less use of long-term funding and means of obtaining external funds depend on the quality of their innovations. Although the coefficients in the previous section are small in value, they are consistent with the coefficient of the diversification variable and throughout different definitions of dependent variables.

To investigate firms' propensity of forming close bank relationships, probit models are presented in estimations (7)–(9), where estimation (9) is the selection equation for a Heckman estimation, where *Innovative* was used as exclusionary variable. Single bank relationships are a common indicator of relationship banking (e.g. Berger and Black, 2011) and are used as in the following as proxy for relationship lending. The results are displayed in table 3.[10] The Inverse Mill's Ratio in estimation (10) is insignificant, thus not suggesting any sample selection issues, which could arise due to e.g. firms facing lock-in situations with single bank relationships.

Firm size concentration, local overall industry specialization and establishment of new firms have strong influences on the choice whether to engage in relationship banking. Those variables, especially firm size distribution, are strong indicators of competition, thus suggesting that hypothesis two cannot be rejected: Competition, measured by firm size distribution and higher overall industry specialization decrease the probability of multiple bank relationships as suggested.

Banking competition, grasped by the number of bank branches in a circumference of 25 km from the firm, increases the probability of relationship banking, while the coefficient of the

[10] Firm level controls correspond to the variables as shown in table 1.

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outcome equation is negative, indicating less bank relationships in the presence of a higher number of bank branches in the vicinity of the firm. This is unexpected: stronger bank-level competition could lead on average to more banking relationships, as e.g. found by Neuberger et al. (2008). Consequently, firms might face lower credit constraints from their own bank, reducing the probability of lock-in situations. The result obtained here, together with the coefficient on PD suggests that not only firm competition, but the location itself matters. A higher number of bank branches frequently prevails in an urban location and a higher level of diversification suggests economies of urbanization rather than localization. Carlino (2001) suggests that firms located in urban areas tend to use more patents as for them the maintenance of private information secrecy is more expensive. More patents therefore might not reflect higher innovative activity but rather higher effort to keep private information secret. This could additionally allow for transaction-based banking, using e.g. patents as collateral (Mann, 2018). To check this, population density was included additionally in unreported regressions to capture effects associated with urbanization, the centrality of the location and other related properties. Though being highly statistically significant, the coefficient on inhabitants per square-kilometre was not economically significant and did not alter virtually any of the other coefficients in magnitude or significance.

In line with those findings, the positive coefficients on $COMP_{ij}$ and local share of firm's own industry indicate a lower probability for firms under industry specific competitive pressure to engage in relationship banking.

This reflects previous results from estimations (1)–(6) that showed c.p. lower shares of long-term external funding for firms in competitive areas. The result thus could be a consequence of a local industry specific competition for funds or less innovative activity due the distribution of local market power. In fact, $Share_{Industryi}$ and the number of patents have no statistically significant correlation, [...] *Long Term Liabilities/Total Assets* and industry share have a statistically significant negative correlation of about -0.1 similar to the share of intangible fixed assets (about -0.06). The correlations of $COMP_{ij}$ towards these variables are about -0.01 with very low significance, insignificant and negative (about -0.02), thus only roughly in line with the correlations of $Share_{Industryi}$. Although the correlations are not too high in magnitude, they point to a use of transaction-based banking in the presence of local industry specialization, thus enabling firms to engage in multiple bank relationships without having to fear a loss of secrecy.

The ratio between actual and former managers proved to have a highly significant impact and to be positive throughout the regressions. This could be due to size effects, as a higher coefficient suggests firm growth, thereby creating additional demand for financial services or products.

The coefficient on industry concentration in estimation (8) is highly significant and negative. Firms of concentrated industries might choose less banking relationships, as the redistribution of collateral in case of default might be facilitated for industries that are not geographically disperse. Yet, the coefficient could also capture other firm specific preferences for external financing, which are grasped by industry dummies in other estimations (see Cetorelli and Strahan, 2006).

Overall local specialization has a highly significant correlation of about -0.05 towards intangible fixed assets, which might further explain the higher probability of engaging in single bank relationships for firms located in industrially diversified areas.

Along with theoretical arguments, firms with on average highest share of intangible fixed assets maintain no banking relationship. This indicates the shortcomings of a lack of collateral. The availability of tangible assets might thus indicate the degree of how strongly firms are credit constrained (see Hombert and Matray, 2017, p. 2427); Farinha and Santos, 2002, p. 140, use the ratio of $\frac{Tangible\ Assets}{Debt}$ to assume firms' ability to grant securities to lenders).

The results here show that the rejection of hypothesis two, i.e. stronger competition and industry specialization decrease c.p. a firm's probability to engage in transaction-based banking, depends on competition indicators. While we find that industry-specific competition and industry

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share increase a firm's probability to engage in multiple bank relationships, unequal firm size distribution, more foundations of new firms and higher overall industry concentration robustly decrease its probability of engaging in relationship lending.

In line with this, there is slight evidence that diversification, measured by PD, decreases firms' probability of using multiple bank relationships as well as the number of bank relationships. The coefficient on innovative activity is positive, which is in line with the previously found negative coefficient in estimation (1), indicating a more frequent use of transaction-based banking for innovative firms. This contradicts hypothesis three at a first glance, hence a more differentiated analysis could shed light on the relation between innovation, competition and bank relationships.

The empirical distribution of the number of bank relationships does not match the Poisson distribution with equal mean. Overdispersion tests reveal deviation of the sample variance from the mean and further investigations indicate underdispersion, which is due to a higher number of single bank relationships than suggested by a Poisson distribution, possibly due to lock-in effects.

Table 2
OLS regressions on external funding

	Dependent Variable					
	Long Term Financial Debt / All Liabilities		*Trade Credit / All Liabilities*		*Long Term Financial Debt / Total Assets*	*Trade Credit / Total Assets*
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.085	-0.247**	0.332***	0.254***	0.028	0.163*
Trademarks	0.0001*	0.0001	0.00001	0.00001	0.00004	-0.00001
Age	0.001	0.001	-0.009***	-0.009***	-0.004	-0.005***
Manager act/form	0.003***	0.003***	0.0001	-0.00000	0.001**	0.0003
Equity ratio	-0.171***	-0.172***	0.023***	0.025***	-0.285***	-0.115***
Patents	0	0	0	0	0	0
Locations	-0.0004**	-0.001**	0.0001	0.0001	-0.0004**	0.0001
Act Managers	-0.002***	-0.002***	-0.0002*	-0.0002*	-0.001***	-0.0001
Intangible	0.156***	0.149***	-0.010	-0.009	0.265***	0.065
Total assets	0.021***	0.021***	0.004***	0.004***	0.007***	0.0004
$Banks_{25}$	-0.0002***	-0.0002***	-0.00002***	-0.00002***	-0.0001***	-0.00001*
$HHI_{Firmsize}$	0.384***	0.404***	0.082	0.06	0.271***	0.067*
COMP	0.001	0.0005	0.002***	0.002***	0.001	0.0005
PS	0.008**	0.008**	-0.003*	-0.003	0.006*	-0.003**
PD	-0.210	-0.217	0.286***	0.298***	-0.305***	0.122*
Firms est.	-0.021	-0.004	0.033*	0.031*	-0.013	0.038***
Firms acq.	0.00004	0.009	-0.007	0.004	-0.078	0.017
$Avg.\ Citations_{2010–2015}$	0.006		-0.004*			
Innovative	-0.037***		-0.005			
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Legal Form Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,860	25,021	23,860	25,021	25,021	25,021
adj. R^2	0.2059	0.2038	0.06223	0.06104	0.1396	0.1092

Significance levels are based on robust standard errors and are indicated by * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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Table 3
Probit and sample selection estimation on multiple banks dummy

	Dependent variable			
	Multiple Banks Dummy		Multiple Bank Relations No	
	Probit		Selection	Outcome
	(7)	(8)	(9)	(10)
Intercept	0.574 (1.067)	0.498 (1.15)	6.313 (146.955)	6.040*** (0.452)
$Banks_{25}$	-0.0004*** (0.0001)	-0.0004*** (0.0001)	-0.0004*** (0.0001)	-0.0002*** (0.0001)
$HHI_{Firmsize}$	-1.312*** (0.4)	-1.161*** (0.398)	-1.645*** (0.408)	-1.773*** (0.424)
COMP	0.006 (0.007)	0.011** (0.005)	0.005 (0.007)	-0.005 (0.007)
PS	-0.001 (0.018)		0.0003 (0.018)	0.015 (0.018)
PD	-1.527* (0.831)		-1.286 (0.85)	-1.397* (0.834)
$HHI_{Concentration}$		-23.547*** (2.156)		
$Share_{Industry}$		0.212** (0.099)		
$HHI_{Specialization}$		1.243*** (0.354)		
Firms est.	-0.914*** (0.15)	-0.943*** (0.15)	-0.920*** (0.153)	-0.575*** (0.178)
Firms acq.	-0.527 (0.349)	-0.551 (0.346)	-0.443 (0.357)	-0.601* (0.36)
$Avg.\ Citations_{2010–2015}$			-0.001 (0.023)	
Innovative			0.114* (0.062)	
Inverse Mill's Ratio				0.179 (0.188)
Firm Level Controls	Yes	Yes	Yes	Yes
Legal Form Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	No	Yes	Yes
Observations	25,031	25,031	23,869	15,279 (uncensored)
Log Likelihood	-14,307.59	-14,482.9	-13,699.13	
Akaike Inf. Crit.	28,733.17	29,051.82	27,512.26	
Pseudo-R^2 (McFadden)	0.12617	0.11546	0.16333	
Adj. R^2				0.1143

Significance levels are based on robust standard errors and are indicated by * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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As the dependent variable's mean and variance do not coincide in all samples, a maximum likelihood (ML) poisson approach might not be suited best (see e.g. Ronning, 1991; Zeileis, 2008). Therefore, sandwich errors are used rather than Quasi Maximum Likelihood estimation, with the former having preferable properties (see Cameron and Trivedi, 2013). The results of the estimations can be found in table 4 (Average mean effects can be found in the Appendix).

To begin with, most of the results of the previous estimations are confirmed in significance and sign with some adaptions in magnitude. Firm age, number of current managers, firm size (Total assets) and number of locations are mostly significant and have the expected positive sign. The positive coefficient on the Herfindahl-Index on local specialization indicates more bank relationships for firms as the local industry composition becomes more uniform, which is in line with the previous results on long-term financial debt. The coefficient on the more elaborate diversification measure *PD* is negative and significant, confirming the aforementioned result.

The coefficient on the *Innovative* dummy variable in estimation (14) again is positive, indicating that firms with a high innovative activity tend to engage in multiple bank relationships instead of securing long-term access to funding or firm secrecy by relationship banking as suggested (e.g. Jiménez et al., 2009; Rheinbaben and Ruckes, 2004). With innovation being measured via patent applications, the need for secrecy might be represented insufficiently. Similarly, the quantity of patents does not seem to impact firms' decisions on financing partners, possibly as the procedure of protecting new innovations by patent applications, grasped by the *Innovative* dummy variable, could allow for a multitude of external funding partners.

The coefficient on *Firms acq.* is significant throughout estimations (12) to (14) indicating that firms engage in less bank relationships in places, where a large share of firms is acquired.

Additionally, the portion of newly established firms within the county has a significant negative impact on the number of banking relationships with an average mean effect ranging between -0.87 and -0.91. This result seems to confirm that positive location effects do not outweigh increasing competition and rather point to a higher ambition for relationship banking in the presence of strong competition embodied by new firms and firm takeovers, which is in line with hypotheses two and three. This could secure long-term external funding in the presence of high competitive pressure and include a more thorough monitoring and higher disclosure of firm level information.

As the coefficient on the interaction term between *Innovative* and *PD* is very high in magnitude, potential interdependencies between the coefficient and industry specialization must be considered. The impact of local diversification is notably higher for innovative firms, which could be evidence that innovative firms in diversified areas try to reduce information asymmetries and obtain long-term funding by engaging in relationship banking. Furthermore, Jaffe et al. (1993) find citations of patents within patents often to originate from different industry fields. Thus, diversification might benefit innovation which would be evidence for Jacobs externalities, in line with Feldman and Audretsch (1999) who found that less competition benefits the innovative activity of an area. This suggests that competition is stronger in diversified areas, which could be due to smaller pools of labour force or infrastructure. Therefore, more local diversification represents stronger competition for innovative firms and induces them – in line with hypothesis three – to maintain closer banking relationships.

This result could as well point to credit constrains of firms in specialized areas. Banks, trying to limit their dependency on one industry, might restrict their business in terms of loan amounts. As a result, firms would have to engage in additional bank relationships. But the industry-specific measures of specialization and competition are still very small and insignificant.

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Table 4
Results of Poisson Estimation

	Dependent Variable			
	Number of Bank Relationships			
	(11)	(12)	(13)	(14)
Intercept	-0.006	1.223	1.162	2.175***
Trademarks	0.0001	0.00005	0.0001	0.00003
Age	0.223***	0.219***	0.232***	0.219***
Manager act/form	0.018***	0.017***	0.017***	0.017***
Equity ratio	0.026*	0.014	-0.016	0.012
Patents	-0.00001	-0.00001	-0.00001	-0.00001
Locations	0.001**	0.001***	0.001**	0.001***
Tradecredit	-0.004	-0.005	0.026	-0.011
Act Managers	0.003***	0.003***	0.003***	0.003***
Intangible	-0.116*	-0.102	-0.123*	-0.103
Total assets	0.030***	0.033***	0.029***	0.034***
$Banks_{25}$		-0.0002***	-0.0002***	-0.0002***
$HHI_{Firmsize}$		-0.831***	-0.808***	-0.914***
COMP		-0.001	0.005**	
PS		0.002		
PD		-0.768**		
$HHI_{Concentration}$			-12.485***	
$Share_{Industry}$			0.039	
$HHI_{Specialization}$			0.552***	
Firms est.		-0.396***	-0.404***	-0.413***
Firms acq.		-0.379***	-0.379***	-0.330**
Avg. $Citations_{2010–2015}$				-0.011
Innovative				0.377**
Innovative*COMP				0.017
Innovative*PS				0.014
Innovative*PD				-2.568**
Legal Form Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	No	Yes
Observations	25,031	25,031	25,031	23,869
Akaike Inf. Crit.	78,867	78,744	78,964	75,110
Pseudo- (McFadden)	0.04705	0.04871	0.04566	0.048742

Significance levels are based on sandwich errors and are indicated by * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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While competition seems to increase the number of bank relationships, consistent with our previous findings, the effect is not robust and small in number. Thus, local industry specific specialization does not have significant effects on the number of bank relationships, which undermines the previously found weak relevance of local specialization in firms' industries for their number of bank relationships. Considering the findings of the highly significant and negative coefficients on firm establishment, firms might rather tend to engage in relationship banking in areas where new competition prevails rather than merely industry specific competition. Also, the negative sign of the coefficient on size concentration indicates less bank relationships if firm sizes are more unequally distributed.

Overall, the results suggest that firms' choice on its number of bank relationship is strongly negatively influenced by local overall industry specialization, local firm size distribution, and establishments and acquisitions of new firms rather than industry specific competition as measured by PS_{ij}, firms' own industry share and $COMP_{ij}$. This is surprising, as one would expect firms located in areas with industry specific competition to have a higher demand for secrecy of their innovation.

Focusing on innovative firms, the quantity and quality of patents does not seem to impact firms' decisions on financing partners, whereas the *Innovative* dummy variable, again suggests a multitude of external funding partners. The previously found negative impacts of overall industry diversification and competition embodied by changes in local firm entities can be confirmed for innovative firms. Thus, hypothesis three must be accepted with a caveat: Innovative firms have c.p. less bank relationships when located in diversified environments with strong changes in local corporate landscape. Industry specific competition or specialization in firms' own industries does neither seem to impact local firms' choice on their number of bank relationships, nor that of innovative firms.

While local industry specific specialization does not have clear effects on the number of bank relationships, a tendency for secrecy in those areas cannot be detected. As industry specialization in a location might even drive off non-competitive firms, the probability for banks to have a good borrower from such a market could be even higher. To evaluate this, the bank relationships of neighbouring firms are taken into account.

4.4. Effects of Neighbours' Bank Relationships

4.4.1. Data selection and spatial weight matrix

Considering the possibility of spillover effects due to firms adjusting to the number of their neighbour firms' banking relationships, spatial dependence is additionally taken into account. The effects of spatial autocorrelation are grasped using a k-nearest-neighbour's matrix as spatial weight matrix. The additional consideration of spatially close competitors' bank relationships accounts for the observability of bank relationships by other firms and strategic choice of its quantity as proposed by Yosha (1995). Furthermore, being an additional empirical test for the relevance of informative secrecy in competitive environments, firms might try to avoid cross-banking-relations with competitors. The spatial component thus includes all effects that have an impact on a firm's choice of bank relationships and estimate whether those have an impact on the bank relationship quantity of its neighbours.

As Moran's-I-Tests indicate the presence of spatial autocorrelation, I used spatial autoregressive (SAR) models, including the spatially lagged dependent variable to grasp the impact of the number of banking relationships of competitors in the vicinity. Unreported spatial expansion

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models had a bad overall fit and only few spatially weighted variables were significant.[11] The estimated equation has the basic form of

$$y = \boldsymbol{X}\beta + \lambda \boldsymbol{W}y + \epsilon \tag{4}$$

where $\boldsymbol{W}y$ is the spatial weight matrix multiplied with the vector of endogenous variables. In order to be able to infer a company's closest neighbours, data on firm's location (i.e. addresses) must be converted into operable measurement. Therefore, geo-coordinates in the form of decimal degrees of longitude and latitude were used. Decimal coordinates were obtained from Google Maps via reverse geocoding, with exact addresses of ZIP-code communities and the street names of firms' addresses. As a number of firm locations were missing detailed information on street name, zip code or town, they had to be removed from the dataset, leaving 16,642 observations.

Using this information, k-nearest neighbour spatial weight matrices were calculated with k = 10, k = 25, and k = 50. The weight matrix is row standardized, but, due to the nature of firms' spatial properties, asymmetrical. Lower distance between a firm and its closest competitor increases the spill over effects and thus has more impact on firm's financing decisions. Therefore, it is assigned higher relevance by the spatial weight matrix.

4.4.2. Estimation results

Due to limited computational capacities, calculation of eigenvalues of the spatial weight matrix, which would have been necessary to calculate the Jacobian $\ln|\boldsymbol{I} - \lambda \boldsymbol{W}|$ could not be pursued. As furthermore the calculation of the eigenvalues encounters some difficulties for non-symmetrical weight matrices, the maximum likelihood approach was not taken into further account.

Instead, a two-stage approach as described in Land and Deane (1992) and Bivand and Piras (2015) was applied. This procedure also enhances the use of robust standard errors and provides superior estimates compared to the maximum-likelihood approach in the presence of non-normality (Arbia, 2014).

Controlling for local factors, the coefficient λ represents the spatial autocorrelation of the dependent variable. As can be seen from table 5, λ remains positive and significant throughout all estimations. Thus, an increase of the quantity of bank connections of firms' k nearest neighbors, has a positive impact on firms' own number of bank relationships. This is an indicator that firms do not try to strengthen secrecy of their private information by engaging in less banking relationships than their neighbours in order to avoid common links to banks. Firms rather seem to adapt to local situations and engage in a similar number of bank relationships as their neighbours. This could be a consequence of less trade credit prevailing in some areas, affecting the bank relationships of neighbouring firms as well. The impact, nevertheless, is rather small and increasing with *k*: if e.g. k = 50 firms increase the number of their banking relationships, the spillover effect on the own effect increases to 0.40.

Taking the observability of the bank relationship quantity into account, firms might as well try to strengthen (allow to decrease) their external funding after observing an increase (shrinkage) of the number of bank relationships of their closest competitors. This could either be due to reflect perceived financial strength or due to other external events as e.g. regional liquidity shocks.

While the coefficients on the quantity of bank branches and local overall diversification have the same signs and similar magnitudes compared to the initial estimations, the coefficient on local industry specialization becomes significant and positive when taking neighbour firms into account. The result was robust when replacing *PS* with the industry share: The coefficient increased by the factor 10, while the mean of *PS* is about 6.5 times the size of industry share. The other coefficients did not change notably in size or significance. The consideration of the spatial

[11] As other characteristics of neighbour firms are not assumed to affect the number of firms' banking relationships directly, the use of e.g. Spatial Durbin Models was not pursued.

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autoregressive term might reveal the effect of firms in the vicinity who also face strong industry specialization, reinforcing the effects of *PS*.

Table 5
Results of spatial two-stage autoregression

	Dependent variable: Number of Bank Relationships		
	(15)	(16)	(17)
λ	0.33113*** (0.045913)	0.2028*** (0.038272)	0.40432*** (0.049499)
Intercept	0.29701 (0.61559)	1.2607** (0.57726)	-0.31188 (0.63829)
Trademarks	0.00056** (0.000256)	0.000525** (0.000256)	0.000558** (0.000259)
Age	0.50019*** (0.014127)	0.50122*** (0.014175)	0.49802*** (0.014115)
Manager act/form	0.026733*** (0.004441)	0.026371*** (0.004435)	0.026494*** (0.004441)
Equity ratio	0.015228 (0.039211)	0.012755 (0.039145)	0.022397 (0.039193)
Patents	-0.000025** (0.000012)	-0.000025** (0.000012)	-0.000025** (0.000012)
Locations	0.004109*** (0.00146)	0.004157*** (0.001439)	0.00425*** (0.001461)
Tradecredit	-0.075528 (0.056259)	-0.078864 (0.056222)	-0.082352 (0.056234)
act Managers	0.011493*** (0.002166)	0.011624*** (0.0022)	0.011462*** (0.002169)
Intangible	-0.018828 (0.10442)	-0.012958 (0.10515)	-0.007398 (0.10479)
Total assets	0.066915*** (0.009774)	0.067286*** (0.00981)	0.065563*** (0.00978)
$Banks_{25}$	-0.000289*** (0.000063)	-0.000352*** (0.000062)	-0.000258*** (0.000063)
$HHI_{Firmsize}$	-0.99759** (0.48748)	-1.4497*** (0.47624)	-0.58586 (0.50079)
COMP	-0.003193 (0.00725)	-0.001157 (0.007279)	-0.003815 (0.007233)
PS	0.047033** (0.020818)	0.049526** (0.020811)	0.050002** (0.02082)
PD	-2.0001** (0.98291)	-2.4615** (0.9762)	-1.8463* (0.98059)
Firms est.	-0.46003** (0.19009)	-0.70393*** (0.18133)	-0.33647* (0.19245)
Firms acq.	-0.62874 (0.41161)	-0.76593* (0.41054)	-0.57988 (0.41233)
Industry Dummies	Yes	Yes	Yes
Number of nearest neighbours	25	10	50
Observations	16,642	16,642	16,642

Significance levels were calculated based on robust standard errors and are indicated by * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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The positive coefficient for *PS* as well as the positive coefficient of the spatial autoregressive term in estimations (15)–(17) might thus confirm that the number of bank relationships has a minor role in firms' financing decisions w.r.t. secrecy. These decisions are rather made considering different forms of external funding. Therefore, the results suggest a rejection of hypothesis four. Yet, the mere existence of neighbouring firms does not necessarily impose a constraint to keep private information secret. Neighbours from different industries are neither industry specific competitors nor do they have a high likelihood of taking advantage of other firms' private information. Furthermore, the use of trade credit and thus its effects on bank relationships might differ between industry groups (see e.g. Petersen and Rajan, 1997). Therefore, the spatial estimations are repeated, splitting the sample into subsamples, grouped by industry classification (agriculture and mining, manufacturers, and service industries). Coefficients are split up into direct and indirect effects. The latter indicate feedback effects resulting from changes of explanatory variables of neighbouring regions, affecting the dependent variable, of course, of that firm and thereby affecting its neighbours (see Elhorst, 2014, p. 22ff for detailed explanations).

The results are displayed in table 6. λ is significant in the two latter estimations and has a positive sign, confirming the above mentioned results now within different industry classifications. The coefficient for manufacturing is larger in size suggesting a stronger impact of neighboring firms' funding decisions. This could be a result of higher concentration in the service industry sample which is weighted about 0.012 and thus about twice as high as weighted concentration in the manufacturing industry subsample. The ratio between indirect and direct explanatory variables is 0.5521 in estimation (19) and 0.3545 in estimation (20), i.e. there are more spillover effects, pointing to stronger links among firms. As a majority of firms can be grouped into manufacturing and service industries, I will focus on the results of those.

As most interesting result, the coefficients of industry specific specialization vary both in sign and magnitude. This finding could support the findings of Beaudry and Schiffauerova (2009) and Paci and Usai (1999), mentioned above. A nearby explanation for this finding, closely in line with the result of Neuberger et al. (2008) that service industries engage in less banking relationships, is the ability to engage in transaction-based bank relationships. While manufacturing firms supposedly own more fixed assets that can be pledged as collateral, firms from service industries benefit from close bank relationships. This is aggravated in specialized service industries areas, where high competitive pressure could put additional credit constraints on firms. On the contrary, higher local specialization of manufacturing industries and competition could increase manufacturing firms' demand for finance. Thus, due to the firm-level competition transferring into a competition for funds, firms will engage in more bank relationships in order to maintain stable external funding. Additional evidence w.r.t. protection of innovations comes from the average (mean) number of patents, which, in the manufacturing subsample, is about 15 times the number of the mean in the service industries subsample.

While there are no other significant competition variables in the manufacturing subsample, most of the local coefficients for service industries have the same signs and are similar in magnitude to estimation (12). As the service industries subsample is twice the size of the manufacturing industries, the results of the full sample could be driven by the former. Investigating the coefficients on industry dummy variables in estimation (12), the coefficients for the four manufacturing industries are highly significant and positive.

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Table 6
Direct and indirect effects of spatial autoregression (k = 25), different industry sectors

	Primary Sector (18)			Manufacturing Industries (19)			Service Industries (20)		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
λ		-0.0573			0.35919***			0.26368***	
Intercept	10.16442			-0.66865			1.38550		
Trademarks	0.02084	-0.00113	0.01971	-0.00022	-0.00012	-0.00035	0.00113***	0.00040	0.00153
Age	0.41329**	-0.02244	0.39085	0.54145***	0.29894	0.84039	0.51429***	0.18247	0.69676
Manager act/form	0.04710	-0.00256	0.04454	0.03998***	0.02207	0.06205	0.01841***	0.00653	0.02494
Equity ratio	-0.94240**	0.05116	-0.89125	0.06322	0.03490	0.09812	-0.13128***	-0.04658	-0.17786
Patents	-0.00108	0.00006	-0.00102	-0.00001	-0.00001	-0.00002	-0.00015*	-0.00005	-0.00020
Locations	0.01251	-0.00068	0.01183	-0.00279	-0.00154	-0.00433	0.00742***	0.00263	0.01005
Tradecredit	-0.21449	0.01164	-0.20284	0.19747	0.10903	0.30650	0.05223	0.01853	0.07076
act Managers	0.00589	-0.00032	0.00557	0.01455***	0.00803	0.02259	0.01126***	0.00399	0.01525
Intangible	-1.25230	0.06798	-1.18432	-0.14437	-0.07971	-0.22408	-0.03478	-0.01234	-0.04712
Total assets	0.20150	-0.01094	0.19056	0.05461***	0.03015	0.08476	0.06299***	0.02235	0.08533
$Banks_{25}$	-0.00057	0.00003	-0.00054	-0.00012	-0.00006	-0.00018	-0.0003***	-0.00011	-0.00041
$HHI_{Firmsize}$	-5.07086	0.27527	-4.79559	-0.81275	-0.44872	-1.26148	-1.17144*	-0.41561	-1.58705
COMP	-0.04471	0.00243	-0.04229	0.00509	0.00281	0.00790	-0.01072**	-0.00380	-0.01452
PD	1.18866	-0.06453	1.12413	0.78271	0.43214	1.21485	-1.59731	-0.56671	-2.16402
PS	-0.12191	0.00662	-0.11529	0.20388***	0.11256	0.31644	-0.08457***	-0.03000	-0.11457
Firms est.	-6.04795***	0.32832	-5.71963	-0.11229	-0.06200	-0.17429	-0.81915***	-0.29062	-1.10977
Firms acq.	-8.82831**	0.47925	-8.34906	0.29447	0.16258	0.45705	-1.33821***	-0.47478	-1.81299
Observations		128			5,594			10,339	

Primary Sector contains firms with German industry classification (WZ 2008) codes 'A' and 'B', *Manufacturing Industries* is made up by codes 'C', 'D', 'E' and `F' and *Service Industries*, i.e. service industries by 'G' up to 'T', excluding financial and insurance firms (classification code 'K'). Significance levels were calculated based on robust standard errors and are indicated by * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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Again, the results indicate that higher specialization in a firm's local environment is rather associated with an increase in bank relations if certain requirements like collateral can be met. Therefore, the demand for a diversification of external funding sources could be higher than avoiding multiple bank relationships due to potential losses in firm level secrecy. Consistent with all of the previous estimations, the number of bank relationships decreases with an increase in location based competitive measures, except for local industry specific specialization. Therefore, a reduction in bank relationships can be assigned to increased overall competition, while a smaller number of affiliated banks does not seem to take place in order to maintain firm level secrecy. Hypothesis four thus has to be rejected.

5. CONCLUSIONS

With firm level competition being one of the major drivers of innovation and market prices, a highly relevant aspect has been neglected so far when it comes to banking relationships. Besides demand side competition, firms especially try to maintain secrecy regarding private information. Such private information can comprise innovative activity, but also relevant non-public information concerning firms' profits, planned activities, or other information. Thus, focusing solely on the impact of lending relationships and innovative activities could neglect a relevant part of internal information which should be kept secret.

To promote the secrecy of private information in competitive markets, firms might try to reduce their banking relationships, as the revelation of information towards a multitude of external lenders and deposit takers could have serious drawbacks. Private information could be obtained by firms' competitors when shared with too many banks (Rheinbaben and Ruckes, 2004), which would be aggravated in environments, where its usability was high, as in industrially specialized areas.

Another aspect concerning the number of bank relationships is their intensity. Firms could try to ensure a multitude of bank relationships to avoid credit crunches while not disclosing private information to banks. If firms lack collateral for transaction-based banking, they will have to disclose more private information with higher probability. Yet, relationship banking could offer more long-term external funding to those firms.

To analyse the potential outcomes concerning firm financing and number of bank relationships, several variables measuring local competition are employed. Investigating a sample of data of about 25,000 German firms, there is robust evidence that local competition in part has a negative impact on firms' number of bank relationships. This partially can be reconciled with theories on innovation, predicting less innovation in the presence of stronger competition.

This holds true but for local industry specific specialization. While there is some statistical but low economical significance in estimations (1)–(6), the choice on the number of bank relationships is not robustly affected by a firm's local industry specialization. Including spatially lagged terms and splitting up the sample by industry categories, there are positive effects of industry specific specialization on the number of bank relationships for manufacturing firms and negative effects for service firms. These results point to an existence of MAR externalities for manufacturing firms regarding external funding; spill-over effects might induce firms to engage in c.p. more bank relationships if their competitors do so. This could e.g. be a result of new ways of conducting business within that particular industry or new policies of banks. Another implication of the results is that market entrant banks in areas specialized in manufacturing industries could have an advantage in gaining market shares.

Overall, the results suggest that firms do not try to protect private information by engaging in less bank relationships. The dummy variable is positive in Probit (Poisson) estimations on use of multiple (number of) bank relationships. Yet it is negative when determining long-term financial

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debt of firms. This indicates that innovative firms engage in a multitude of bank relationships, where probably most of them are transaction-based due to less long-term financing. Trade credit on the other hand is reduced in specialized environments and for high quality inventors. This indicates that firms consider protection of private information as more relevant when dealing with other firms than with banks.

The results illustrate the relevance of transaction-based banking for innovative firms. This can only take place if those firms have sufficient possibilities of protecting their innovations from disclosure and sufficient collateral. As it is especially firms from service industries that have only little fixed assets, innovative firms from this industrial areas probably could incur difficulties at finding ways of external funding. Furthermore, access to a multitude of banks could require plants or offices close to financial services. Thus, innovations are not only bound locally by human resources but also financial input. Disparities in regional innovative capacity thus could strongly drift apart.

The results could furthermore be the starting point for another approach to find MAR or Jacobs externalities by reuniting (local) knowledge and financial input, where the latter could be expressed by availability of funds in terms of loan applications or other ways of funding than bank loans. Further research additionally could cover not only the number of firms' bank relationships, but – if data are available – also frequency and ways of communication, length of bank relationships and additional loan data as interest rates, duration, and covenants, to get additional evidence on the closeness of bank relationships to gauge their relevance for firms' financial strategy. E.g. data on loan applications could help to answer the question whether the number of bank relationships is chosen or the result of credit constraints. Additionally using banks' loan portfolio data would furthermore allow to check for industry specific knowledge and banking policies.

References

Aghion P., Bloom N., Blundell R., Griffith R., Howitt P. (2005). Competition and Innovation: An inverted-U Relationship. *Quarterly Journal of Economics*, 120(2), pp. 701–728.

Alessandrini P., Presbitero A.F., Zazzaro A. (2010). Bank size or distance: what hampers innovation adoption by SMEs? *Journal of Economic Geography*, 10, pp. 845–881.

Almeida P., Kogut B. (1997). The Exploration of Technological Diversity and the Geographic Localization of Innovation. *Small Business Economics*, 9, pp. 21–31.

Arbia G. (2014). A primer for spatial econometrics: with applications in R. (1st ed.), Basingstoke et al., Palgrave Macmillan.

Aristei D., Gallo M. (2017). The deteminants of firm-bank relationships in Italy: bank ownership type, diversification and multiple banking relationships. *European Journal of Finance*, 23(15), pp. 1512–1543.

Beaudry C., Schiffauerova A. (2009). Who's right, Marshall or Jacobs? The localization versus urbanization debate. *Research Policy*, 38, pp. 318–337.

Benfratello L., Schiantarelli F., Sembenelli A. (2006). Banks and innovation: microeconometric evidence on Italian firms (IZA Discussion Paper No. 2032), Bonn: Institute for the Study of Labor.

Berger A. N., Black L. K. (2011). Bank size, lending technologies, and small business finance. *Journal of Banking & Finance*, 35, pp. 724–735.

Berger A.N., Miller N. H., Petersen M.A., Rajan R.G., Stein J.C. (2005). Does function follow organizational form? Evidence from the lending practices of large and small banks. *Journal of Financial Economics* (76), pp. 237–269.

Berger A.N., Udell G.F. (1995). Relationship Lending and Lines of Credit in Small Firm Finance. *Journal of Business*, 68(3), pp. 351–381.

Bittelmeyer C. (2007). Patente und Finanzierung am Kapitalmarkt: Eine theoretische und empirische Analyse, Wiesbaden: Universitaets-Verlag.

Bivand R., Piras G. (2015). Comparing Implementations of Estimation Methods for Spatial Econometrics. *Journal of Statistical Software*, 63(18). doi.org/10.18637/jss.v063.i18.

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

DOI: 10.7172/2353-6845.jbfe.2019.2.5

Boot A.W.A., Thakor A.V. (2000). Can Relationship Banking Survive Competition? *Journal of Finance*, 55(2), pp. 679–713.
Cameron C.A., Trivedi P.K. (2013). Regression Analysis of Count Data. (2nd ed.). Cambridge: Cambridge University Press.
Carlino G.A. (2001). Knowledge Spillovers: Cities' Role in the New Economy. *Business Review* (Q4), pp. 17–26.
Carmignani A., Omiccioli M. (2007). Costs and benefits of creditor concentration: An empirical approach. Temi di discussione (Working papers) No. 645, Italy: Bank of Italy.
Cenni S., Monferrà S., Salotti V., Sangiorgi M., Torluccio G. (2015). Credit rationing and relationship lending. Does firm size matter? *Journal of Banking & Finance*, 53, pp. 249–265.
Cetorelli N., Strahan P.E. (2006). Finance as a Barrier to Entry: Bank Competition and Industry Structure in Local U.S. Markets. *Journal of Finance*, 66(1), pp. 437–461.
Cornaggia J., Mao Y., Tian X., Wolfe B. (2015). Does banking competition affect innovation? *Journal of Financial Economics*, 115, pp. 189–209.
Cosci S., Meliciani V. (2002). Multiple banking relationships: Evidence from the Italian Experience. *The Mancheseter School*, 70(1), pp. 37–54.
Detragiache E., Garella P., Guiso L. (2000). Multiple versus Single Banking Relationships: Theory and Evidence. *Journal of Finance*, 55(3), pp. 1133–1161.
Duranton, G., Puga, D. (2004). Micro-foundations of urban agglomeration economies. In V.J. Henderson, J.-F. Thisse (Eds.), Handbook of Regional and Urban Economics, Elsevier B.V., Amsterdam et al., pp. 2063–2117.
Einem E. v. (2011). Wissensabsorption in Staedten und Regionen. *Jahrbuch für Regionalwissenschaften*, 31, pp. 131–153.
Elhorst J.P. (2014). Spatial Econometrics: From Cross-Sectional Data to Spatial Panels. Heidelberg et al.: Springer.
Farinha L.A., Santos J.A.C. (2002). Switching from Single to Multiple Bank Lending Relationships: Determinants and Implications. *Journal of Financial Intermediation*, 11, pp. 124–151.
Feldman M.P., Audretsch D.B. (1999). Innovation in cities: Science-based diversity, specialization and localized competition. *European Economic Review*, 43, pp. 409–429.
Foglia A., Laviola S., Reedtz P.M. (1998). Multiple banking relationships and the fragility of corporate borrowers. *Journal of Banking & Finance*, 22, pp. 1441–1456.
Fritsch M., Slavtchev V. (2010). How does industry specialization affect the efficiency of regional innovation systems? *Annals of Regional Science*, 45, pp. 87–108.
Gianetti C. (2009). Relationship Lending and Firm Innovativeness. CentER Discussion Paper. Tilburg.
Guiso L., Minetti R. (2010). The Structure of Multiple Credit Relationships: Evidence from U.S. Firms. *Journal of Money, Credit and Banking*, 42(6), pp. 1037–1071.
Harhoff D., Körting T. (1998). Lending relationships in Germany – Empirical evidence from survey data. *Journal of Banking & Finance*, 22, pp. 1317–1353.
Hombert J., Matray A. (2017). The Real Effects of Lending Relationships on Innovative Firms and Inventor Mobility. *The Review of Financial Studies*, 30(7), pp. 2413–2445.
Hussinger K. (2004). Is Silence Golden? Patents versus Secrecy at the Firm Level. ZEW Discussion Papers, No. 04-78.
Jaffe A.B., Trajtenberg M., Henderson R. (1993). Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. *The Quarterly Journal of Economics*, 108(3), pp. 577–598.
Jiménez G., Salas V., Saurina J. (2009). Organisational distance and use of collateral for business loans. *Journal of Banking & Finance*, 33, pp. 234–243.
Land K.C., Deane G. (1992). On the Large-Sample Estimation of Regression Models with Spatial- Or Network-Effects Terms: A Two-Stage Least Squares Approach. *Sociological Methodology*, 22, pp. 221. https://doi.org/10.2307/270997.
Mann W. (2018). Creditor rights and innovation: Evidence from patent collateral. *Journal of Financial Economics,* 130, pp. 25-47.
Micucci G., Rossi P. (2013). Financing R&D investments: Relationship lending or financial markets?, Banca d'Italia. Retrieved 26.09.2017 from https://www.bancaditalia.it/pubblicazioni/altri-atti-convegni/2014-innovazione-italia/Micucci-Rossi.pdf
Mina A., Lahr H., Hughes, A. (2013). The demand and supply of external finance for innovative firms. *Industrial and Corporate Change*, 22(4), pp. 869–901.
Neuberger D., Pedergnana M., & Räthke-Döppner S. (2008). Concentration of Banking Relationships in Switzerland: The Result of Firm Structure or Banking Market Structure. *Journal of Financial Services Research*, 33, pp. 101–126.
Neuberger D., Räthke S., Schacht C. (2006). The Number of Bank Relationships of SMEs: A Disaggregated Analysis of Changes in the Swiss Loan Market. Economic Notes by Banca Monte dei Paschi di Siena SpA, 35(3), pp. 319–353.

DOI: 10.7172/2353-6845.jbfe.2019.2.5

Ongena S., Smith D.C. (2000). What Determines the Number of Bank Relationships? Cross-Country Evidence. *Journal of Financial Intermediation*, 9, pp. 25–56.

Ongena S., Tümer-Alkan G., Westernhagen N. von (2012). Creditor concentration: An empirical investigation. *European Economic Review*, 56, pp. 830–847.

Paci R., Usai S. (1999). Externalities, knowledge spillovers and the spatial distribution of innovation. *GeoJournal*, 49, pp. 381–390.

Paul, S. (2007). Finanzierungsbedarf im Mittelstand: Zwang zur (Neu-)Positionierung von Sparkassen? In Bernhard Schaefer (Ed.), *Handbuch Regionalbanken* (pp. 365–393). Wiesbaden: Gabler.

Petersen M.A., Rajan R.G. (1995). The Effect of Credit Market Competition on Lending Relationships. *The Quarterly Journal of Economics*, 110(2), pp. 407–443.

Petersen M.A., Rajan R.G. (1997). Trade Credit: Theories and Evidence. *The Review of Financial Studies*, 10(3), pp. 661–691.

Prantl S., Almus M., Egeln J., Engel D. (2008). Kreditvergabe durch Genossenschaften, Kreditbanken und Sparkassen: Eine empirische Analyse von Foerderkrediten für junge, kleine Unternehmen. *Journal of Applied Social Science Studies* 129, pp. 83–129.

Rheinbaben J. von, Ruckes M. (2004). The number and the closeness of bank relationships. *Journal of Banking & Finance*, 28, pp. 1597–1615.

Rice T., Strahan P.E. (2010). Does Credit Competition Affect Small-Firm Finance? *Journal of Finance*, 65(3), pp. 861–889.

Rogers M. (2004). Networks, Firm Size and Innovation. *Small Business Economics*, 22, pp. 141–153.

Ronning G. (1991). Mikrooekonometrie. Heidelberger Lehrtexte für Wirtschaftswissenschaften, Berlin et al., Springer.

Shenoy, J., Williams, R. (2017). Trade credit and the joint effects of supplier and costumer financial charceristics. *Journal of Financial Intermediation*, 29, pp. 68–80.

Shuai X. (2013). Will specialization continue forever? A case study of interactions between industry specialization and diversity. *The Annals of Regional Science* (50), pp. 1–24.

Stein I. (2015). The Price Impact of Lending Relationships. *German Economic Review*, 16(3), pp. 367–389.

van der Panne G. (2004). Agglomeration externalities: Marshall versus Jacobs. *Journal of Evolutionary Economics*, 14, pp. 593–604.

Yosha O. (1995). Information Disclosure Costs and the Choice of Financing Source. *Journal of Financial Intermediation*, 4, pp. 3–20.

Zeileis A., Kleiber C., Jackman S. (2008). Regression Models for Count Data in R. *Journal of Statistical Software*, 27(8), pp. 1–25.

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APPENDIX

Table A.1
Variables and their definitions

Variable	Description
Trademarks	Firm's number of trademarks
Age	Log (1+Firm Age in years)
Manager act/form	$\frac{\text{number of current managers}}{\text{number of former managers}}$
Equity ratio	Equity/Total Assets
Patents	Firm's number of patents
Locations	Number of documented firm locations
Tradecredit	Trade credit in thsd. EUR
Act Managers	Current managers
Intangible	$\frac{\text{Intagible fixed assets}}{\text{Total assets}}$
Total assets	Log (1+Total Assets in thsd. EUR)
$Banks_{25}$	Number of bank branches in a circumference of 25 km
$HHI_{Firmsize}$	Herfindahl index of local firm size categories (0–9, 10–49, 50–249 and more than 250 employees)
COMP	see equation (2)
PS	see equation (1)
PD	see equation (3)
$HHI_{Concentration}$	Herfindahl index over industries' spatial concentration, calculated using counties
$Share_{Industry}$	Share of employees in a firm's industry relative to all employees in the county
$HHI_{Specialization}$	Herfindahl index of local industries, categorized by WZ 2008
Firms est.	$\frac{\text{new firm establishments}}{\text{established firms}}$
Firms acq.	$\frac{\text{corporate take overs}}{\text{newly reg. firms}}$
Avg. $Citations_{2010–2015}$	$\frac{Citations_{2010–2015}}{Patents_{2010–2015}}$
Innovative	Dummy variable; equals 1 if firm had at least one patent application between 2010 and 2015

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Table A.2
Average mean effects of Poisson estimations

	Dependent Variable:			
	Number of Bank Relationships			
	(11)	(12)	(13)	(14)
Trademarks	0.000130	0.000103	0.000190	0.000075
Age	0.488227	0.479346	0.508465	0.480784
Manager act/form	0.038677	0.036277	0.036918	0.036953
Equity ratio	0.057229	0.030521	-0.035227	0.027296
Patents	-0.000024	-0.000023	-0.000025	-0.000021
Locations	0.002578	0.003137	0.002408	0.003221
Tradecredit	-0.008617	-0.010608	0.057763	-0.023485
Act Managers	0.005937	0.006074	0.006731	0.005608
Intangible	-0.253929	-0.223917	-0.26915	-0.226831
Total Assets	0.065932	0.072940	0.062654	0.074048
$Banks_{25}$		-0.000382	-0.000339	-0.000385
$Avg.\ Citations_{2010–2015}$				-0.023195
$HHI_{Firmsize}$		-1.820603	-1.769926	-2.005393
COMP		-0.001222	0.009944	
PS		0.004387		
PD		-1.683332		
$HHI_{Concentration}$			-27.35917	
$Share_{Industry}$			0.086371	
$HHI_{Specialization}$			1.209034	
Innovative				0.827701
Innovative*COMP				0.037530
Innovative*PS				0.031756
Innovative*PD				-5.635223
Firms est.		-0.868405	-0.885654	-0.906758
Firms acq.		-0.830876	-0.830449	-0.724315

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