Influences of Regional Economics on Banking Relationships and Lending - Evidence from Germany

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Abstract

Research on the links between regional economics and banking comprises many problems that affect spatial patterns of economic activity in various ways. In economics, capital is frequently supposed to be completely mobile across different regions, hence geographical dimensions in finance have produced a rather small body of literature compared to other fields of research. This thesis analyzes several links of regional factors to banking, namely the impacts of regional industrial clustering and distance on bank relationships as well as the effects of local real estate price growth on banks' risk-taking. A common factor of all of these issues is the impact of distance on the transmission of information, which applies to knowledge transfers within industrially specialized firm clusters, potential information asymmetries between distant borrower and lenders, and the ability to produce reliable predictions for price changes on local markets. Therefore, the thesis offers an insight whether distance is still a constraint of the transport of all relevant information in the age of strong development of digital techniques and whether being in proximity to a market changes firms' funding or banks' lending.

The first two chapters of this thesis introduce the topics and show how the different aspects that are analyzed in the following are connected to each other. Furthermore, I discuss some of the relevant concepts that are the basis of the following analyses.

Local industrial specialization plays a crucial role in chapter 3, where the effects of potential industry externalities and competition on firms' external funding are analyzed. A special focus is placed on innovative firms, which might on the one hand benefit from industry externalities but on the other hand suffer under harsher competition and incur more problems when it comes to gaining access to external funding. The analysis finds that local competition robustly affects firms' number of bank relationships negatively, while local industry specialization only has robust effects if the analyzed firm sample is split up w.r.t. industrial sectors.

Distance, which is highly relevant for the existence of industrial externalities, is a key component of chapter 4, where I analyze the effect of spatial distance between borrowing firms and lending

banks in single bank relationships. As distance could increase loan rates either due to information asymmetries or higher transport costs, I expect interest rates of loans to increase with distance as compensation. Analyzing a cross-section of 8,200 German firms, I find that borrower-lender-distance has a significant effect on the interest rates paid in single bank relationships.

Besides using higher risk premia for loans, collateral is a frequent method of overcoming risk in lending that is caused by information asymmetries. The impacts of real estate - which is one of the assets most commonly used as collateral - on banks' loan portfolio risk is investigated in chapter 5. This chapter analyzes whether information on local real estate price growth, which captures a variety of economic conditions, can explain changes in banks' risk-taking in lending. If banks have a good knowledge about local real estate market development, they should b able to recognize whether price increases are fundamentally driven and therefore adapt their risk-taking. Analyzing a panel data of 390 German savings banks, which have a strong affiliation with local economies as well as with local real estate markets, I find that changes in local real estate price levels do not alter their risk-taking.

The key results of the thesis are summarized in chapter 6.

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Chapter 1

Introduction

1.1 Motivation

The way economic mechanisms shape spatial patterns of settlement, industries, trade, prices and allocation of input factors has always been of special interest to researchers. This is not surprising; regional disparities and differences between urban and rural conditions of life have had a prominent role for all kinds of aspects of human living, including inequalities in culture, technical progress, and wealth. For economic subjects, these issues are not only more visible and less abstract than national or even global economic developments, they shape their lives in a more immediate and often quicker way.

Research has posed a focus on the impact of the quality, quantity and (spatial) distribution of the sources of local productivity growth. The latter include economic forces that promote agglomerations as e.g. knowledge spillovers and centrifugal forces, i.e. economic conditions that counteract infinite growth of a single location, e.g. transport costs or rents. These factors can reinforce themselves and determine the location of production factors and therefore centers of productivity and growth (s. a. Cook et al. 2007, p. 1338, Palivos and Wang 1996).

There are at least some reasons for a lack of research in regional finance. A variety of economic theories (except Post-Keynesian economics) assume that monetary supply is determined endogenously in a regional context and that capital is perfectly mobile and financial flows only are reflections of real flows (Dow and Rodríguez-Fuentes 1997, 904ff). Furthermore, data availability is scarce when it comes to data on loans or even specific data on locations of lenders and borrowers.

Research furthermore has barely figured connections between finance and issues from regional

economics. Although there have been attachment points like investigations on loan portfolio specialization (Berger et al. 2010, Böve 2009, Degryse and Ongena 2004, Paravisini et al. 2014, Winton 1999) this has not been investigated in the light of regional economic theories.

Forces that promote the agglomeration of economic activity, such as prevention of market power, reduction of information asymmetries and knowledge spillovers (Bröcker and Fritsch 2012, 93ff) are not only relevant to banks as enterprises, but also for their relationships with their costumers. Especially personal contacts as a means of sharing information, thus creating knowledge spillovers and symmetry of information in regional economic markets and firm bank relationships, play a prominent role (s. Deyoung et al. 2012; Storper and Venables 2004, 352f): This link between local economy and finance has gained special relevance since the emergence and development of impersonal ways to do business in finance has accelerated.

This 'new' ability of getting access to funds from banks allows firms to develop different financing strategies in the presence of higher competitive pressure. As we will learn from chapter 3, competition and spatial distribution of a firm's industry seem to affect its choice of banking relationship.

Yet in many cases, the choice of the bank relationship type is not solely determined by a firm's industry or its position within competitive hierarchy. First, it should be clear whether the desired relationship type is available, i.e. whether there are banks located in the vicinity of the firm to engage in relationship banking or whether the firm has access to a multitude of banks and would rather rely on transaction based banking. Which of those is chosen ultimately depends on the costs and benefits caused by a variety of factors.

One of those is the spatial distance between borrower and lender, as will be shown in chapter 4. Distance causes transport costs in credit relationships in order to reduce either information asymmetries or avoid (or exert) some kind of market power by the lender (s. e.g. Agarwal and Hauswald 2010, Bellucci et al. 2013, Degryse and Ongena 2005). Close bank relationships to regional banks have a high relevance for the German economy which is highly dependent on small and medium sized enterprises (SMEs), which are often opaque w.r.t. available corporate information (Stiroh 2004, p. 136). Small regional banks play a special role for SMEs and are commonly regarded as having an advantage when analyzing and processing information on those firms as well as the local economy.

As can be seen from figure 1.1, banks with a local basis still have an important and even growing relevance for loan origination. Thus, the relevance of local banks for external funding has even

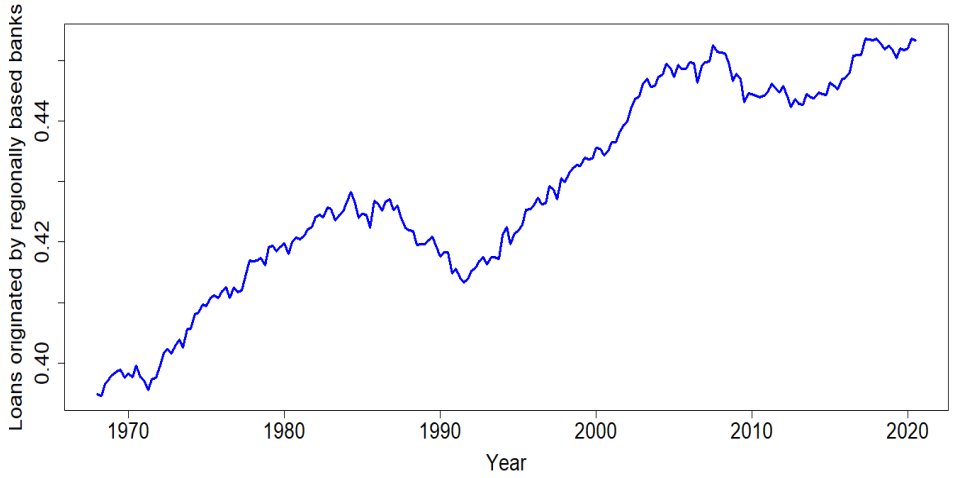


Figure 1.1: Lending activity of German regionally based banks.
Monthly share of loans originated by locally based banks (savings, cooperative, and regional banks) in percent of all loans originated to non-MFIs. Data source: Deutsche Bundesbank.

increased during the last decades, besides an increase of globalization or a constant augmentation of the ways of external funding. A number of reasons therefore can be found in literature; most of all, regional operating banks are spatially closer to their costumers, which includes not only a common background (Alessandrini et al. 2010, p. 846), but also lower transport costs and higher frequency of interaction, which is especially important for inexperienced firms.

Yet, although proclaiming to have strong bonds to their affiliated region, banks of all kinds have steadily reduced the number of their branch offices. On the one hand, this again increases spatial distances towards their lenders and lowers their accessibility for individual and firm clients as well. On the other hand, branch reduction decreases bank officers' knowledge and sense of local economy, shrinking their informative advantage to commercial banks (Alessandrini et al. 2016, p. 546).

But as their relevance at loan origination still rises (s. figure 1.1), doubting the relevance of distance in lending seems to be justified (perhaps mostly recognized by Petersen and Rajan 2002) and if firms rather rely on impersonal relationships with their banks, information asymmetries can be overcome by a variety of techniques. Prominent examples include scoring methods, enabling banks to transmit the riskiness of a borrower over long distances and detached from knowledge of the local economic background of the borrower.

One of the most known ways of influencing borrowers' behavior (besides the setting of interest rates) are collateral requirements (Stiglitz and Weiss 1981, p. 394). Real estate as collateral has a long tradition and is commonly used to secure long term debt (s.a. Niinimäki 2009). As its

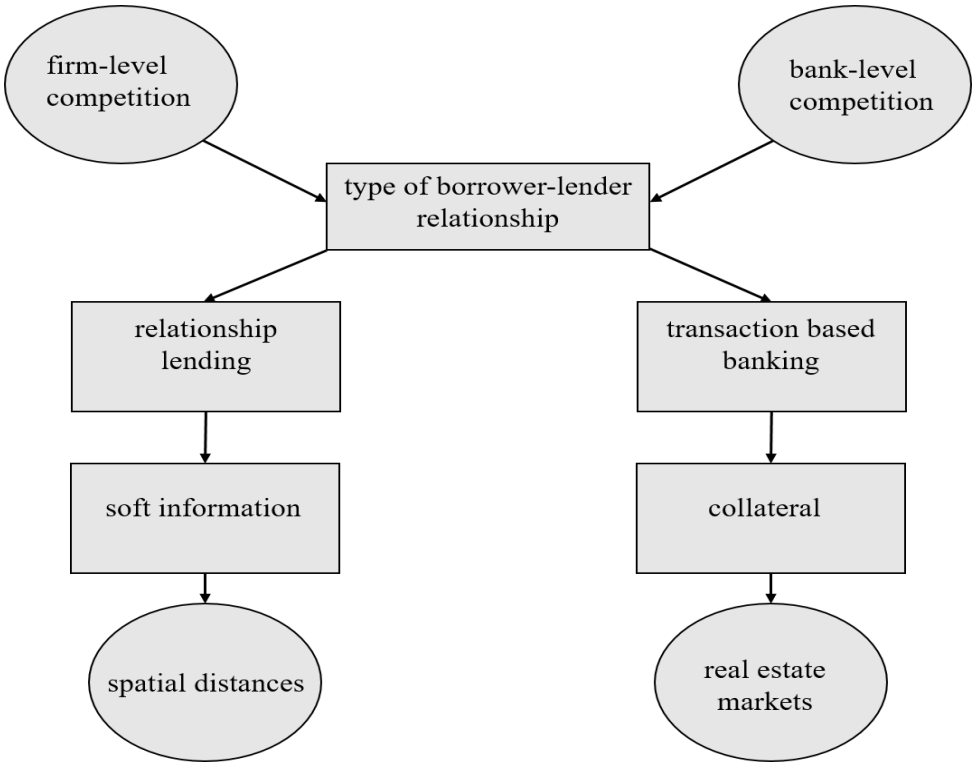


Figure 1.2: Local economic factors and lending techniques

value depends on the local economy, regional banks, being more in touch with the former, could have a comparative advantage when lending under collateral in terms of forecasting real estate values. Thus, being a local bank could even pay off when it comes to lending techniques that initially do not require being close to a borrower. As we will see in chapter 5, this could induce those banks to extend credit to riskier costumers.

As a result of the analysis, regionally based banks do not seem to engage in riskier loans if real estate prices rise; rather, these banks' loan portfolio risk is connected to overall local economic condition. This clearly indicates the strong interdependency of a well working financial system in the vicinity of on-site firm clusters and underlines the relevance of further studying the connection of regional economics and informative asymmetries in bank relationships.

1.2 Structure of thesis

The focus of this thesis is the analysis of borrower-lender relationships and how locally specific factors affect the perception of mutual trust and the assessment of the counterparty's reliability. The main investigated components that shape this relationship are presented in figure 1.2.

While competition has a major stake at determining the kind of borrower-lender relationship between firms and banks, the relationship itself can either be rather close or impersonal. The dif-

ference between the two types mainly is made up by the way how informational asymmetries are handled: while relationship banking tries to overcome those asymmetries using personal contact and frequent (personal) exchange, transaction based lending uses *hard* information techniques. The latter describe a lending relationship that is based on quantifiable economic data that is used to gauge a borrower's creditworthiness or to mitigate default risks using securities. Common types of hard information techniques include credit scoring, which uses economic figures to estimate a borrower's default risk or reducing the loss given default of a loan by demanding collateral. Either relationship type affects firms' and banks' behavior differently, depending also on the local economical setting surrounding them.

The first part of the thesis offers an overview of the intersection of regional economics and finance and identifies topics that have already been examined and missing links between those. In order to present the economic context in which the following chapters are embedded, I focus on an overview of basic regional economic concepts.

The second part investigates the relationship between local industry specialization and innovation and firms' choice of the number of bank relationships, which is closely related to firms' ways of external funding. After a short literature review, theories on how local industry specialization affects competition and innovation in the first place and consequently firms' number of bank relationships and ways of external funding are developed. Afterwards, several empirical investigations, including Maximum Likelihood, Spatial Two Stage Least Square and Ordinary Least Square analyses find that innovative firms do not engage in c.p. less bank contacts, while there is at least some overall effect for local industry specialization on firms' financial relationships. Using the term structure of debt as proxy for the duration of a relationship, there is evidence that innovative firms rather engage in transaction based bank relationships.

After the investigation of the choice of the closeness of borrower-lender-relationships, the following part of the thesis focuses on an organizational aspect of external funding, that comes into being in relationship lending: I investigate whether spatial distance between borrower and lender plays a role for the determination of interest rates due to potential informational asymmetries that aggravate with increasing distance and transport costs. After a literature review and discussion of theories and results of other studies, I present the methodology and the results of the empirical analysis. As a result, I find that increased spatial distance between borrowers and lenders comes along with on average higher interest rates that have to be borne by the borrower. Switching to lenders' point of view and transaction based banking the final part of the thesis

discusses the effects of real estate value on lending. Real estate plays a crucial part for collateralizing debt, and its price development is highly relevant for transaction based banking. As collateralization of debt relaxes banks' necessity for monitoring, growth of real estate prices could induce banks to increase the nominal risk of their lending. After a short introduction, theoretical arguments are presented in the second subsection, and data are presented in the third subsection. The fourth subchapter consists of empirical investigations, which comprise an analysis of causality between real estate and loan growth, as well as several dynamic panel analyses on the relationship between real estate price growth and German locally based savings banks' overall lending risk. Additional insights compared to previous studies come from the fact that micro data on local bank lending and real estate price development are included as well as regional economic data. As a result of the study, there is no robust impact of real estate price growth on the risk-taking of German savings-banks. This result is an indicator that if local banks rely on transaction based lending, their information concerning local markets enables them to identify the risk of the loan and borrower's risk.

Thus, considering the results listed above, the main finding of the thesis is that firms' environment plays a minor role for its choice between relationship and transaction based borrowing, whereas it has a significant impact if firms decide for relationship banking: potential informational asymmetries (due to higher distances) are translated into higher risk premia by banks. This is confirmed in parts by lending behavior of locally operating savings banks: local economic development, expressed by unemployment figures, has an effect on the risk of banks' loan portfolio, with banks reducing their loan portfolio risk, when local economic downturns are observed. On the contrary, banks do not seem to rely promptly on the development of collateral values. This indicates that banks do not fully separate borrower from loan risk, but could rather use transaction based lending techniques to gauge borrowers' ability to pay, i.e. their whether their financial condition allows them to repay their debt. Soft information obtained in relationship lending can additionally be used to grasp the willingness to pay, describing borrowers' disposition to abstain from consumption in order to repay their loans.

Chapter 2

Regional economic conditions and banking

2.1 Local economy, industry specialization and concentration

As local economy forms the basis of the latter investigation, we will briefly have a closer look on a few economic variables that will be used in the subsequent sections. On the one hand, this section discusses essential properties and implications of different industrial patterns that are to some extent essential for the comprehension of the following arguments. On the other hand, definitions are introduced for terms that are often used synonymously and thus could lead to misunderstandings (e.g. the difference between specialization and concentration).

The spatial distribution of economic activity can either be explained exogenously or endogenously; while the former approach considers input factors (such as land) as spatially fixed and the the settlement of production dependent on it, the latter considers relevant productive input - such as labor and capital - as mobile. Forces that shape geographical patterns can loosely be grouped into factors that promote agglomeration of production (*centripetal* forces) and those that foster dispersion (*centrifugal* forces) (Bröcker and Fritsch 2012). One of the main centripetal forces is sharing knowledge and input markets, which enhances productivity and promotes regional economic and population growth (s. Duranton and Puga 2004). The most notable effect of sharing local input markets is achieved if firms of the same industry settle in geographically close areas.

Commonly, local industry specialization describes the composition of industries within a defined area. The size of a respective industry is commonly measured using employees within an industry rater than the number of firms. Thus, while we keep specialization as attributed towards a place, concentration describes the spatial distribution of an industry within one defined area (Möller 2012, p. 21). Thus concentration is a measure that varies with each industry, but is constant for that spatial entity (usually on a country level).

Figure 2.1 offers a first glimpse on how these variables might affect banking conditions. Comparing figure 2.1a to 2.1b, we can see that there is some negative correlation between the degree of industry diversification and lending diversification by bank types with a stronger industrial specialization going in hand with a stronger diversification by bank types. Reasons therefore could include various firm sizes within industrial clusters or externalities, whose effects on firm funding are thoroughly examined in chapter 3. Contrarily, trying to explain funding patterns by economic conditions could be misleading: looking at population growth, which can be considered

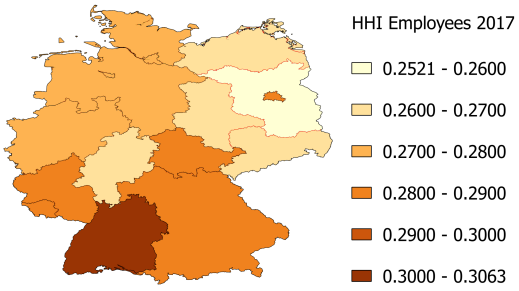
a more comprehensive indicator of overall local economic activity[1], there is no clear correlation with concentration of lender type on the level of German countries (s. figures 2.1c and 2.1d). Thus, the mechanisms between local economy and firm funding seem to be more complicated than just adapting to an overall economic state.

For regional economics, there is a history of over 100 years of research concerning beneficial effects of industry specialization on productivity and innovation. Before turning to aspects of firm financing and the integration of financial institutions in the local economic framework, the next section briefly introduces effects of industry clusters and urban structures on local economies.

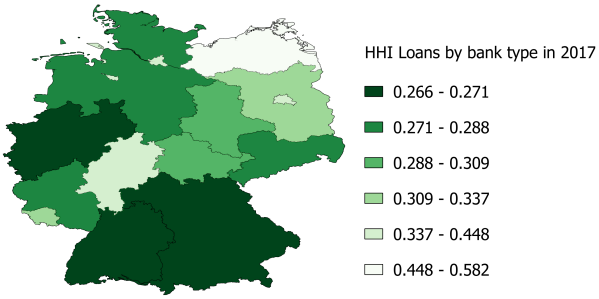
2.1.1 Economies of localization and urbanization

Turning to aforementioned local industry composition, the immediate question arises whether high regional industry specialization is beneficial for firms or exposes them to stronger competition, reducing their profits and possibilities of expansion. Positive externalities of local clustering of industrial sectors are commonly described by *economies of localization*. These describe positive effects of local industry specialization on firms' productivity growth, while positive influences of local industry diversification are known as *economies of urbanization*, i.e. productivity gains which are achieved by maintaining sites among firms of other industries in a densely inhabited area (Henderson 1997). Henderson 1997 separates economies of localization and urbanization as static concepts from *Marshall-Arrow-Romer* (MAR) and *Jacobs* externalities, describing the benefits of local industry specialization and diversification respectively in a dynamic environment. MAR externalities are gains in productivity (i.e. more output and less average costs) that do not arise from firm specific factors, but from an industrial specialization in the periphery of the firm. This specialization includes sharing of common infrastructure, suppliers and labor markets, with the latter being essential for the transmission of industry-specific non-ubiquitous knowledge. This information is often not codified, i.e. can only be transferred between persons, which is why these knowledge externalities have a geographically limited scope and require spatially close settlement of firms (i.e. industry clusters) (van der Panne 2004, p. 594). In contrast, Jacobs externalities describe knowledge externalities that occur between different industries, i.e. stimuli across industries. With the variety of industries being largest in urban areas (which is closely related to the availability of services and goods in urban centers), these knowledge spillovers are

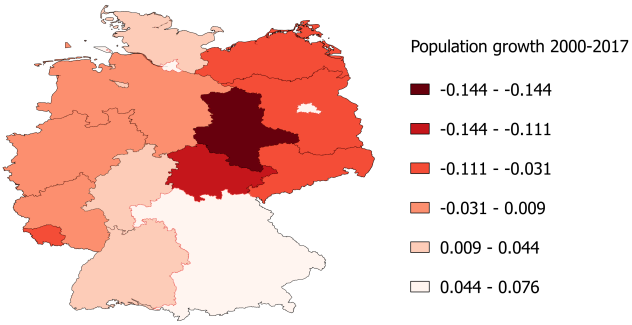
[1] On average, more people living within a certain space share a broader knowledge basis, promoting spillovers and increasing productivity, which in turn increases wages and thus attracts more workers (Palivos and Wang 1996).



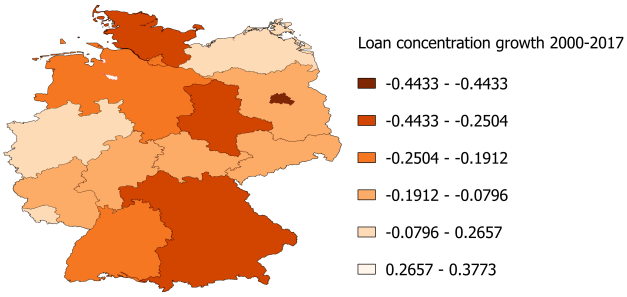
(a) Industry specialization in 2017 (employees)



(b) Firm lending concentration in 2017 (bank types)



(c) Population growth 2000-2017



(d) Growth of firm lending concentration 2000-2017 (bank types)

Figure 2.1: Economic figures of German countries
Concentration is measured by Herfindahl Indices; own graphic representation based on data of German Federal Office of Statistics, Deutsche Bundesbank, and the German Federal Agency for Cartography and Geodesy

most likely to happen there. Thus, according to this theory, economic growth is independent of exact industry composition, but rather of the size of the urban location which is closely related to the variety of inherited industries (Feldman and Audretsch 1999, p. 412).

Research has not come to a final result which externality finally drives productivity growth. E.g. Shuai 2013, p. 11 argues that established industries might rather be in need for new ideas from other industries and benefit from Jacobs externalities and Duranton and Puga 2004, p. 2100 suggest that it is rather young firms who are in need of a diversified environment.

The prevalence of either externality could depend on cities' sizes (Beaudry and Schiffauerova 2009, Henderson 1997) or initial endowment: E.g. Kluge and Lehmann 2012 find that the existence of MAR or Jacobs externalities depends on local initial industry specialization.

The effects are not mutually exclusive, though. For example, besides of firms of the same industry, firms benefiting from a specialized industry environment can be in need of other industries, that are supplementary for firms' production, as e.g. banks, law firms, etc. Hence those firms benefit from diversification of industries in that part of firms that do not belong to their own industry (Kluge and Lehmann 2012).

A common feature of both effects is the common use of infrastructure and sharing input markets (Duranton and Puga 2004; e.g. labor market pools, s. Beaudry and Schiffauerova 2009, p. 319). Along with common input markets , spatial proximity between firms is a promoter of growth: Storper and Venables 2004, 352f argue that personal contact plays a crucial role for the existence of MAR and Jacobs externalities, which leads to a prominent role of urban areas when it comes to productivity growth. Furthermore, personal contact allows for the transmission of specific, non-codifiable knowledge (s.a. Cook et al. 2007, p. 1327), which can be considered locally bound or 'sticky' (s.a. Einem 2011, p. 134).

Proximity thus enhances firms' exchange of knowledge, with distance and intensity of exchange being negatively correlated (Beaudry and Schiffauerova 2009, p. 320, Kluge and Lehmann 2012). Yet, although the capacity of spatial exchange can comprise a variety of regional entities, spillover effects between firms are not spatially unlimited (Paci and Usai 1999, p. 389). E.g. Rosenthal and Strange 2003, p. 386 find that economies of localization rather decline quickly with increasing distance to neighbor firms (e.g. due to reduction of personal interaction, including the recognition of non-verbal signals, Cook et al. 2007, p. 1334), while distance has an ambiguous effect for economies of urbanization; whereas one the hand, higher distance to firms impedes exchange, it reduces firms' congestion costs on the other hand.

Both externalities are closely related to firm level competition, which is another externality that possibly fosters innovation (s. e.g. Beaudry and Schiffauerova 2009, Carlino 2001, and van der Panne 2004) and will be introduced in the next section.

2.1.2 Local firm competition

Local specialization of course can affect competition between firms and vice versa (Aghion et al. 2005, 708f): Spatial proximity to other firms not only includes sharing input factors, but also higher comparability between firms (Cook et al. 2007, p. 132). Regarding competition itself, local industry composition is less essential for the direction of competition than for the type of competition: while MAR externalities are closely linked to product market competition, the notion of rivalry in the context of Jacobs externalities rather describes competition for ideas (van der Panne 2004, p. 595).

The interplay between industry composition and competition is as different as the benefits of specialization and diversification w.r.t. firm sizes: while MAR based theories think of monopoly as advantageous to prevent innovations from foreign exploitation (there are less rivals that can imitate innovators and thereby lower their returns), Jacobs externalities are rather based on the idea that competitive markets in urban areas foster the sprawl of ideas and inventions (s. Beaudry and Schiffauerova 2009, p. 319; Carlino 2001, p. 19). Empirical evidence comes from Rosenthal and Strange 2003: strong competition within an industry is beneficial for firm establishments while a strong competition in all other industries rather deters the foundation of new firms.

The choice of firm location not only depends on industry specialization: As it is often small innovative firms that are credit constrained (Alessandrini et al. 2010, p. 851), the choice of location is crucial for those firms and linked to a trade-off: on the one hand, settling in a specialized environment can promote productivity and the probability of inventions, on the other hand, if the number of banks is limited, credit constraints can thwart firms' innovative activities. Therefore, firms' access to funding and the geographical distribution of financial services are closely related to firm competition.

2.2 Firms' locations and external funding

2.2.1 Location of banks and access to finance

MAR and Jacobs externalities not only impact firms' growth and policies, they also shape the development of service and financial centers, as in Frankfurt and Dusseldorf (Gehring 2000, p. 428, Kluge and Lehmann 2012, p. 17). E.g., analyzing a sample of data of Chinese cities, Liang et al. 2014 find, that an accumulation of financial services goes in hand with higher spillovers, which indicates that financial services have a tendency for local concentration.

First evidence for Germany as presented in figure 2.2 seems to confirm the suggested spatial clustering of financial services industries; using the share of employees in financial services as indicator for the relevance of a financial center (s. Porteous 1999), there clearly exist core areas around Frankfurt, Munich and Dusseldorf.

This stronger concentration of (financial) services goes in hand with a higher distance of firms towards external funding, while firms located in those centers can obtain more information and easier access to funding than other firms (Klagge 1995). Yet the direction of causality is not clear: while firms have an incentive to locate close to financial institutions, the latter might settle close to firms. Thus, locations also depends on who came first and the existence of financial centers also has some path dependency (Porteous 1999). Concerning industry specialization, higher proximity towards financial centers would for at least a high fraction of firms come along with localization effects of their own industries.

As the offered services are not uniform for all branches, differentiation in the spatial distribution of banking services can be found even if branch/population measures would suggest otherwise. Klagge 1995 predicted, that branches with standardized services would be located in peripheral areas, while there would be an emphasis of bank clerks in the headquarters.

Consequently, banks following this strategy of centralization can lose touch with local economy in smaller political entities in their area when geographically focusing their (personnel) activity on urban areas. Banks then are hardly embedded in a local economic framework which can have severe consequences: while there is a high probability that locally operating banks will continue lending to firms, even if they might be in trouble, as they try to maintain relationships to retail customers (Jackson and Thomas 1995), being spatially more separated to the latter reduces this incentive. While this can probably not be applied to large firms - as they can employ hard lending techniques or are located rather in urban centers anyway - SMEs could encounter problems

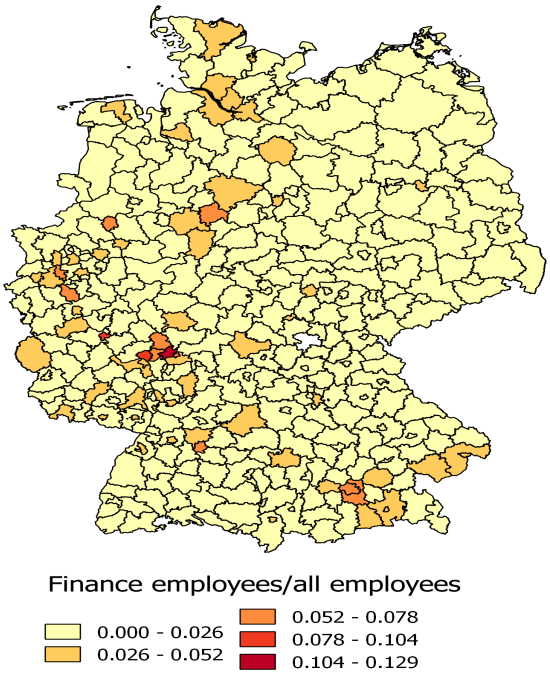


Figure 2.2: Share of employees in finance of all employees
Representation by counties. As can be seen, there are regional clusters of financial services, with a focus on large agglomerations. Own graphic representation based on data of German Federal Office of Statistics, Deutsche Bundesbank, and the German Federal Agency for Cartography and Geodesy

if banks withdraw from firm lending in peripheral areas.

SMEs furthermore often have to spend much effort on obtaining long term funding not having sufficient equity or collateral (Paul 2007, p. 369). This lack of securities is another reason why they cannot engage in multiple lending, especially if they are young innovative firms that cannot fulfill prospective lenders' collateral requirements. Concluding, the location of firms not only has an impact on their innovative activity, but also on their access to funding, which is also endogenous to their innovative activity itself (s. chapter 3) and on the distance to their financing bank (s. chapter 4).

Higher functional distance towards sources of external founding can be a problem for innovative firms (Alessandrini et al. 2010, p. 847). That is, firms that depend to some degree on secrecy of their competitive advantage and personal ways of communication to obtain external funding when introducing their innovations as will come under scrutiny in chapter 3.

In fact, firms depending on the exchange of soft information between borrower and lender can encounter problems in borrowing if located far from financial centers or facing centralized structures within the financing institution (Alessandrini et al. 2010, p. 875). For small firms, an increase in distance to a correspondent branch of their lending bank (possibly due to a closure of a former branch office) can thus have an ambiguous effect: on the one hand, banks' availability

of soft information decreases and might cause extra costs that are transferred to the firm. On the other hand, the market power of the bank decreases and enforcement of banks' desired loan conditions becomes more difficult (Alessandrini et al. 2009, 174f; s.a. Bellucci et al. 2013).
Additionally, banks tend to fund only innovations that build up on existing assets, which is an additional difficulty for young start ups (Handke 2011, p. 74). Consequently, this impacts location choice of innovative start-up firms and leads to an uneven geographical distribution of innovative activities (Klagge and Martin 2005, p. 388). This not only underlines the relevance of local industry specialization and national industry concentration, but also the high importance of spatial proximity between innovative firms and their funding institutions.

2.2.2 Local knowledge and loan portfolio specialization

Loan portfolio specialization[2] could arise if locally operating banks benchmark their industry specialization on the surrounding economy. An obvious shortcoming of loan portfolio specialization is being threatened by sector-specific shocks (Hayden et al. 2007). Locally operating banks in industry-specialized areas could be hit harshly by sector-specific economic downturns, leading to downward-spirals for the whole local economy. Thus, banks face a trade-off between monitoring efforts and default risks (Winton 1999, p. 2): On the one hand, one of banks' main features is diversification, so one could expect rewards for highly diversified banks (Morgan and Samolyk 2003, p. 5). On the other hand, local industry specialization allows banks to build up a stock of industry specific knowledge which could lead to better monitoring abilities (s. Jahn et al. 2013) and as a consequence better investment decisions.
This specific knowledge could e.g. enable specialized banks to handle loans more efficient and to realize securities quicker, such that banks face lower write-offs than diversified banks lending to borrowers with the same aggregate risk level (Böve 2009, p. 261).
One problem of higher loan portfolio industry diversification is that it can hardly be achieved by small banks with either geographically limited business areas or limited input, leading to inefficiencies when handling wider geographic borrower distribution (Emmons et al. 2004, 263f) on the one hand. On the other hand, evidence on the advantages of geographically larger market areas is mixed anyway; while there are several studies which find that larger business areas have a positive effect on banks' risk-return-profiles (Berger and Deyoung 2006, p. 1487), Morgan and

[2]In what follows, *loan portfolio specialization* describes a high concentration of industries within a portfolio of business loans. For closely related concentration w.r.t. spatial proximity of borrowers, see Barro and Basso 2006.

Samolyk 2003, p. 15 do not find significant advantages for small banks only by increasing their degrees of geographical diversification.

Empirical insights on this topic are in favor of loan portfolio specialization: Marquez and Hauswald 2002, 24f find that loan portfolios' industry diversification increases their risk. Similarly, Hayden et al. 2007 finds that loan portfolio specialization is beneficial for German banks in terms of return, as long as banks engage in low risk loans, while it has negative effects for banks that engage in risky lending. Jahn et al. 2013 find that specialized banks on average bear lower credit risks.

Yet, Kamp et al. 2005 find that on average German bank types have decreased loan portfolio specialization, which is mainly due to greater diversification of savings banks and credit cooperatives. This result indicates that either those banks tried to minimize the danger to be flawed in economic downturns of their local lead industry, as those banks only have geographically limited business areas or lost market shares within specialized locations.

Thus, local economy has a large impact on banks' strategical decisions and risk which will be shown in chapter 5. This is indirectly and directly affected by the degree of local industry concentration: as industry specific knowledge is embodied in persons, conducting banking that is focused on one industrial sector, requires a large pool of employees - which is a positive externality that can be used by rival banks.

2.2.3 Regional impacts on bank lending and banking competition

Competition in banking and advantages caused by spatial proximity to rival banks are closely related, as MAR externalities are a common explanation for the existence of financial centers (Grote 2003, p. 201). Higher degrees of banking competition come along with higher costs: on the one hand, the availability of external funding is limited or only can be achieved by increasing deposit rates (Jackson and Thomas 1995, p. 330). On the other hand, stronger competition can decrease the quality of screening and monitoring processes in order to gain market shares and thus increase average risks of banks' loan portfolios (Forssbaeck and Shehzad 2015, p. 2015). In fact, empirical results indicate that it is easier for firms to obtain credit in less competitive banking markets (Handke 2011, p. 88).

Forssbaeck and Shehzad 2015, p. 2016 find that banks' market power has a positive impact on their risk, with the effect being especially pronounced in concentrated loan markets. This is confirmed by the results of Kick et al. 2015, p. 19 for German savings and cooperative banks.

The latter are locally based and strongly depend on the economic well-being of their business area and are closer connected to it. Following Neo-Keynesian literature, asymmetrical information between borrowers and lenders is responsible for the competitive advantage of local banks when it comes to information, local market power and lower monitoring costs (s. Rodriguez-Fuentes 1998, p. 65, Dow and Rodríguez-Fuentes 1997, p. 914).

Information on local conditions therefore can be a competitive advantage and have a significant impact on banks' performance. Some empirical evidence on regional factors' impact on savings banks comes from Conrad 2008: Analyzing German savings banks, he finds that local purchase power has a positive effect on savings banks' earnings, while they reduce the density of branches within their business area in the presence of stronger competition.[3] This indicates the increasing relevance of savings and cooperative banks for peripheral areas as suggested by (Klagge 1995). Reichling and Schulze 2018 find environmental variables make up a large part of German savings banks' efficiency. They find that savings banks in wealthier regions are more efficient, possibly due to economies of scale that arise when dealing with higher amounts. Similarly, Cyree and Morris 2018 find that U.S. single county banks in high income areas outperform those in low income areas. Additionally, the authors find that returns on assets are higher for banks in low population counties. Local wealth also determines banks' deposits and hence their ability to expand their credit business (Dow and Rodríguez-Fuentes 1997, p. 916).

Turning to a borrower's point of view, less bank competition promotes hold-up problems, while strong banking competition impedes long lasting relationships between borrower and lender, as it is targeted by rival banks (Handke 2011, p. 152).

2.3 Firms' bank relationships

The kind of relationship between firms and their banks has been of high interest to researchers. This holds especially true in Germany, where the term *Hausbank* was coined, describing an intensive partnership between firm and a financial institute. These banks play a prominent role for firms that are unable to achieve external funding in capital markets (Gischer and Herz 2016, p. 179), which is the case for most small firms (Deyoung et al. 2008, p. 116).

There are not only differences in the role of banks for external firm funding between Germany and other countries in the world: The strength of (local) bank relationships is on average higher in Europe than in the US (Alessandrini et al. 2009, p. 180). As Ongena and Smith 2000, 30ff

[3] A similar study analyzing cooperative banks was published by Maurer and Thießen 2016.

find, German firms value their bank relationships strongly, having on average about eight bank relationships.

The quantity of bank relationships and their intensity is determined by a variety of factors, as already addressed in previous sections. This also includes how transparent a firm acts and how easy it can communicate relevant information credibly to outside investors in order to reduce information asymmetries. Therefore, we will focus on the latter and its connection to bank relationships and firms' missing informational transparency (*opacity*) in the following chapter.

2.3.1 Soft information and its use in finance

Non-codifiable or *soft* information and personal contact not only play a vital role in generating externalities of specialization and urbanization as discussed above, but also when establishing relationships, including borrower-lender-relationships between firms and banks. This kind of information comprises a variety of factors that cannot be transmitted objectively between different persons or even be codified, e.g. subjective knowledge about the firm (Berger and Black 2011, p. 725) or the quality of firms' management or strategical orientation (Degryse and Ongena 2004, p. 573). Although there has been great technical progress during the last decades, the relevance of these issues still cannot be denied as this information type yet cannot ultimately be 'hardened'. Hard information on the other hand commonly describes quantifiable information (as e.g. accounting reports or financial ratios) that can easily be transmitted via different communication techniques (Deyoung et al. 2008, p. 117). Besides economic data that is used to create credit scorings or other ways to estimate borrowers' default probabilities, lending using loss mitigating techniques such as collateral are frequently subsumed by credit relationships using hard information. Both types of information are applied in lending: while credit analysis based on borrowers quantifiable information that could grasp the borrower's capacity to repay her obligations and allow for lending over wide distance, the willingness of the lender to pay must be inferred by qualitative information and face-to-face meetings with the loan applicant (Golin and Delhaise 2013, p. 9).

As the ratio of the quantity and quality of hard to soft information somewhat determines the degree of opacity of firms and thus (again) the relevance of soft information when obtaining credit, the field of application of soft information in lending is narrowed: Using firm size as indicator of the availability of soft information (e.g. Berger et al. 2005, p. 243), soft information has a high relevance for those firms that are too large or specialized for the use of standardized products or

enterprises that are too small to be fully evaluated by hard information techniques: Soft information is important for loans with individual characteristics, while for standardized products, hard facts dominate the loan assigning process (Dou et al. 2018, p. 1199). This difference on the one hand applies to loan market competition and on the other hand to costumer bases: While retail and SME loans are often standardized products (s. Agarwal and Hauswald 2010, p. 6, Altman et al. 2008, p. 7), large volume loans of enterprises have many individual components. This illustrates the relevance of soft information in lending in industrially specialized areas, where firms albeit their small size are in need of non-standard loans.

Commonly, the use of soft information lending techniques is considered as determinant of *relationship* lending, which relies on the collection and gain of information during the connection of borrower and lender (Berger and Black 2011, p. 725).

2.3.2 Relationship and transaction based lending

There are two ways to handle informational asymmetries in borrower lender relationships: being close to the counterparty and observing its economic state by frequent personal exchange or creating credit contracts in a more restrictive way for the business partner and 'relying on facts rather than on feelings'.

A prominent feature that separates relationship lending from transaction based banking is that banks try to build up a relationship with the borrower and plan to engage in multiple (i.e. repetitive) transactions with her. Therefore, banks collect information about borrowers, including especially private information that gives them some advantage over competitors. This enables banks to reduce loan rates in the beginning of the relationship in order to prevent firms from taking too risky projects. After the relationship has been stabilized, a *lock-in* situation arises in which firms cannot credibly switch lenders. Therefore, the relationship bank can increase the rates on loans (Hartmann-Wendels et al. 2019, 145f). This can be continued up to a state of full information, in which banks can resign from (costly) collateral and adjust loan rates not only to a borrower's or loan's risk, but to expected profits of the borrower (Besanko and Thakor 1987, 673f).

In order to achieve such a degree of monitoring, soft information requires spatial proximity, as it cannot be sent in codified ways and - due to its frequency - personal exchange would become too costly over a relevant period of time. Proximity yet not only has a spatial dimension, but also a cultural and personal in the sense of a common background of borrower and lender (Handke

2011, p. 151).

E.g., rural areas might be different from urban when it comes to the ability of employing relationship lending: banks might have easier access to soft information and have a closer affiliation with local business. Analyzing this hypothesis, Deyoung et al. 2012 find that rural banks lending to rural borrowers have more efficient monitoring, which significantly lower defaults in this constellation.

Also, Stein 2015 mentions two strands of literature: one that predicts a reduction of firms' lending costs due to lower information asymmetries and another predicting higher interest rates on loans due to lock-in effects and better knowledge of future profits of the firm. Her analysis considers time *and* space as dimensions of bank relationships and she finds that interest rates on average decrease with the proximity between firm and bank, while they moderately increase with the duration of the relationship.

In contrast, ways of screening in transaction based banking are limited to the use of hard information and the determination of credit conditions in the spirit of Stiglitz and Weiss 1981, 393f. Transaction based banking comprises financial statement lending, credit scoring, real estate or asset based lending and leasing. These techniques initially were thought to be suited best for transparent small firms, which could offer enough information for making a credit decision. But further studies put an emphasis on the separation of loan and borrower risk, which can be found in transaction based lending techniques, especially those relying on collateral. Therefore, these lending techniques could be applied when lending to small opaque firms (Udell 2009, p. 17).

2.3.3 Determination of relationship type

Which firms ultimately relies on close concentrated banking relationships is not only dependent on firm location, but also firms' financial characteristics; firms with higher leverage and lower cash holdings rather engage in concentrated borrowing relationships, as those firms do not have a strong credit growth and cannot use their cash flow as covenant for additional borrowing (Gobbi and Sette 2014).

Furthermore, firms which are dependent on stable external funding could benefit from relationship banking: Gobbi and Sette 2014 find that concentrated borrowing went along with higher credit availability for firms after the financial crisis of 2008, while it hindered credit growth before it. Therefore, although not being ultimately determined by it, relationship and transaction

based banking are closely linked to the number of bank relationships of the firm (s.a. Neuberger et al. 2008, p. 102). This especially holds true for small firms, whose credit availability is often linked to maintaining a long term relationship towards their lenders (Agarwal and Hauswald 2010, p. 2).

On the contrary, the increasing use of transaction based banking, and along with it, sinking costs of lending has made it possible for formerly rationed firms to obtain credit (Udell 2009, 18f). This includes not only *per se* opaque borrowers, but also those that remained opaque due to missing geographical proximity to the lender: Due to higher costs of transport and communication, monitoring distant firms becomes expensive (Degryse and Ongena 2004, p. 575), impeding their credit availability.

Thus, a bank relationship is also influenced by spatial distance. In line with this, Brevoort and Hannan 2004 using US Data find that the probability of granting credit decreases with spatial distance to the borrower, with the effect being more pronounced for small than medium sized banks. Relationship type is also determined by local banking competition, which is closely connected to location type: as it becomes harder for market entrants to beat incumbent banks if soft information has a high relevance (Dou et al. 2018), mergers and acquisitions can be an efficient way of entering such markets (Degryse and Ongena 2004, p. 573).

Which type of lending relationship will be in place also depends on the characteristics of the bank: As relationship lending demands the transmission of borrower related information within the financial institution, information could vanish between a multitude of layers between loan officer and decision making persons (s. Berger et al. 2014; Berger et al. 2015, p. 1966). Therefore, small banks and community banks will have advantages in relationship lending relative to large institutions, virtually only by their smaller organizational structure (Deyoung et al. 2012, Emmons et al. 2004, Felici and Pagnini 2008, p. 519, Meyer and Yeager 2001).

This applies to German savings banks and credit cooperatives, which have always been important funding partners for SMEs, and meanwhile have extended their borrowing to large enterprises (Handke 2011, 85f). In fact, Stein 2015 finds that the strength of a bank relationships is strongly negatively correlated with firm size, underlining the relevance of strong bank relationships for German SMEs. Locally based banks' relevance for small firm lending in Germany was virtually reinforced by the onset of the Financial Crisis and the European Sovereign Debt Crisis: Profits from traditional borrowing and lending business of banks eroded and locally operating savings banks and credit cooperatives often did not have a statutory opportunity of investing in capi-

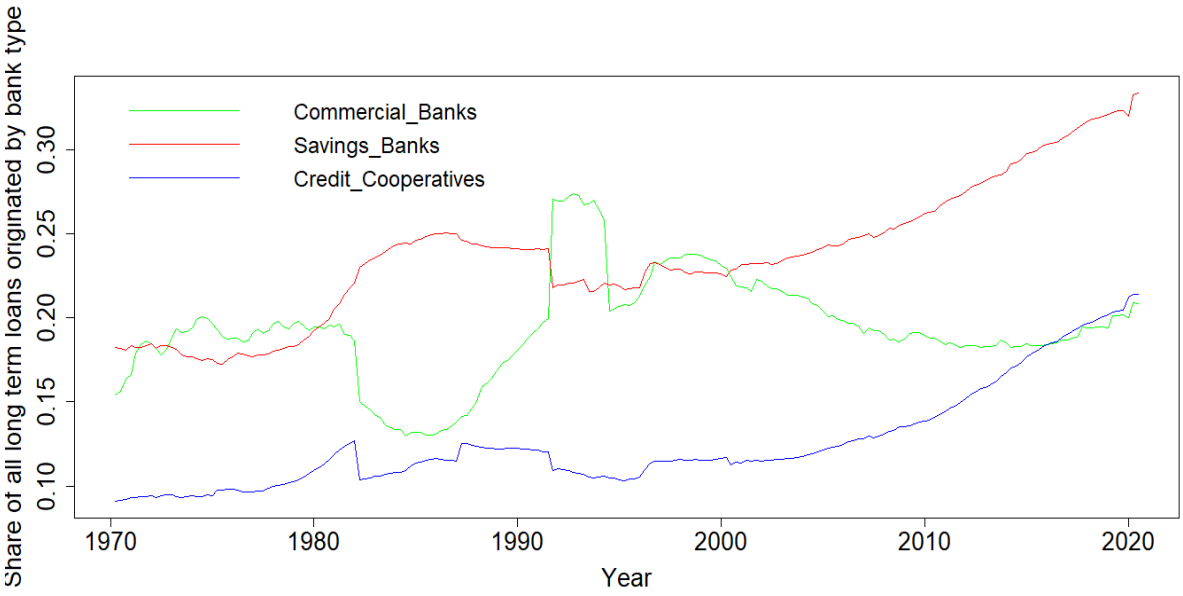


Figure 2.3: Long term loans by bank type
Origination of corporate long term loans (term>5 yrs.) by bank type (to all originated long term loans). Data source: Deutsche Bundesbank.

tal markets. Relying on a normal term structure, extending long term credit was one of their possibilities to counteract a reduction of earnings (s. figure 2.3).[4]. On the other hand, the long term of the loans plotted in figure 2.3 (> 5 years) comes at a cost: if interest rates are fixed in the years after 2010 for e.g. ten years, increases of interest rates cannot be transferred to acitve positions, but will be demanded from depositors. Therefore, the relevance of interest rate management increases with the extension of long term loans.

For firms, loans with long duration have two major advantages: First, they ensure a long lasting supply of capital and second, a higher share of long term debt goes in hand with a lower probability of liquidation when distressed (Carmignani and Omiccioli 2007, p. 15).

Yet, taking a look at table 2.1, it becomes clear that German firms, although not having increased their capital market funding significantly, reduced the amount of bank debt expressed in weighted means of balance sheets. Although the figures are notably higher when only considering small (about 29% in 2017) and medium sized (22% in 2017) firms, the overall trend of reduction of bank based finance in favor of other funding sources is also visible there. This raises the question, how long intermediation in financial markets will endure and whether disintermediation of firms in the spirit of Schmidt et al. 1999 finally is going to be pushed ahead.

Banks' organization type and business area not only impact the use of soft information in lending, but also the use of collateral in lending: Jiménez et al. 2009 not only find that duration

[4]Yet, credit growth is limited to banks' equity reserves.

Table 2.1: German enterprises' liability structure

Weighted means (excluding activities of holding companies); figures represent percentages of balance sheets. Data source: BACH (Banque de France)

year	Bonds and similar obligations	Amounts owed to credit institutions	Other creditors	Trade payables	Total Liabilities
2000	2.52	12.75	24.72	5.49	68.14
2001	2.31	12.31	25.64	4.9	67.52
2002	2.06	11.71	27.9	4.56	67.57
2003	2	10.62	29.21	4.24	67.1
2004	1.49	10.87	28.19	4.57	66.8
2005	1.81	9.94	27.8	4.53	65.46
2006	1.82	9.56	29.79	4.39	65.67
2007	1.7	9.74	29.25	4.31	64.46
2008	1.77	10.97	29.27	4.09	65.54
2009	1.91	11.02	29.39	3.9	66.37
2010	2.15	10.03	30.83	4.18	65.35
2011	2.1	9.47	31.14	4.26	65.57
2012	2.38	9.25	30.74	4.26	64.45
2013	2.55	8.9	30.72	4.12	63.84
2014	2.73	8.79	30.18	4	62.77
2015	2.91	9.09	29.66	3.97	63.76
2016	3.19	8.99	27.36	4	61.13
2017	3.32	8.6	29.77	3.87	61.43

of borrower-lender relationships affects the probability of using securities in lending negatively, but also higher distances between bank branches and their headquarters - which indicates the aforementioned difficulty of transmission of soft information between organizational layers.

2.4 Collateral

Collateral in lending is a common way of reducing agency costs of borrower-lender relationships; yet, literature has not come to an ultimate conclusion whether collateral based lending is rather employed for risky or safe borrowers (Berger et al. 2016, 29f). On the one hand, banks could rather demand collateral from riskier borrowers, while on the other hand safer borrowers rather pledge collateral in situations of unknown borrower risk, as borrowers themselves know their higher probability of repayment (s. Besanko and Thakor 1987, Berger and Udell 1990, 21ff). Thus, for interest rates, there is also an optimal amount of collateral to be demanded by lenders, as too high requirements would deter safe borrowers or lead to moral hazard (Stiglitz and Weiss 1981, p. 394).

From the viewpoint of banks, screening and collateral are substitutes, with banks reducing screening effort in the presence of collateral with high value (Manove et al. 2001). Lending using collateral is also considered as most efficient hard information lending technique by Berger and

Black 2011, as it enables lenders to reserve some recovery before other lenders. This benefit can have an impact on loans' required interest rates, as risk and monitoring costs are reduced (Bester 1985, p. 850). Using this circumstance, banks can estimate borrowers' risk by offering different contracts that adjust different marginal rates of substitution between interest and collateral requirement (Bester 1985, 852ff).

Without going in too much detail, borrower distance and local firm level industry allocation are closely related to collateral: On the one hand, banks' request for collateral can depend on their knowledge of the industry (e.g. if prospective borrower does not belong to leading industry) and firm sizes and duration of bank relationship, i.e. severity of information symmetry (s.a. Jiménez et al. 2009), which are closely related to industries. On the other hand, firms' industry plays a role for obtaining credit, as some industries are rather able to pose collateral (Handke 2011, p. 147). This could allow larger firms operating in capital intensive sectors to finance more research and development activities in order to promote growth (s.a. Pagano and Schivardi 2003) without disclosing too much private information.

Higher spatial borrower lender distance increases information asymmetries, which is an argument for the use of collateral. [5] Another way to compensate for this higher risk is by demanding higher interest rates from remote borrowers. This trade-off between interest and collateral requirements for locally based lenders with informative advantage and transaction based lenders is also illustrated in Inderst and Mueller 2006. Here, local lenders will demand reduced interest rates than distant transaction based lenders in order to attract more costumers and compensate this lower rate by higher collateral requirements.

Collateral demand of course has a direct impact on banks' loan portfolios, as e.g. low risk aversion or expectation of increasing value of collateral, i.e. wrong estimation of ex post risk, impact banks' stability (s. Niinimäki 2009). This can create feedback effects[6] that affect local banks with informational advantages, and cause credit crunches for local borrowers.

Thus, local financial infrastructures are clearly determined endogenously, as well as the local economic and industry framework they are operating in. This mutual interference of local banks and enterprises requires disentangling the factors and effects in smaller parts and analyzing and discussing the processes that substantially constitute regional economy and finance.

[5] In fact, Bellucci et al. 2019 find a negative relationship between borrower-lender-distance and collateral requirement for Italian SMEs.

[6] s.a. Constantinescu and Lastauskas 2018 for an analysis of feedback effects of increasing real estate prices, higher collateral requirements and credit availability.

Chapter 3

Local competition, innovation, and bank relationships of firms

[7]

[7] This chapter is accepted for publication at the *Journal of Banking and Financial Economics*. Due to the requirements of the journal, the language here is held in British English.

3.1 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 on the other hand (Foglia et al. 1998)).[8] 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.

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

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[9] 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. 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

[9] According to the Deutsche 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.

the data and summary statistics. Empirical analyses are performed in section four. Section five concludes.

3.2 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.

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 Körting 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 Körting 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 Körting 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).

3.2.1 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.[10] 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 and should thus ease availability to and quality of a variety of production factors.[11] 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 infrastruc-

[10] 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.

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

ture 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.

3.2.2 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 Matray 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.

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.

3.2.3 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 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 and 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.

3.2.4 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 proba-

bility 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.

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). 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.

3.3 Data and variables

3.3.1 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 3.1).

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 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).

3.3.2 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.[12] 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 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[13], 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 van der Panne 2004, the specialization index PS_{ij}, indicating the share of industry i in county j is used to grasp MAR externalities

$$PS_{ij} = \frac{E_{ij} / \sum_i E_{ij}}{\sum_j E_{ij} / \sum_i \sum_j E_{ij}} \tag{3.1}$$

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

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

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

of firms within a certain industry within a also country is captured by the variable $COMP_{ij}$ following van der Panne 2004.

$$COMP_{ij} = \frac{firms_{ij}/E_{ij}}{\sum_i \sum_j firms_{ij} / \sum_i \sum_j E_{ij}} \tag{3.2}$$

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.

$$PD_j = \frac{2}{(n_j - 1) \cdot \sum_i E_j} \sum_{i=1}^{n-1} \sum_i E_j \tag{3.3}$$

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 and 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[14], 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 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 ($\frac{Fixed+IntangibleAssets}{TotalAssets}$). 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[15], 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

[14] 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.

[15] German classification system (WZ 2008).

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.

3.4 Empirical investigation

3.4.1 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 3.1, it is firm specific variables that are unevenly distributed, while the gaps between mean and median for the local variables are smaller. 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.

	Min	Median	Mean	Max
$Trademarks$	0	0	3.153	3890
Age	0	3.219	3.248	6.405
$Manageract/form$	0.05556	2	2.77943	54
$Equityratio$	0	0.3678	0.3885	1
$Patents$	0	0	31.47	187286
$Locations$	0	0	2.404	283
$Tradecredit$	0	0.073906	0.134246	1
$ActManagers$	0	7	9.198	394
$Intangible$	0	0.002659	0.023446	5.553051
$Totalassets$	4.32	9.601	9.85	19.761
$Banks_{25}$	0	203	261	829
$HHI_{Firmsize}$	0.6984	0.8113	0.8088	0.8825
COMP	0.01632	1.36054	1.68858	41.23486
PS	0.03522	1.06823	1.17036	10.25425
PD	0.08466	0.14229	0.14	0.19942
$HHI_{Concentration}$	0.005346	0.008075	0.009549	0.025377
$Share_{Industryi}$	-0.002961	0.201992	0.188091	0.57668
$HHI_{Specialization}$	0.1566	0.1933	0.1992	0.3766
$Firmsest.$	0.7714	0.9845	0.9927	1.2209
$Firmsacq.$	0.01069	0.07612	0.07685	0.33857

Table 3.1: Summary statistics for explanatory variables
Sources: Author's calculation based on data from the German Federal office of Statistics, Yellow Pages, and Amadeus.

3.4.2 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 3.2.

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 (s. 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 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 (*Firmsest.*). 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.

Table 3.2: OLS Estimations on external funding forms

Estimation	(9)	(10)	(11)	(12)	(13)	(14)
Dependent variable:	$\frac{Long\ Term\ Financial\ Debt}{All\ Liabilities}$		$\frac{Trade\ Credit}{All\ Liabilities}$		$\frac{Long\ Term\ Financial\ Debt}{Total\ Assets}$	$\frac{Trade\ Credit}{Total\ Assets}$
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^{***}
$Manageract/form$	0.003^{***}	0.003^{***}	0.0001	-0.00000	0.001^{**}	0.0003
$Equityratio$	-0.171^{***}	-0.172^{***}	0.023^{***}	0.025^{***}	-0.285^{***}	-0.115^{***}
$Patents$	0.00000	0.00000	-0.00000	-0.00000	0.00000	-0.00000
$Locations$	-0.0004^{**}	-0.001^{**}	0.0001	0.0001	-0.0004^{**}	0.0001
$ActManagers$	-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
$Totalassets$	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	0.060	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^{*}
$Firmsest.$	-0.021	-0.004	0.033^{*}	0.031^{*}	-0.013	0.038^{***}
$Firmsacq.$	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
adj. R^2	0.2059	0.2038	0.06223	0.06104	0.1396	0.1092
n	23,860	25,021	23,860	25,021	25,021	25,021

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

3.4.3 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 3.3.[16] 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 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

[16] Firm level controls correspond to the variables as shown in table 3.1

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, $Share_{Industry_i}$ and the number of patents have no statistically significant correlation, $\frac{Long\ Term\ Liabilities}{Total\ Assets}$ 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 $Share_{Industry_i}$. 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 $\frac{TangibleAssets}{Debt}$ 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 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.

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 et al. 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 3.4 (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

Table 3.3: Probit and sample selection estimation on multiple banks dummy

	Dependent variable:			
	Multiple Banks			Bank Relations No.
	Probit		*Selection*	*Outcome*
	(5)	(6)	(7)	(8)
Intercept	0.574	0.498	6.313	6.040***
	(1.067)	(1.150)	(146.955)	(0.452)
$Banks_{25}$	−0.0004***	−0.0004***	−0.0004***	−0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$HHI_{Firmsize}$	−1.312***	−1.161***	−1.645***	−1.773***
	(0.400)	(0.398)	(0.408)	(0.424)
$COMP$	0.006	0.011**	0.005	−0.005
	(0.007)	(0.005)	(0.007)	(0.007)
PS	−0.001		0.0003	0.015
	(0.018)		(0.018)	(0.018)
PD	−1.527*		−1.286	−1.397*
	(0.831)		(0.850)	(0.834)
$HHI_{Concentration}$		−23.547***		
		(2.156)		
$Share_{Industry_i}$		0.212**		
		(0.099)		
$HHI_{Specialization}$		1.243***		
		(0.354)		
$Firmsest.$	−0.914***	−0.943***	−0.920***	−0.575***
	(0.150)	(0.150)	(0.153)	(0.178)
$Firmsacq.$	−0.527	−0.551	−0.443	−0.601*
	(0.349)	(0.346)	(0.357)	(0.360)
$Innovative$			0.114*	
			(0.062)	
$Avg.\ Citations_{2010-2015}$			−0.001	
			(0.023)	
$Inverse\ Mill's\ Ratio$				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	−14,307.590	−14,482.910	−13,699.130	
Akaike Inf. Crit.	28,733.170	29,051.820	27,512.260	
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

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 *Firmsacq.* 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.

While competition seems to increase the number of bank relationships, consistent with our

Table 3.4: Results of Poisson estimation

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

	Dependent variable:			
	Number of Bank Relationships			
	(1)	(2)	(3)	(4)
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***
$Manageract/form$	0.018***	0.017***	0.017***	0.017***
$Equityratio$	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
$ActManagers$	0.003***	0.003***	0.003***	0.003***
$Intangible$	−0.116*	−0.102	−0.123*	−0.103
$Totalassets$	0.030***	0.033***	0.029***	0.034***
$Banks_{25}$		−0.0002***	−0.0002***	−0.0002***
$Avg.\ Citations_{2010-2015}$				−0.011
$HHI_{Firmsize}$		−0.831***	−0.808***	−0.914***
$COMP$		−0.001	0.005**	
PS		0.002		
PD		−0.768**		
$HHI_{Concentration}$			−12.485***	
$Share_{Industryi}$			0.039	
$HHI_{Specialization}$			0.552***	
$Firmsest.$		−0.396***	−0.404***	−0.413***
$Firmsacq.$		−0.379***	−0.379***	−0.330**
$Innovative$				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-R^2 (McFadden)	0.04705	0.04871	0.04566	0.048742

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.

3.4.4 Effects of neighbours' bank relationships

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 models had a bad overall fit and only few spatially weighted variables were significant.[17] The estimated equation has the basic form of

$$y = \mathbf{X}\beta + \lambda \mathbf{W}y + \epsilon \tag{3.4}$$

where $\mathbf{W}y$ 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.

Estimation results

Due to limited computational capacities, calculation of eigenvalues of the spatial weight matrix, which would have been necessary to calculate the Jacobian $ln|\boldsymbol{I} - \boldsymbol{\lambda W}|$ 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 supe-

[17] 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.

rior 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 3.5, λ remains positive and significant throughout all estimations. Thus, an increase of the quantity of bank connections of firms' k nearest neighbours, 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 autoregressive term might reveal the effect of firms in the vicinity who also face strong industry specialization, reinforcing the effects of PS.

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 decision 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' pri-

Table 3.5: Results of spatial two-stage autoregression

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

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

vate 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 firms 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, 22ff for detailed explanations). The results are displayed in table 3.6. 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 neighbouring 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 PS 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.

Table 3.6: Direct and indirect effects of spatial autoregression

k=25, different industry sectors. *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

Estimation	(18) Primary Sector			(19) Manufacturing Industries			(20) Service Industries		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
λ	-0.0573			0.35919***			0.26368***		
Intercept	10.16442			-0.66865			1.3855		
Trademarks	0.02084	-0.00113	0.01971	-0.00022	-0.00012	-0.00035	0.00113***	0.0004	0.00153
Age	0.41329**	-0.02244	0.39085	0.54145***	0.29894	0.84039	0.51429***	0.18247	0.69676
Manageract/form	0.0471	-0.00256	0.04454	0.03998***	0.02207	0.06205	0.01841***	0.00653	0.02494
Equityratio	-0.9424**	0.05116	-0.89125	0.06322	0.0349	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	-0.0002
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	0.3065	0.05223	0.01853	0.07076
actManagers	0.00589	-0.00032	0.00557	0.01455***	0.00803	0.02259	0.01126***	0.00399	0.01525
Intangible	-1.2523	0.06798	-1.18432	-0.14437	-0.07971	-0.22408	-0.03478	-0.01234	-0.04712
Totalassets	0.2015	-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	0.0079	-0.01072**	-0.0038	-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***	-0.03	-0.11457
Firmsest.	-6.04795***	0.32832	-5.71963	-0.11229	-0.062	-0.17429	-0.81915***	-0.29062	-1.10977
Firmsacq.	-8.82831**	0.47925	-8.34906	0.29447	0.16258	0.45705	-1.33821***	-0.47478	-1.81299
n	128			5,594			10,339		

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.

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.

3.5 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 *Innovative* 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 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.

3.6 Appendix

3.6.1 Variable definitions

Table 3.7: Variables and their definitions

Variable	Description
$Trademarks$	Firm's number of trademarks
Age	Log (1+Firm Age in years)
$Manageract/form$	$\frac{number\ of\ current\ managers}{number\ of\ former\ managers}$
$Equityratio$	Equity/Total Assets
$Patents$	Firm's number of patents
$Locations$	Number of documented firm locations
$Tradecredit$	Trade credit in thsd. EUR
$ActManagers$	Trade credit in thsd. EUR
$Intangible$	$\frac{Intangible\ fixed\ assets}{Total\ assets}$
$Totalassets$	Log (1+Total Assets in thsd. EUR)
$Banks_{25}$	Number of bank branches in a circumference of 25 km
HHI_{Firm_Size}	Herfindahl index of local firm size categories (0-9, 10-49, 50-249 and more than 250 employees)
COMP	see equation (3.2)
PS	see equation (3.1)
PD	see equation (3.3)
$HHI_{Concentration}$	Herfindahl index over industries' spatial concentration, calculated using counties
$Share_{Industryi}$	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
$Firmsest.$	$\frac{new\ firm\ establishments}{established\ firms}$
$Firmsacq.$	$\frac{corporate\ takeovers}{newly\ registered\ firms}$
$Avg.\ Citations_{2010-2015}$	$\frac{Citations_{2010-2015}}{Patents_{2010-2015}}$
$Innovative$	Dummy variable; equals 1 if firm had at least one patent application between 2010 and 2015

3.6.2 Average mean effects of Poisson estimation

	(11)	(12)	(13)	(14)
$Trademarks$	0.00013	0.000103	0.00019	0.000075
Age	0.488227	0.479346	0.508465	0.480784
$Manageract/form$	0.038677	0.036277	0.036918	0.036953
$Equityratio$	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
$actManagers$	0.005937	0.006074	0.006731	0.005608
$Intangible\ fixed\ assets$	-0.253929	-0.223917	-0.26915	-0.226831
$Totalassets$	0.065932	0.07294	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	
$Share_{Industryi}$			0.086371	
$HHI_{Specialization}$			1.209034	
$Firmsest.$		-0.868405	-0.885654	-0.906758
$Firmsacq.$		-0.830876	-0.830449	-0.724315
$Innovative$				0.827701
$Innovative * COMP$				0.03753
$Innovative * PS$				0.031756
$Innovative * PD$				-5.635223

Table 3.8: Average mean effects of Poisson MLE

3.6.3 Two stage procedure applied for spatial estimation

The two stage procedure to estimate (3.4) is based on rearranging the initial equation:

$$y(I - \lambda \mathbf{W}) = \mathbf{X}\beta + \epsilon \tag{3.5}$$

The expectation therefore is

$$E(y) = (I - \lambda \mathbf{W})^{-1}\mathbf{X}\beta = \mathbf{X}\beta + \mathbf{X}\mathbf{W}\beta\lambda + \mathbf{X}\mathbf{W}^2\beta\lambda^2 + ... \tag{3.6}$$

For $\mathbf{H} = [\mathbf{X},\mathbf{XW},\mathbf{XW}^2]$, $\mathbf{M} = [\mathbf{X}, \mathbf{W}y]$ and $\gamma = [\lambda, \beta]$, the first stage of the estimation is

$$\mathbf{M} = \mathbf{H}\delta + \eta \tag{3.7}$$

Thus, $\hat{\mathbf{M}} = \mathbf{H}(\mathbf{H'H})^{-1}\mathbf{H'M} = [\mathbf{M},\mathbf{H}(\mathbf{H'H})^{-1}\mathbf{H'W}y]$

The second stage is estimated using OLS:

$$y = \hat{\mathbf{M}}\gamma + u \tag{3.8}$$

Chapter 4

The Effects of Spatial Distance on Loan Pricing in Relationship Lending - Evidence from Germany

[18]

[18] This chapter has been published as *The Effects of Spatial Distance on Loan Pricing in Relationship Lending - Evidence from Germany* in *Die Unternehmung*, Vol. 72, No. 3, p. 212-228

4.1 Introduction

The literature on firm-bank relationships, mainly focusing on credit relations has often considered large distances between debtors and creditors to aggravate the difficulties and costs of transferring non-codifiable information from borrowers to lenders. This type of information might be relevant for estimating data such as the probability of default or the loss given default. Less hard facts provided by the borrower thus should result in increasing monitoring and screening costs which will be borne by the borrower, when being charged higher interest rates by the lender (s. e.g. Cenni et al. 2015, p. 251; Knyazeva and Knyazeva 2012, p. 1195; Degryse and Ongena 2005, p. 234; Petersen and Rajan 2002, 2543f). The increase in interest rates on the other hand is only supposed to happen up to a certain location. At some point in space, other banks, located closer to the borrowing firm, are able to assign a loan to the borrower with lower interest rates due to lower incurring costs.

Furthermore, it is commonly assumed that enterprises' opacity decreases with firm size due to a larger stock of employees, more reporting (obligations) and especially a longer history of the firm resulting in a better availability of firm specific data. Hence, large firms are able to provide hard facts as reliable information to their lenders when applying for credit and thus, in theory, ruling out distance to some high degree.

Empirical Evidence on this topic is mixed. While e.g. Bellucci et al. 2013 and Knyazeva and Knyazeva 2012 find loan interest rates to increase with borrower-lender-distance, Agarwal and Hauswald 2010 and Degryse and Ongena 2005 find borrowers located closer to their lenders to be charged on average higher loan rates, due to local market power of the lending bank. This paper seeks to address whether geographical distances between banks and firms manifest in interest rates on firms' liabilities as lenders allocate their transport and information costs to debtors. The verification of the theoretical argumentation cannot be done without incorporating characteristics of the lending bank. Banks of different types and sizes might use varying techniques to cope with larger distances. As the relevance of distance is assumed to be more pronounced for relationship lending, only exclusive banking relationships are analyzed. With the initial sample consisting of firms with no or multiple banking relationships as well, Heckman's two stage procedure is used to correct for possible sample selection. While I find strong evidence for the relevance of location in determining whether a firm engages in relationship lending, distance on average has a high positive effect on firms' loan rates in the outcome equation. Therefore, higher costs of monitoring

seem to be borne by borrowers. On the other hand, local market power as well has an impact on interest rates, with the number of banks in the vicinity of firms on average decreasing interest rates.

The paper proceeds as follows: In the following section, I'll give a short review on the theoretical argumentation on bank and firm relationship, which will rely on bank and firm size and introduce geographical distance between enterprises and banks. The data used in the analysis will be introduced in section three. Empirical investigations will be performed in section four, using German individual firm level data. Section five concludes.

4.2 Firm-bank relationships and distance

While some time ago, a well working bank relationship was crucial for external funding, nowadays many, especially large multinational firms, can participate at capital markets without intermediation. In Germany, as a bank-based system of financing, enterprises have relatively long-lasting and often exclusive bank relationships, with bank loans being by far the most important source of external funding (Handke 2011, 77f).

The exclusiveness of a bank relation could have different possible outcomes: Harhoff and Körting 1998 did not find the number of banking relationships to matter for the interest paid in data on German firms. In contrast, Stein 2015 finds interest rates paid by enterprises to increase over time, if the bank owns a large share of the firm's debt, thus exhibiting a hold-up in their relationship. This finding is reasoned with firm growth during the relationship and thus the need for larger loan amounts. The resulting higher concentration risks of the bank might be prized with higher interest rates. Focusing on distance and market power, it is commonly assumed that borrowers located in the geographical vicinity of the lending bank are priced higher loan rates due to the local market power of the lending bank, whereas loan rates decline as firms' location approaches towards competing banks (s. Bellucci et al. 2013, Degryse and Ongena 2004, Degryse et al. 2009).

The ability of banks to augment loan rates even increases when the firm is relatively opaque and the bank has a long lasting relationship with the firm and thus an informational advantage compared to competitors. On the one hand, due to resulting lock-in situations, the borrower is stuck with the same lender (s. Slotty 2009, 2f). On the other hand, with the bank exercising some control over the firm, due to its exclusive status and intense relationship, the lender might

influence the borrower to act as 'lender-friendly' as possible and reward her with constant access to external funding (s. Agarwal and Elston 2001, p. 230). Therefore, besides the increasing difficulty of transferring soft information over a larger distance, also the (geographical) structure of the banking market and banks' competition should be considered, as the latter might mitigate the firm's costs associated with transportation and hence the interest rate increasing effect of distance.

Due to their small size and/or young age small and medium sized enterprises (SMEs) do neither own large divisions to communicate or quantify their business plans and results, nor is there a documentation of former firm performance or frequent new information. Thus, due to missing possibility to assess the riskiness of the borrower or high costs of monitoring and screening, it is either impossible or too costly for outside investors to engage in borrowing towards opaque SMEs. To assess such firms' creditworthiness and future returns, it is crucial to be capable of processing soft information. Such could include the personality of the manager or owner, being a 'key' person of a small enterprise (Berger et al. 2014, p. 266), her 'business vision', her social behavior. Furthermore, soft information could include the mood and the attitude of the workers within the firm as well as relations toward costumers or suppliers.[19] Therefore, to gather and process soft information in order to complete or build the (risk) profile of a firm, high costs arise when relying on relationship banking, enabling the use of personal contacts for credit assessment beyond hard facts.[20]

Borrower lender distance thus has a high relevance to loan transactions in situations, when soft information, that cannot be transported over large distances is essential for assessing a borrower's creditworthiness. Therefore, distance correlate positively with loan costs. On the one hand, the borrower has to visit the lender at least once when applying for a loan (Agarwal and Hauswald 2010, p. 5). On the other hand, a more remote lender incurs distance related costs for monitoring and screening the borrower, e.g. higher travel costs (Brevoort and Hannan 2004, p. 5); (Cenni et al. 2015, p. 251); (Brevoort and Wolken 2009, 29f). Furthermore, monitoring activities including personal interaction are directly related with the possibility of processing soft information which is therefore dependent on frequent mutual encounters.

Several studies find soft information to improve the predictions of banks' risk models on default, when used additionally to hard facts.[21]

[19] A detailed overview over informational aspects that can be considered as soft can be found in Ahnert et al. 2005

[20] S. Berger and Black 2011 for a discussion of hard vs. soft lending techniques

[21] S. Altman and Sabato 2007 and Deyoung et al. 2008 argue that the reduction to quantifiable informa-

Nevertheless, the use of soft information can be misleading, too, and hence a sole focus on hard facts could reduce the chance of granting loans that are riskier than expected (Emmons et al. 2004).[22]

Banks' organizational layers also matter when processing soft information through those layers with resulting filter effects. Therefore, one must differentiate between the place where the borrower contacts the lender (e.g. branch office of a bank) and the place where decisions on the loan approval and/or conditions are made (e.g. head office of a bank). Alessandrini et al. 2009 term the former operational distance and the latter functional distance. According to the above argumentation, transport costs for soft information rise with a higher operational distance, whereas functional distance between branch office loan officers and the decision-making manager in the head office can result in agency costs (Jiménez et al. 2009).

Considering this, the fewer hierarchical layers of savings and cooperative banks relative to commercial banks might leave the former with some comparative advantage in terms of using soft information (Prantl et al. 2008, p. 12). Furthermore, their denser net of branch offices, spread over a small geographical area might allow them more opportunities to let soft information improve their credit assessment, as the transfer of those data would occur over a short distance.

Such small lenders are especially beneficial for small firms, which are less able to provide hard information and therefore depend more on soft information. Additionally, those small lenders often can rely on knowledge of the local market area (Stiroh 2004). Furthermore, with higher monitoring costs being charged in form of higher loan rates, and the necessary intense monitoring, small firms do not have access to more distant financial centers and are therefore dependent on local operating lenders (Alessandrini and Zazzaro 1999, p. 75).

Berger and Black 2011 find that lending to small firms including the use of collateral or scorings seems to replace also the importance of soft information, whereas soft information still is relevant for larger enterprises. Furthermore, established firms might be forced to offer collateral to a lower extend, as they had time to build up reputation (Harhoff and Körting 1998, p. 1336). Scorings and additional securities[23] of the borrower thus can be seen as a way to overcome the

tion(scoring) might lead to riskier lending. Ahnert et al. 2005 propose that soft information related to large firms can be used to detect (financial) problems before a crisis would be notified in quantitative ratios. For instance, soft information could have an increased value between two dates of publication of new quantified facts.

[22]Note, however, that a mere use of soft facts in lending is not possible from a regulatory point of view (KWG § 18 (1) and CRR, Art. 179 (1a)).

[23]Berger and Black 2011, p. 727 argue that lending under the use of collateral has a higher efficiency than lending e.g. solely on a basis of quantitative financial information, as banks, whose loan agreement includes a declaration of a fixed asset as collateral, have a higher probability of receiving some kind of repayment in case of the borrower's bankruptcy.

informational disparity between large banks and small opaque firms (s. Berger and Deyoung 2006).

Brevoort and Wolken 2009 find distance between firm and bank to be on average closer when the bank provides asset or financial management services rather than loans and that loans were rather operated in person when there was no/less valuable asset the lender could rely on in case of default. Their analysis of the NSSBFs of 1993/1998/2003 has a similar result: of all services offered by financial institutions, banks and firms have by far the highest median distances when it comes to 'leases'. This supports the finding of the aforementioned decrease of importance of distance in the presence of scorings or collateral.

For those reasons, the effect of firm size on the loan rate in the context of borrower-lender-distance is hard to determine, as its impact on the loan rate not only seems to depend on distance, but as well on the loan pricing policy and lending technique employed by the lending bank.

4.3 Data

The data used was obtained from Bureau van Dijk's enterprise database Amadeus, Bisnode's Hoppenstedt Firmendatenbank für Hochschulen, the INKAR database of the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and coordinates of zip code areas are obtained from the OpenGeoDB-project. Data on bank branch locations was obtained from Gelbe Seiten, a German provider of telephone directories. As Amadeus only provides the names of the affiliated banks but neither balance sheet data nor their (postal) address, those data have to be looked up in the Hoppenstedt Firmendatenbank für Hochschulen providing information on employees and turnover for banks' head offices. The addresses, streets and postal-codes (ZIP-Code) of the banks' head offices and branches are provided by Gelbe Seiten. Amadeus contains financial and accounting information on European enterprises as well as the names of the banks the enterprise is affiliated with in 2014 as well as their locations. As information on the nature of the relationship is not provided, i.e. it is not known whether the enterprise is a borrower or depositor of the bank.[24] To cope with the problem of unknown type of banking relationship and to restrict the investigation to relationship lending, only data of German enterprises having an exclusive bank-relationship is used. First, using only data on German financially indebted enterprises with complete data for 2013 and 2014 reduces the initial sam-

[24] E.g. Shikimi 2005, using similar data, assumes the loan interest rates to be equal among banks and each firm to have established a lending relationship with the banks named, which possibly assigns lending relationships to deposit or other relationships.

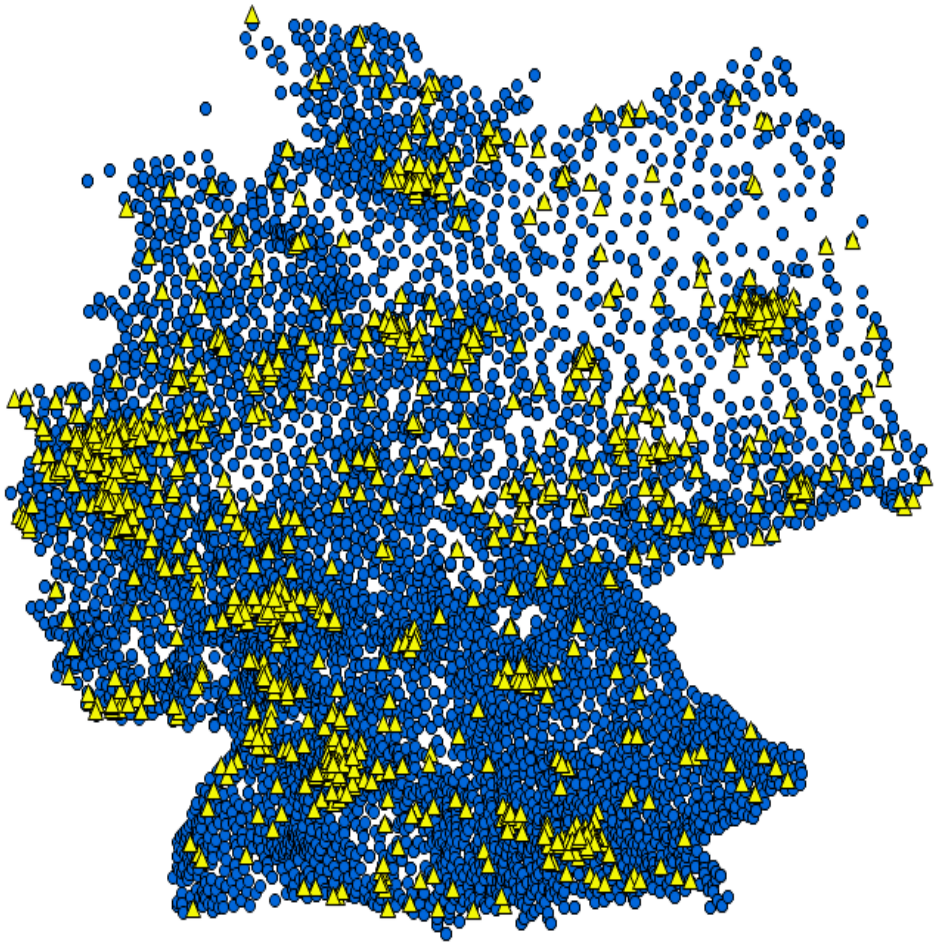
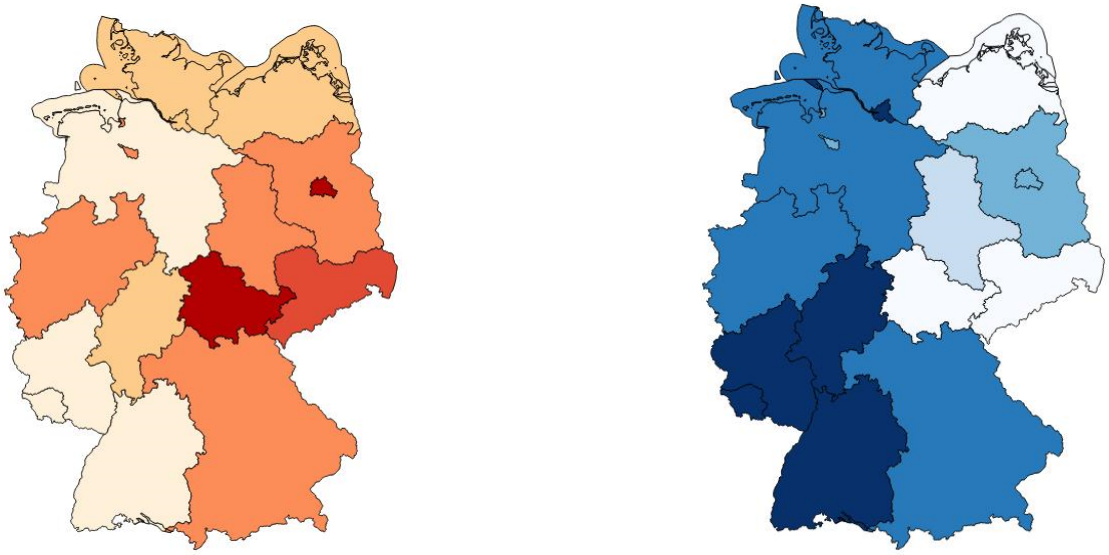


Figure 4.1: Firm and bank locations
Geographical representation of firms (yellow triangles) and bank branches (blue dots)



(a) Unweighted average borrower-lender-distance.

(b) Unweighted average interest rates

Figure 4.2: Differences between German countries. w.r.t. interest rates and borrower-lender-distances
Lighter areas indicate lower values. Shape data provided by the German Federal Agency for Cartography and Geodesy

ple size of about 90,000 firms to about 8,200 observations. Selecting financially indebted firms with exclusive banking relationships, where data on banks could be matched with the data of the Hoppenstedt database yielded 2,185 single bank-firm-relationships. Matching the ZIP-Codes with the decimal degrees obtained from the OpenGeoDB-project, borrower–lender-distances were calculated. Hence, borrower-lender-distance is measured as actual distance between the bank's branch, the firm is affiliated to, and firm's headquarter-location. Assuming banks' headquarters to be the relevant point for calculating borrower-lender-distance does not seem reasonable, as results would probably be biased by nation-wide operating banks, yielding a large variety of distances. The distances were calculated as euclidean distances in kilometers using decimal degrees (Distance). Note, that the total number of banks' addresses does equal neither the number of firms nor the number of banks that are affiliated to a enterprise but is 22,932. Therefore, the quantities of the locations in Figure 4.1 differ. The resulting dataset is unique, as most analyses of bank-firm relationships using German data do not have information on firm-level bank relations or locations. Furthermore, research until now has not considered the use of data describing firms' locations in order to assess their probabilities to conduct relationship banking. Thus, until now, an important aspect possibly contributing to banking relationships and loan pricing has been neglected so far.

4.4 Empirical analysis

4.4.1 Variables and descriptive statistics

Before turning to the econometric analyses, I give a description of the employed variables as well as summary statistics in table 4.1.

Amadeus provides data on total interest payments on loans and data on firms' long and short-term financial debt. To infer the effects of geographical distance on the costs firms are charged by banks for loans, firms' total interest payments on loans are set into relation with the sum of short and long-term loans to calculate an average interest rate over all loans a firm owes to its bank (s. also Shikimi 2005). To avoid impact of few extreme outliers, the resulting variable Interest rate was winsorized at the 95% level. The resulting vector contains firms with average interest rates of close to zero and 14.35%, whereas the mean interest rate is about 7.5% in the full sample as well as in the subsample containing only firms engaged in relationship lending.

Instead of using the actual distance measured in kilometers, the natural logarithm of 1+ borrower-lender-distance is used to grasp operational distance. The logarithmic trend is employed, as one unit of additional distance should matter more when the distance has not reached a high level (s. eg. Felici and Pagnini 2008, p. 508). The number of bank branches within a circumference of 25 km from the firms' location could indicate higher banking competition in the surrounding of the firm. Lower interest rates due to competition induced higher efficiency of banks could be inferred by this variable (s. Chen et al. 2001, p. 14, Conrad et al. 2014, p. 559). Logarithmized total assets (in thsd. €) not only controls for more available hard information on the firm (s.a. Berger et al. 2005, p. 243, Illueca et al. 2014, p. 1228), thus including its ability of transaction banking, but also indicates its need of external financing sources. Large firms on average have more locations and a higher need for varying services and higher loan amounts. The sample has a high variation with total assets ranging between about 0.25 mio. € up to 351.247 mio. €, with the maximum of total assets being considerably smaller in the subsample of exclusive bank relationship firms.

Instead of the size of the bank as proxy for lending technology, the employees of the bank are set in relation to the bank's turnover (in bio. €) to control for personnel intensity of the bank (personnel). As soft information has to be processed personally, banks relying on relationship lending need c.p. more personnel as they do for more intense monitoring, too. The share of tangible fixed assets to total assets in 2013 describes firms' ability to assign collateral to loans. A

	Min	Mean	Max	SD	n
Average Interest Rate	0	0.0734	0.1435	0.0449	8,202
Average Interest Rate (RB only)	0	0.0766	0.1435	0.0459	2,185
$log(1 + distance)$	0	2.635	8.788	1.8592	2,185
$\frac{long\ term\ loans}{all\ loans}$	0	0.7007	1	0.3443	8,202
$\frac{Financial\ liabilities}{Total\ liabilities}$	0	0.3863	0.9968	0.2766	8,202
$Ncomm$	-392.8	2.35	76.9	46.5916	8,202
$Banks_{25}$	0	266	829	189.9704	8,202
$\frac{Turnover\ in\ thsd.\ e}{Employees}$	1.39	721.85	69142.42	2602.454	8,202
$\frac{Tangible\ fixed\ assets}{1+fixed\ assets}$	0	0.7692	1	0.2901	8,202
$\frac{Provisions_{2013}}{Total\ Assets_{2013}}$	0	0.1199	0.9649	0.1186	8,202
$log(Total\ Assets)$	5.584	10.747	19.677	1.5436	8,202
$Solvency\ Ratio_{2013}$	-15.82	37.11	98.22	22.5755	8,202
$log(Age)$	0.6931	2.9526	29.9336	1.399	2,185
$personnel$	0	0.0116	0.0901	0.0078	2,185

Table 4.1: Summary statistics of sample and subsample

higher share of tangibles in total assets thus should increase firms' ability to conduct transaction based banking on the one hand, but also decrease firms' overall interest rates due to lower risk premia banks will demand. For similar reasons, the solvency ratio (in %) of the preceding year is included to describe firms' endowment with equity. The provisions relative to total assets in 2013 might explain loan rates in the investigated period, as banks might consult last year's results to estimate the future development of the firm. Turnover per employee describes firms' personnel efficiency.

Firm age is logarithmized, as the advantages of firm age w.r.t. lower information asymmetry between borrower and lender decline with increasing age of the firm (Jackson and Thomas 1995, p. 342). Firm age on the one hand is regarded as a proxy variable for the duration of the firm bank relationship (s. Berger et al. 2014, Berger et al. 2015). On the other hand, it can be employed to control for hold-up costs, as elder firms are unlikely to maintain only one banking relationship except when there is either no firm growth and/or hold-up costs. Net commuters $NComm$ should to grasp the centrality of firms' locations,[25] with the difference between incoming and outgoing workers related to all employees at a location and multiplied with 100.

The relation of long-term loans to all loans indicates the maturity of debt. Therefore, it could indicate either firms' likelihood to form close banking relationships or the impact of financial debts' term structure on interests paid. As especially (German) small firms depend on long-term loans, there could be different effects of a higher share of long-term debt on behalf of the bank

[25] $NComm$ is defined by the BBSR as $\frac{incoming-outgoing}{all\ local\ employees} \times 100$

(Agarwal and Hauswald 2010, p. 2), (Prantl et al. 2008, 4f). There could be a higher ability of gathering firm specific information on the one hand and higher risk of the loan on the other hand.

Finally, financial liabilities (i.e. the sum of long and short term financial debt) in relation to all liabilities could assess firms' dependency on external bank based finance, similar to the measure used in Ongena et al. 2012, p. 835. Note, that the variable is not set in relation to firms' equity or total assets, to avoid gauging firms' indebtedness twice, as it is already grasped by solvency ratio.

As can be seen from figure 4.2a, borrower-lender-distance in the sample is on average higher in the federal states of (north)east Germany, which can possibly be explained by lower bank branch density in those areas (s. figure 4.1). Thus, the coincidence of lower loan rates and higher borrower-lender-distances, as suggested by figure 4.2, might stem from those differences and varying regional economic performance. This graphical insight might not point to a negative relationship between distance and loan rate per se, but rather to some relationship due to local economic conditions impacting both variables. Therefore, dummy variables for German regions will be included in the subsequent analysis, where an impact on the coefficient of $Banks_25$ is expected.

As can be gauged from table 4.1, there is a high degree of heterogeneity among firms. K-Means cluster analyses most frequently revealed clusters of outliers and additionally did not yield valuable insights regarding bank-firm-distance or interest rate payments.[26]

4.4.2 Econometric analysis

At a first stage, one must control for the potential sample selection biases which might arise when only firms with exclusive banking relationships are regarded. E.g., Petersen and Rajan 2002, p. 2540 and Berger et al. 2005, p. 254 find empirical evidence that spatial distance between borrowing firms and their lenders increases when the enterprise does not have deposits at their lending bank, possibly because of the resulting less frequent transactions between bank and borrower. Thus, due to arising endogeneity concerns, a Heckman two-stage procedure is employed, where the first stage is a probit estimation on whether firms engage in relationship banking. As the application of relationship banking cannot be observed directly, I follow Berger and Black 2011 and use the exclusiveness of the banking relationship as proxy. This furthermore suits the

[26] According to several criteria, the optimal number of clusters in most cases, varying firm level variables, was three, with the cluster sizes pointing to outlier clusters and a separation between large firms and SMEs.

problem of unknown banking relation type mentioned above. The following OLS estimation tries to capture the determinants of the average interest rate on firm's financial debt in relationship banking, where special attention is paid to the effects of the included distance variable.

As the variables employed in selection and outcome equation differ, error terms were checked separately for correlations with the right hand side variables and no correlation could be detected. Logarithmized total assets and firms' dependency on bank-based finance were used in the selection equation as exclusionary variable, as those variables might rather affect the choice on relationship versus transaction banking directly than on interest rates. Large firms might rely on more banking relations in order to satisfy their need for external funding (s. Cosci and Meliciani 2002, Neuberger et al. 2008, p. 103). Furthermore, it is commonly assumed that small firms strongly depend on soft information and thus have a higher incentive to form a close relationship with their lender (Jiménez et al. 2009, p. 237).

As small firms are expected to have on average more concentrated borrowing (s. Harhoff and Körting 1998, p. 1331), a significant negative impact of the variable on the probability of exclusive banking relationships is expected. As can be seen from table 4.2, the coefficient of the Inverse Mill's Ratio is significant in both estimations, indicating the presence of sample selectivity bias. Before turning to other coefficients, the results on borrower-lender-distance in the outcome equation are discussed. In both estimations, the coefficients prove to be positive, of similar magnitude and highly significant. If borrower-lender-distance increases by one percentage, firms have to pay on average c.p. 0.22 bp (0.2 bp) higher interest rates. The result thus is in line with the findings of Bellucci et al. 2013 and Knyazeva and Knyazeva 2012, indicating that German firms engaged in relationship lending have to bear higher costs of screening and monitoring. Thus, there is no evidence for banks' use or relevance of local market power as found by Agarwal and Hauswald 2010, using US-data.

A confirming result can be found in the outcome equation of estimation (2), where the significant negative coefficient on bank's personnel intensity indicates lower interest rates if information can be processed more from person to person. Yet, as this coefficient is not significant in estimation (1) and, due to missing additional information, those results must be interpreted with care.

The number of bank branches in a 25 km circumference increases firms' probability of engaging in relationship banking, which contradicts expectations at a first glance.[27] One would assume to increase matching probabilities between firms and banks with more banking branches in the

[27] Following Degryse et al. 2009, distance of competing banks is not interacted with their size as the latter does have little explanatory power on the lending technique used by the bank.

Table 4.2: Estimation results of Heckman-2-stage models

Standard errors are indicated in parentheses. Due to heteroscedasticity problems in outcome estimations, robust standard errors were used. Levels of significance are indicated by *** (99%), ** (95%) and * (90%).

	(1)		(2)	
	Selection	*Outcome*	*Selection*	*Outcome*
Intercept	-0.4495***	0.43403***	0.4071*	0.119***
	(0.1254)	(0.025295)	(0.222)	(0.01195)
$COM1$			0.2368***	
			(0.03686)	
$COM5$			0.1683**	-
			(0.07577)	
$NComm$			0.001097***	
			(0.00041)	
$Banks_{25}$	0.000651***	-0.000119***	0.000276***	-0.000022**
	(0.00008)	(0.000009)	(0.000009)	(0.000006)
$\frac{Financial\ liabilities}{Total\ liabilities}$	-0.1369**		-0.2705***	
	(0.06375)		(0.06725)	
$log\ (Distance)$		0.002197***		0.002242***
		(0.000468)		(0.000484)
$\frac{Turnover}{Employees}$	0.000003	-0.000001***	0.000005	0*
	(0.000006)	(0)	(0.000006)	(0)
$\frac{Long\ term\ loans}{All\ loans}$	0.3626***	-0.080852***	0.2625***	-0.024612***
	(0.04556)	(0.004868)	(0.04835)	(0.003152)
$\frac{Tangible\ fixed\ assets}{1+Fixed\ assets}$	-0.1755***	0.009499**	-0.1072*	-0.011797***
	(0.05358)	(0.003703)	(0.05684)	(0.003247)
$\frac{Provisions_{2013}}{Total\ assets_{2013}}$	0.2393*	0.061146***	0.147	0.10943***
	(0.145)	(0.008527)	(0.1506)	(0.00736)
$log\ (Total\ assets)$	-0.0344***		-0.05289***	
	(0.0101)		(0.01077)	
$Solvency\ Ratio_{2013}$	-0.00238***	0.000486***	-0.003663***	0.000288***
	(0.000703)	(0.000051)	(0.000755)	(0.000048)
$personnel$		0.13195		0.005734
		(0.10854)		(0.10636)
$log\ (Age)$		0.001729***		0.001369**
		(0.000645)		(0.000579)
$Inverse\ Mill's\ Ratio$		-0.25352***		-0.063838***
		(0.017543)		(0.007707)
$Industry\ dummies$	-	-	18	18
$n\ (total)$	8,202		8,202	
$censored\ obs.$		6,017		6,017
$adj.R^2$		0.2882		0.2654

vicinity of the firm. The result might in part stem from location of firms and banks: With banks' headquarters located in Central Places, providing quantitative and qualitative above average services to firms, there might be a lower necessity to engage in multiple banking relationships.
Additionally, as distance in lending relationships might matter, due to lower distances (Petersen and Rajan 2002) firms located in urban environments might have an advantage in relationship lending, including the transfer of qualitative or non-codifiable information. As banks have higher incentives to build up long lasting relationships with their borrowers in competitive markets, the result could indeed indicate a higher prevalence of relationship lending in urban environments. This is also indicated by the coefficient of the dummy variable for firms located in large cities (COM1), which is even larger in magnitude than its rural counterpart (COM5), indicating a c.p. smaller probability for firms located in small rural communities to engage in relationship lending compared to urban enterprises. The higher likelihood of rural firms to keep close ties with their lending bank as exclusive banking relationship might stem from lower availability of different banking services in such locations or different characteristics of firms in rural areas, such as smaller sizes, higher opacity or higher volatility.
Furthermore, banks in rural environments could have advantages in operating in a 'familiar' environment and have better connections to their borrowers as well as to the local economy (Deyoung et al. 2012).
In unreported additional regressions, dummy variables for the community types between COM1 and COM5 were included in the probit estimation with varying specifications of the equation. All of them proved to be significant and negative. Thus, there seems to be some quadratic impact of the community type on a firm's probability to engage in relationship lending. Similar to COM1, locations with higher net commuters, indicating higher centrality within interaction with other locations, have a higher probability to dedicate themselves to one bank. Overall, the results of the locational variables in the selection equation are highly statistically and economically significant, thus pointing to the relevance of considering enterprises' environment when investigating its choice of external funding. The negative coefficient of $Banks_25$ in the outcome equation might reflect lower interest rates due to higher banking competition within an area (s. e.g. Degryse and Ongena 2004, p. 577) and a resulting higher cost efficiency in assigning loans. An increase of one banking branch in the firm's vicinity lowers firms' interest rate on average c.p. by 0.0119% (0.0034%). As the number of bank branches in a 25km circumference of the firm is up to 829, a distinct impact of banking competition on loan rates must be considered.

The result thus is in line with the findings of Degryse et al. 2009; Bellucci et al. 2013, that banks demand higher loan rates when firms are located in their proximity and competing banks are relatively distant from the firm. This result at a first glance contradicts the visual evidence of Figure 4.2, but must be interpreted under the consideration of absolute firm location. The regional dummy variables indicate firms' locations in southwest Germany (Baden-Württemberg, Rhineland-Palatinate, Hesse, and Saarland), in one of the states of the former GDR (including Berlin) and northwest of Germany (North Rhine-Westphalia, Lower Saxony, Bremen, Hamburg, and Schleswig-Holstein).[28] The mode of separating the federal states as stated above is motivated by the pattern shown in figure 4.2, yielding an on average 0.6% higher average rate in southwestern Germany and 0.9% lower average interest rate in eastern Germany, relative to Bavaria (i.e. southeastern Germany). The effects of firms' absolute location w.r.t. region seem to be offset by including the variable on banking competition. Excluding either the former or the regional dummy variables, results in insignificant coefficients for the dummy variables or a weaker impact of banking competition. Therefore, the graphical evidence and econometric results can be reconciled. In line with theoretical expectations, firm size has a negative impact on the probability of engaging in relationship banking with an average marginal effect of -1,12% in estimation (1) (-1,69 % in estimation (2)). This is in line with theoretical expectations and empirical findings of other studies (s. Farinha and Santos 2002, Neuberger et al. 2006, Neuberger et al. 2008, Ongena and Smith 2000). The share of firms' financial debt was included in the selection equation. A higher dependency of firms on financial debt could decrease the probability of single bank lending, due to a higher potential for credit crunches and transfer of financial problems of the bank to the firm (Detragiache et al. 2000). As banks with a high share of loans are prone to such problems, the negative coefficient in both estimations is in line with theoretical predictions. The term structure of financial debt has an expected positive impact on the probability of relationship lending, whereas a negative impact on interest rates is observed, contradicting a normal term structure of interest rates. The result might arise because of closer ties in exclusive banking relationships, or as long-term debt usually is used to finance assets that can be used as collateral in case of default. Furthermore, banks can reduce average costs of screening when financing multiple or long-term projects of (opaque) firms (Cenni et al. 2015, p. 251), thus on average decreasing interest rates for long term borrowers.

[28] To test for the application of spatial error models, Moran's-I-Tests with varying k-nearest-neighbor matrices were conducted, which clearly failed to reject the null of no spatial correlation. Spatial autoregressive or spatial expansion models furthermore were not considered, as the sample selection might have led to geographical biases.

The share of firms' tangible fixed assets has, as expected, a negative impact on the probability of relationship lending similar to Knyazeva and Knyazeva 2012, p. 1200. Firms having a higher share of realizable assets that can be employed as securities are rather able to engage in transaction based banking. Furthermore, firms with a higher share of tangible assets could rather be in need of credit (Cenni, et al., 2015). With the coefficients in the outcome equations contradicting, the effect on interest rates is not clear. With exclusive banking relationships, subordination problems in case of default are not reflected in the coefficient, as liquid collateral might be of a higher relevance in exclusive banking relationships, with deposits and securities of firms stored by the lender.

While the effect of firms' provisions of the preceding year is not stable in the selection equation and hardly or not significant, its effect on interest rates is positive as expected. A higher solvency ratio decreases firms' probability to engage in relationship lending, possibly because firms with higher endowment of equity are able to conduct transaction based banking. Although one would expect firms with higher solvency to be charged on average lower interest rates, higher solvency ratios in the preceding year increase interest rates on average in both outcome equations. Firm age has a positive impact on average interest rates paid. This contradicts a higher transparency due to longer firm history and higher probability to survive. Contrarily, with the sample in the outcome equation consisting out of firms with single bank relationships, the coefficient might rather reflect hold-up costs arising for elder firms, which remain with only one banking relationship. To control for bank-type specific loan rate policies, dummy variables were included for savings, cooperative and state-level central banks. The dummy variables indicate that savings and cooperative banks charge on average lower loan rates than commercial banks. The results on the dummy variables must be handled with care; as commercial and savings bank branches certainly are more ubiquitous than commercial bank branches, lower distances must be expected per se when the lender belongs to one of the former bank types. Therefore, lower loan rates also might not only stem from the bank type itself, but also from higher borrower-lender-proximity.

4.5 Conclusions

With many firms keeping close ties with their banks, relationship banking has a high relevance for external funding of German firms. Analyses investigating its impact on lending come to different results, depending on the employed method of research as well as on the investigated international

firm location (e.g. Ongena et al. 2012, Farinha and Santos 2002, Neuberger et al. 2008, Bolton and Scharfstein 1996, Guiso and Minetti 2010). As technical progress modifies methods of communication and collecting information, the proclaimed 'death of distance' in lending seems to be more immanent (e.g. Petersen and Rajan 2002, p. 2537). Furthermore, the use of credit scoring models weakened the importance of soft information and so average distances were able to grow (Berger et al. 2015). Yet, as there is non-codifiable information or information that cannot be transferred or quantified, spatial proximity to asses a borrower's economic situation could further play a major role in lending (s. Agarwal and Hauswald 2010). Therefore, as SMEs make up a large portion of German firms, the impact of distance in relationship lending still has a high economic relevance.

Using a dataset, that allows for the first time to measure spatial borrower-lender-distance for German firms, there is evidence that higher costs of screening and monitoring due to higher distance have to be borne by borrowers. Thus, banks do not seem to have or at least exert local market power, i.e. pricing loans of nearby borrowers differently. Higher banking competition has a negative impact on interest rates, possibly indicating higher efficiency in competitive banking markets. Further research should focus on the question whether the distance related costs arise due to higher transportation costs of surveillance of opaque firms or because of risk premia for distant firms.

Another result are the locational effects of firm location on its probability to engage in relationship lending. There is strong evidence for quadratic relationship between location types and the likelihood to commit oneself to a single bank. With bank branch density varying widely, this in turn might result in c.p. higher loan costs due to firms' location. Thus, banks' interest pricing policies w.r.t. distance and competition might affect the overall spatial location of economic activity in Germany. Especially the importance of small local lenders for SMEs, as discussed in section two, and the disappearance of the former in rural areas might reinforce spatial economic growth patterns.

Chapter 5

Real estate markets and lending: Does growth fuel risk?

[29]

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5.1 Introduction

Investments in real estate and real estate markets have gained increased interest in the wake of the financial crisis, although progresses in real estate markets were a major driver of the latter. Afterwards, especially in Europe because of the European sovereign debt crisis, the constant lowering of interest rates has put real estate investments, considered as 'safe', into a focus. This has increased real estate prices also in Germany, especially in a number of German cities (Siemsen and Vilsmeier 2017, p. 3).

Banking and real estate price growth have a strong common relationship. Because of their high prices compared to other assets, their ubiquity, and their high relevance for living and production, real estate markets cannot work without proper loan markets. At its most negative, this relationship can lead to assigning more loans to riskier borrowers, which increases house prices, before massive defaults result in credit rationing, decreasing house prices strongly.

As empirically evidenced, lending decisions are often made under the consideration of collateral and as real estate crises often precede banking crises, collateral-based lending is susceptible for banking crises (Niinimäki 2009, p. 515). Hence, research has overwhelmingly considered real estate to have two major functions in lending: Serving as collateral and/or being the object ultimately financed by the assigned loan. While the direction of the causality between the influence of credit assignment/loan volumes and real estate prices has been questioned in several publications (e.g. Cvijanovic 2014, p. 2704, Gerlach and Peng 2005), micro-evidence on real estate's impact on risk taking in lending has been scarce.

The topic is highly relevant, as real estate is the most commonly used collateral device in lending. (Niinimäki 2009, p. 515) and demanded collateral has a strong impact on borrowers' behavior (Stiglitz and Weiss 1981, 393f). Empirical research has shown that contrarily, low risk borrowers offer collateral, which can be explained by private information not known to the lender (Berger and Udell 1990, p. 21).

In fact, pledging more collateral could be used as signal for lower borrower risk (Agarwal et al. 2015, p. 637), while demanding it can be an indicator for 'lazy banks' in the spirit of Manove et al. 2001. Collateral thus has a high potential of making banks issue loans to risky borrowers: On the one hand, banks assume collateral pledging borrowers to be less risky *per se*, on the other hand they might exert less monitoring effort when loans are secured.

When loans are collateralized with real estate, banks could avoid losses when property prices

rise. But if they drop on the other hand, loan losses are more severe with recovery decreasing (Niinimäki 2009, p. 514). Less capital held by banks which are heavily engaged in real estate business (Blasko and Sinkey 2006) could reinforce arising problems. Furthermore, borrowers whose loans were overcollateralized in the beginning could have an incentive to default, if the price of the real estate drops below the credit amount outstanding (Herring and Wachter 1999, p. 22).

Additionally, beyond serving as collateral, banks can be suborned to use current or past real estate prices as indicators for current and future economic development or future real estate prices. Banks expecting high price growth rates of real estate in a near future might be willing to accept more risky borrowers whose loans are secured with real estate.

Combining both of these arguments, banks could expect increasing real estate values when observing current prices. Therefore, they might be willing to lend to risky borrowers while expecting them to be wealthier in future, decreasing their default risk and their loss given default.

These issues could even be more pronounced for banks that are regionally constrained and depend on the economic well-being of their surrounding business area. If banks additionally face limitations of their investment policies, an even stronger dependency on real estate price development could result. As this is the case for German savings banks, who are heavily engaged in real estate related lending (s. figure 5.1), their chance to exhibit some interrelation of their risk taking on local real estate prices is high and the consequences of that could be severe.

Analyzing aggregate and micro level data of German savings banks, I do not find that savings banks' loan portfolio risk is robustly driven by real estate price growth or expectations on real estate prices. Results rather suggest that savings banks' loan portfolio risk is affected by overall regional and national economic environment. Thus, there is rather a direct link between loan portfolio and local economy than an indirect channel via housing prices.

The paper proceeds as follows: In section two, I review literature on the topic and outline the hypotheses tested. Here, we differentiate between potential effects of real estate price growth on lending and risk taking behavior of banks. Data are introduced in section three. Additionally, characteristics of German savings banks are discussed. Section four presents the results of the empirical investigation, which is split into a short analysis on aggregate causal effects between real estate and lending and a second part analyzing the impact of real estate on the risk of banks' loan portfolio. In the latter part, I analyze micro data from German savings banks using dynamic panel data methods. Section five concludes.

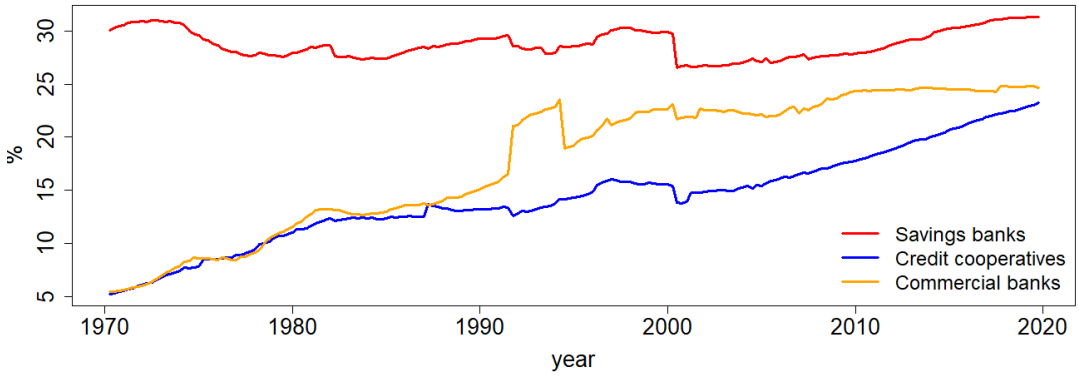


Figure 5.1: Shares of housing loans made to German firms and households across bank types
Data source: Deutsche Bundesbank.

5.2 Theory

The heavy interdependence of real estate price growth and lending can complicate first of all the determination of causality between real estate price growth, loan growth, and loan risk. Therefore, we attempt to disentangle the effects between bank risk taking and real estate price growth and find four major possibilities for how the latter affect lending behavior.

First, as already pointed out, growth in real estate prices might increase loan volumes: On the one hand, higher house prices require higher loan nominal and real estate owners' properties increase in value, thus enabling them to obtain higher loan amounts on the other hand.

Second, high real estate prices might additionally reduce banks' monitoring effort and perceived riskiness of a loan when a property is used as collateral. Collateral can offer insights into borrowers' risk; e.g. Bester 1985, p. 854 argues that borrowers with high risk prefer loans with low collateral requirements and therefore are willing to accept higher loan rates. Thus, real estate, which per se reduces risk compared to uncollateralized loans, can act as a signal for high quality borrowers. This is where the separation between *ex ante* and *ex post* risk (s. Berger and Udell 1990) comes into, with the former describing loan's risk conditional on the information at underwriting and the latter the realized risk of the loan.

Third, the possibility to realize securities reduces agency costs and information asymmetries and alleviates funding of borrowers (Cvijanovic 2014, p. 2696), thus higher collateral values reduce losses given default (LGD), i.e. ex post risk. Anticipating lower LGDs, lenders could be induced to lend to riskier borrowers, which leads to on average ex ante constant risk but ex post higher risk.

Fourth, this risk forecast is based on expectations on real estate price growth. Real estate prices are directly observable, which is not the case for several measures of economic performance such as GDP or figures on unemployment. Therefore, banks might base their expectations on future economic and real estate price growth on current and past property prices. Suspecting economic growth, banks might be willing to assign risky loans as they can expect borrowers' solvency on average to increase. If banks conclude from recent to future property price growth, they might expect real estate prices to rise in future, even decreasing expected losses given defaults. Therefore, there might even be a higher increase in risky lending and, if gambling was too strong, there should be a large gap between ex post and ex ante risk measures.

5.2.1 Real estate prices, loan volumes, and causality

As Gerlach and Peng 2005, 461f point out, the relationship between loans and real estate can have several dimensions. Real estate can serve as collateral in loan demand; higher housing prices thus could enable borrowers to apply for higher credit. In fact, a number of studies finds that financially constrained firms increase their borrowing when the value of their securities increases, i.e. lending volume and covenants can vary with the value of the underlying collateral (Agarwal et al. 2015, p. 637, Cvijanovic 2014, 2705f; s.a. Dougal et al. 2015, p. 167). Cvijanovic 2014 finds that it is not only firms' debt which is increasing with real estate prices, but also the composition of debt changes with firms switching to more long term debt. Cvijanovic 2014, 2694f proposes that on the one hand the costs of external capital for firms decrease and the ability to engage in long term borrowing increases as the liquidation value of collateral augments, because the costs of realization decline. On the other hand, with the liquidiation value of securities increasing, the collateralized part of firms' debt increases as well.

Furthermore, banks' own real estate assets increase in value as well as charge-offs on loans could decrease with increasing property prices (s. a. Herring and Wachter 1999, p. 12). Leaving other aspects constant, this increases a bank's wealth and thus its possibilities of extending credit. Contrarily, lower credit constraints could fuel demand for mortgage or other real estate related loans.

This is reinforced by existing contracts: Profits for borrowers will be generated if real estate prices increase, enabling them to repay their loans (Zhang et al. 2018, 1388f). Banks who try to have a constant level of risk taking will therefore incorporate these new abilities of repayment and increase either loan volumes and/or the number of loans.

Empirical evidence is rather in favor of real estate prices affecting lending than the other way round:

E.g., according to Gerlach and Peng 2005, p. 463, banks increased their mortgage lending in Hong Kong after increased competition due to deregulation of the banking industry. In turn, banks were struck harder by sinking property prices. Results point to an impact of property prices on lending volumes. Gerlach and Peng 2005, p. 473 find a long-term equilibrium between real estate prices and lending. Furthermore, the authors find evidence that extended lending does not have an impact on property prices, but the causality ran the other way round in Hong Kong. Feedback effects were mitigated when lending was restricted.

Contrarily, Favara and Imbs 2015 find that banking branch deregulation led to a higher number and higher amounts of loans which caused real estate prices to rise.

Landvoigt 2017 finds that if it becomes easier for households to increase their leverage than to adapt their housing demand, households will increase their leverage if real estate prices have increased. Cvijanovic 2014, p. 2724 does not find evidence that real estate prices increase due to more demand for credit by large firms.

Defusco 2018 suggests that households will try to smooth their consumption if the values of their homes increase, thus allowing them to post more collateral (s. a. Koetter and Poghosyan 2010).

Applying these arguments and the results of previous studies on a local level suggests that:

H1: Savings banks' loan volumes grow with local real estate prices

Yet, banks might be suspicious, assuming that property price increases are deviations from fundamental values. As a result of such deviations, risky borrowers cannot be distinguished from good borrowers, such that loan loss provisions can hardly be correctly determined.

The extension of credit might only take place when there is an increase of real estate prices and a simultaneous reduction of risks (instead of maintaining a constant risk level) (Koetter and Poghosyan 2010, p. 1130). Considering this, they might refrain from extending loans or increase effort in monitoring with the latter decreasing the quantity of loans due to fixed input factors in the short term. As borrowers will apply for loans due to higher house prices or to invest, banks must check more applications and it might be more tedious for them to distinguish 'good' borrowers from speculative and/or risky borrowers. This is especially true as property prices during high demand phases have a tendency to overestimate collateral values due to bargaining power effects: real estate buyers are willing to pay a price above the value of the property if their utility is higher than the price (Bian and Liu 2018). Yet, a quick adjustment to fundamental

values is not as simple in real estate markets as investors mostly do not have the possibility of going short. Thus, real estate markets are rather driven by optimists (Herring and Wachter 1999, p. 65).

The impact of a strong 'correction' of house prices in the sense of a drop can have huge effects for the German financial sector, as analyzed by Siemsen and Vilsmeier 2017: A drop of house prices can lead to losses of several billion Euros, considering only less significant institutes, which are susceptible to house price movements. Similarly, Koetter and Poghosyan 2010 find that banks located in areas with high deviations of house prices from their fundamental value have a higher probability of being distressed.But as savings banks have a strong knowledge of local markets, they are likely to recognize exaggerated prices and thus reject more loan applications in which collateral is offered.

Following Inderst and Mueller 2006 and assuming savings banks to be local lenders, they are likely to demand higher collateral and lower interest rates for loans than transaction based lenders. Thus, real estate markets have an even higher relevance for those institutions.[30] The dependency of savings banks on local real estate markets can increase banks' risks additionally as loans to the real estate and construction sector must be considered riskier than industrial loans (Salas and Saurina 2002, p. 210). As disaster myopia is often shared by banks because of herding effects (Herring and Wachter 1999, p. 16), savings banks might be especially susceptible for encountering problems rooted in exuberance as they cooperate within an coordinated group.

To detect some exuberance of real estate prices that could threaten financial stability, the deviation from real estates' fundamental value, determined by per capita income and population growth could be considered rather than observed prices as in Koetter and Poghosyan 2010. Deviations from fundamental values could thus be easier to notify in smaller entities where this information is rather observable on a population than a sample level. As a consequence of perceived deviations from fundamental values, screening processes are prolonged, thus:

H2: If house price increases are not fundamentally driven, banks will decrease their lending.

Considerations must also be made about the nature of the deviation: one possibility is that the deviation is the expected increase of real estate prices due to a change of a factor determining the fundamental value. This expectation on factors in the future might then be too high and represent exuberance.

[30] The finding of Christians and Gärtner 2014 that savings banks in rural areas demand higher collateral from their borrowers, could confirm theoretical predictions of Inderst and Mueller 2006.

5.2.2 Ex ante risk: Economic expectations, offering collateral, and monitoring effort

Loan's risk when granting it is termed *ex ante* risk, which is mostly determined by bank's estimates of the borrower's risk properties and the conditions of the loan. We argue that real estate prices have an impact on these estimates of borrower's risk by economic expectations gained from property price changes and by the willingness to accept property as collateral and substituting monitoring.

Expectations on the future economic condition of a household represent a highly important part of the estimation of a loan's risk. Gerlach and Peng 2005, p. 475 empirically find that property price growth can be described by past prices, current changes of unemployment rates and the construction of new housing two periods before. Following these results, real estate price increases might include other economic factors, which are not or hardly observable. Thus, property prices could be used as indicators for overall economic growth.

A theoretical outline of the effects of increased income on real estate prices and lending can be found in Hott 2011: In his model, banks grant mortgage loans to households, who demand housing and consumption. In a first expansion, banks can be optimistic or pessimistic about the equity of a household, consisting of the house value and their different incomes. Banks' mood depends on realized earning in earlier periods. Positive shocks increase households' incomes, decrease defaults and increase banks' profits, thus rendering the latter more optimistic. This optimism has positive effects on real estate prices and as real estate constitutes a part of household wealth, defaults decrease and the process starts over. A strong increase in house prices with resulting smaller growth rates reduces banks' optimism, default rates increase (households lose part of their wealth) and banks' losses will exceed their initial gains as their exposure in the beginning of the downswing is higher than in the onset of an upswing.

In order to keep up business during downswings, banks are supposed to build up anti-cyclical capital stocks, i.e. put money aside in good times to be able to cope in bad times. Thus, we should expect that loan loss provisions (LLPs) increase with GDP or real estate prices. Balasubramanyan et al. 2017 on the contrary find that US banks on average had a negative correlation between provisions and GDP growth between 1997 and 2011. Thus, they built up too little capital to maintain sufficient risk capital in economically weaker times. Yet, there seems to be some learning effect by banks as the authors find a positive impact of loan demand on provisions after the financial crisis. Furthermore, higher interest income before financial crisis indicates

that loans made before the crisis were riskier. Thus, if projecting recent price growth of real estate markets to future prices is not sustainable (Herring and Wachter 1999, p. 19), worrisome overvaluation could be a consequence and ex ante risk should be considered higher.

Furthermore, real estate is frequently used as security. Pledging collateral enables to separate the borrower's risk from the loan's risk: a risky borrower could obtain credit if pledging a security whose value of recourse exceeds the loan amount (Berger and Udell 1990, 21f). Yet, as risky borrowers themselves know their lending quality, they will tend to avoid pledging collateral, although from a lender's point of view, their collateral makes the highest difference (s.a. Berger and Udell 1995 who find that collateralized loans are riskier than unsecured, with the overall risk of the former being reduced by their collateral.). Thus, collateral is not efficient in markets with full information (Bester 1985, p. 854).

Besanko and Thakor 1987 use a model where a bank can lend to two types of borrowers and therefore offer two different (w.r.t. collateral requirement and interest rate) contracts. The type of borrower is ex ante not known by the bank. Banks must chose the collateral requirements, the interest rate and the probability with which they offer a contract (type one or two) to a borrower in order to maximize its expected profits. Under imperfect information, an increase in collateral and decrease in interest rate in a loan contract will attract borrowers of a safer type, as it is no or a little problem for them to pledge collateral. Under additional consideration of perfect banking competition, if collateral requirements are too low to scare risky borrowers off, banks will decrease the probability of assigning low-risk contracts. Therefore, the risk of rationed borrowers can vary.[31]. Hence, the marginal rate of substitution between interest and collateral is higher (i.e. has a smaller absolute amount) for low risk borrowers than for risky borrowers (Bester 1985, p. 853). In fact, Landvoigt 2017 finds that credit rationed home buyers have stronger reactions towards a change of loan conditions.

As an alternative to demanding collateral, banks could thoroughly screen and monitor their borrowers, with the latter usually being more time-consuming and costly. Considerations of Manove et al. 2001 suggest that banks acting in perfect competition will rather use collateral in lending than screening with the former being less costly.[32] Concluding, if the collateral requirement of a bank equals the sum of loan amount and interest, there will be no credit rationing (Bester 1985, p. 852). The cost efficiency of substituting screening with collateral is even higher for low quality

[31] Stiglitz and Weiss 1981, 394f define credit rationing as situation where some borrowers do not obtain credit, although they do not differ from other borrowers whose loan applications are approved.

[32] In monopolistic markets, banks will try to extract all rents from borrowers, thus rather screen them than demand collateral

borrowers, as screening costs the loan agent time and effort (Keys et al. 2010, 309f, 321).

Further analysis of substitution of monitoring by collateral can be found in Niinimäki 2009: In the model, monitoring banks are risk-free, with monitoring raising equal costs per unit, and do not incur positive earnings due to perfect competition, whereas non-monitoring banks demand some high level of collateral to drive risky borrowers away. Each borrower is endowed with one unit of real estate collateral before applying for credit. Collateral only has an impact on interest rates, but not on loan amounts. The value of real estate can increase or decrease within the period under consideration, while the bank cannot earn more than repayment and interest of the loan[33]. As borrowers' wealth consists of collateralized real estate and is fluctuating, banks' return can become more volatile when relying strongly on collateral. As a consequence of perfect competition, a monitoring bank does not achieve profits, Hence, there exists a minimum level of collateral for which banks' profits will be zero. If this level of collateral is exceeded and requirements are below the level to deter risky borrowers from loan applications, banks will rather rely on collateral value with high potential of increasing in value. Thus moral hazard in the form of reliance on high collateral value increases and neglect of monitoring results. The moral hazard scenario becomes even more probably with inside collateral.

Empirical evidence w.r.t. banking competition comes from Zhang et al. 2018 who find Chinese banks to have higher benefits from real estate investment growth in more competitive locations. In line with theoretical evidence of e.g. Besanko and Thakor 1987 and Niinimäki 2009, Agarwal et al. 2015, p. 642 find, interpreting upfront payments of mortgage loans as collateral, that it is especially younger borrowers having a lower scoring and lower income who make on average lower upfront payments. Yet, Keys et al. 2010 find that borrowers in the US in the beginning of the 2000's whose credit score was considered as risky were screened more thoroughly which would be an explanation why loans to borrowers with better scores have a weaker performance. A result of an increase of property prices, the wealth of risky borrowers increases and former collateral barriers that previously deterred the latter will hold no more. Banks might either consider risky loans as safe due to their higher collateral or adapt their collateral requirements as a response to increased real estate prices. Thus, ex ante risk of loans will on average decrease.

H3: Real estate price growth decreases ex ante risk

[33] Higher increases of the value of collateral must be conveyed to the defaulted borrower.

5.2.3 Ex post risk: Default and realization of real estate collateral

Ex post risk of a loan portfolio can be gauged after repayment of loans and net profits of loans can be determined. Here, the above mentioned connection between probability of default and loss given default becomes evident: observably risky borrowers are demanded more collateral. Therefore, higher collateral demand suggests that the probability of default increases with collateralization (Inderst and Mueller 2006).

Berger and Udell 1990, 34ff argue that loans that include some form of realizable collateral and are therefore regarded as safe, could suffer under risky borrowers, leading to non-performing loans. Hence, the realized value of their securities does on average not outweigh the losses incurred by lending to risky borrowers, which is which is why the aforementioned separation of borrower and loan risk does not always work out well. Berger and Udell 1990, 36f find that loans with fixed interest rate[34] and collateral had below average performance, which the authors take as evidence that realization of the security is not sufficient to remove a loan's risk. Furthermore, the finding of on average higher risk premia and higher charge-offs for banks holding more collateralized loans and for real estate collateralized loans, seems to confirm that loan risk cannot be fully covered by collateral and collateralized loans on average bear some high risk. This might lead to even higher risk-taking by banks if officials pose extra-regulation and controls on collateralized loans, as banks then have an incentive to assign those loans without collateral, rendering them even riskier than before (Berger and Udell 1990, p. 41).

Contrarily, Agarwal et al. 2015, p. 646 find that mortgage defaults decrease with upfront payments, which can be seen as evidence for ex post low risk borrowers pledging more collateral.

Again, we should stress the prevalence of provision of collateral by highly creditworthy lenders: As collateral commonly has a higher value for borrowers than for banks and as borrowers could be limited in their use of the pledged asset, pledging collateral can be regarded as costly for the borrower (Coco 2000, 192f; s.a. Agarwal et al. 2015, p. 637).

Here, a distinction must be made between *outside* and *inside* collateral, with the former including collateral not financed by the actual loan and the latter referencing to some investment financed by the loan, e.g. mortgage loans[35]. Thus, there are different costs that may arise with the use of collateral; e.g. pledging (outside) collateral is costly for the borrower in Bester 1985, p. 851, whereas in Besanko and Thakor 1987, p. 673 the lender incurs costs for collateral, while inside

[34] Variable interest rates might rather be in use for high quality borrowers, as they are able to bear changes in rates (Berger and Udell 1990, p. 30)

[35] s. e.g. Niinimäki 2009 for an analysis distinguishing between the two collateral types.

collateral is explicitly without costs for the borrower in Niinimäki 2009, p. 591.

Ex post risk additionally does not rely on banks' current assumptions and estimates, but on all available information before underwriting. Considering long term trends of property price growth allows for a more sophisticated analysis of risk: Zhang et al. 2018 find a negative relationship between local growth of real estate investments and NPLs on average, while if one considers a threshold, there is a twofold effect of real estate investment growth on NPLs: growth per se reduces NPLs, but growth levels below a threshold of about 20% have an increasing effect on NPLs. Thus, if growth of real estate investment slows down, this can affect the stability of the financial system (Zhang et al. 2018, 1399f).

Therefore, it might be better suited to reflect banks' risk taking in the face of changing house prices. As e.g. Hott 2011, p. 2430 finds lending to tighten in response to defaults rather than anticipating them, ex ante risk measures could be erroneous and a strong reliance on them represent a higher threat to banks.

Another differentiation between ex ante and ex post risk can be made by borrowers' rating alterations within the maturity of the loan in line with overall economic conditions, as e.g. interest rates. Delis and Kouretas 2011 analyze risk-taking behavior of banks in 16 Euro-zone countries from 2001-2008. They find that banks in a setting of low interest rates shift their business to more risky investments, as well for ex ante risk (captured by $\frac{riskassets}{totalassets}$) as ex post risk ($\frac{NPL}{grossloans}$). Furthermore, banks redistribute their assets to more risky and non-standard banking assets in the presence of low interest rates. Similarly, Salas and Saurina 2002 find inefficiencies, market power, the share of loans without collateral and decreasing net interest margins to increase problem loans for savings banks. The latter effect can be reasoned with higher pressure to assign riskier loans.

Local economic trends must be considered to have a high stake in determining banks' loan portfolio risk: Salas and Saurina 2002 find that GDP growth affects Spanish savings banks' ratio of problem loans negatively, with the effect being stronger for commercial banks. The authors argue that this difference could occur as the latter have more costumers who are submitted to business cycles. Thus, savings banks' lending success might rather be described by local economic factors that are less dependent on (national) business cycles.

Interest rate risk of course also plays an important role in real estate lending. Blasko and Sinkey 2006 find that banks which are highly engaged in real estate lending over several years have lower net loan losses. Furthermore, such banks in general can be struck hard by realized interest rate

risk. Yet, the authors find that most US commercial banks between 1989 and 1996 did not use interest rate collateralization of loans, except for the largest banks.

Concluding, we should observe at least some effect in either direction of past real estate prices or expectations on real estate price growth on ex post risk. This could happen either by a *collateralization effect*, i.e. by a reduction of losses given default or by an *incentive effect*, i.e. by increasing borrowers' incentives not to default as losses would increase with real estate prices:

H4: (Previous) real estate prices affect ex post risk

5.2.4 Default forecasts and (over-optimistic expectations) on real estate prices

As real estate investments are commonly regarded as having only little risk and local lending could be perceived the same, due to spatial proximity (as some kind of 'home bias' in lending), the risk of lending with real estate collateral in a local setting could easily be underestimated. Therefore, expectations on risk and hence, real estate price growth as determinant of LGDs should get some additional attention.

A more direct impact of real estate prices on lending behavior is the expectation of development of future property prices themselves. Hott 2011, 2426f argues that banks might rather stick to Momentum forecasts than fundamental real estate values as they are well diversified, thus having only minimal risk exposure towards fundamental factors. The author additionally cites banks' myopic strategies that do not take real estate cycles into account. Positive income shocks might then have an impact on price expectations, therefore increasing current prices. As banks base their expectations on current prices, expected prices then increase and continue the feedback process.

Recent experiences in house price development might not only influence lenders' expectations of future prices, but also those of borrowers, who therefore could make higher upfront payments for mortgage loans (Agarwal et al. 2015, p. 647) or rather apply for loans, even not being able to signal low risk and receive a favorable contract. Thus, there might not only be a higher offering of credit but also demand from risky borrowers.

Due to low LGDs, banks have a high willingness to lend secured real estate loans (Zhang et al. 2018, p. 1392), and expecting future growth in property prices, this will also hold for risky borrowers: Assuming real estate price growth, the net present value (NPV) of the loan increases as well and if banks attempt to maintain a NPV level for loans, they would be able to grant loans to borrowers with higher probabilities of default. Therefore, banks' risk could increase with real

estate prices as book values of loans differ from banks own internal calculations.

Unconsciously engaging in riskier lending would especially be meaningful, as unprepared losses of banks might have considerable impacts. If house prices grow, on average lower ex post risk can be expected than suggested by ex ante risk measures if banks have not anticipated real estate price growth. If they did but real estate price growth was weaker than expected, ex post risk will be lower than suggested by ex ante risk. As a result of both scenarios, the gap between the two measures should widen with recent real estate price growth.

H5: Higher recent real estate price growth weakens banks' risk forecasting ability

Indeed, banks should certainly be concerned about new loans being riskier when collateral values have had a recent increase: Defusco 2018 finds, analyzing data on US homeowners, that loans that were obtained by 'extracting equity', i.e. using the increases of property value to get additional loans, are riskier than comparable loans, with the risk being measured using foreclosures. The author concludes that the increase in house prices is not used to decrease existing debt, but rather for other purposes.

Furthermore, this effect might vary throughout the location of savings banks. Christians and Gärtner 2014 find German savings banks to demand more collateral when located in rural areas. An explanation for this finding might be that savings banks base their collateral demand not only on current values of securities, but also include future price developments: Expected decreasing values in real estate might further shift banks' attention to future incomes of borrowers as indicator of future solvency.

Banks located in areas with high average income might thus be less cautious as their counterparts in areas with on average lower income. Therefore, the former might be rather willing to 'gamble' as they not only can use property as collateral, but also future income or other assets as security. Additionally, diversified savings banks in terms of business lines might be prone to engage in riskier loans, with the performance of the bank being determined only partly by lending.

5.3 Data

5.3.1 Real estate and economic data

One of the key information of this paper are real estate data, hence a careful choice and thorough investigation of the data in use is obligatory. Using micro-level data of regions with varying real

estate growth allows to infer whether the relationship between property investment and non-performing loans is sensitive to property cycles (Zhang et al. 2018, p. 1393).

Cvijanovic 2014, p. 2700, uses land prices for real estate prices rather than prices of buildings, as the former do not demand additional consideration of depreciation costs. Furthermore, using indices for house prices would possibly describe characteristics that cannot be found at offices or other buildings of commercial use. Yet, the availability of data on land prices is limited: as land prices mostly only can be determined by observed transactions, the number of transactions, the size and location of the area sold and prices may vary considerably throughout years and between spatial entities. As observed land prices do not include offers, a relevant fraction of information is furthermore skipped.

Hedonic house price indices use data from actual transactions and offers and therefore offer a variety of information sources, covering a large fraction of local real estate markets. Their correction for individual property characteristics overcomes differences of house characteristics, such as age, size, and location.

Real estate data on a county level were obtained from *empirica AG* as quarterly database, using offered buy and rent prices with hedonical adjustment. This overcomes on the one hand biases that might have been caused by low transaction volumes and on the other hand those due to different qualities of real estate transactions. To have a higher comparability and ability to calculate price-rent ratios, we use prices and rents for condominiums of all ages.

Information on the spatial entities that are included in savings banks' (official) business areas was collected from their annual accounting reports, the addresses of their branches, their statues or other reports published on their homepages. This information was matched with the data on counties' real estate price growth and brought to a single value by calculating averages.

Information on unemployment within business areas was collected from the German Federal Employment Agency.

The results must be interpreted with care w.r.t. applicability for all kinds of banks. Performance differences of loans might occur even when controlling for hard facts due to different use of soft information (e.g. Keys et al. 2010, p. 330). This kind of information is often used by small local banks when granting loans, so it might affect savings banks, which exhibit some differences compared to privately managed banks.

5.3.2 German savings banks

The main part of the empirical investigation uses micro-level data on German savings banks, obtained by Orbis Bank Focus. Bank-level data include data from balance sheets and profit and loss statements, including information on non-performing loans, loan loss reserves, and loan net charge-offs on portfolio level, which can be used as ex ante or ex post risk measures. The unbalanced panel dataset comprises 390 savings banks with observations spanning from 2011 to 2018.

The analysis on aggregate levels uses data provided by Deutsche Bundesbank.

Savings banks are one of three pillars of the German banking system and have a high relevance in firm financing and for retail costumers, with a focus of their business on traditional banking: Loan volumes to non-MFIs of German savings banks have grown by almost 24% from the beginning of 2011 to the end of 2017, leading to a loan volume towards non-MFIs of 951 bn. Euro.[36] Savings banks possess some properties that make them especially suitable for the subsequent analyses: Their business areas are geographically limited and they are ubiquitous throughout the whole country. Conducting business outside their business areas would take place in their neighbor savings bank business areas and thus is not stipulated. Those business areas furthermore are often congruent with counties or county-free cities, which makes them very convenient for analyses including business areas and local factors (Conrad 2008, p. 13).

Due to their limitations w.r.t. business areas and practices, economic variables highly impact savings banks; e.g. Reichling and Schulze 2018, p. 459 find that up to 70% of inefficiencies of Eastern German savings banks are made up by local economic environment. Thus, differences between results of analyses on an aggregate and individual level could be based on the sensitivity of locally operating banks towards their (economic) environment as analyses on aggregate levels cannot reflect the large variety of outcomes of micro perspectives. Additionally, Salas and Saurina 2002, p. 221 find that individual bank level characteristics, such as market power and local indebtedness of borrowers have a high explanatory power for Spanish savings banks' growth of problem loans. Such non-bank specific economic data is available and can be matched with banks' business areas.

An additional advantage is that savings banks' business policies are similar throughout areas and banks' sizes, thus there should not be systematic variations of risk-taking (Conrad et al. 2014, p. 536). E.g. Koetter and Poghosyan 2010, p. 1134 find that savings banks even have

[36] Aggregate data on savings banks was obtained by Deutsche Bundesbank.

a lower probability of becoming distressed than small-sized and regionally based cooperative banks, which could reflect savings banks' risk averse business.

Considering the legal reliance of savings banks on public entities, such as counties or towns and furthermore the interaction between savings banks and state backed *Landesbanken*, one could suppose that savings banks have some tendency for risk taking within their codified types of business as they can expect governmental support on the one hand. On the other hand, as publicly held banks might not be under high pressure to achieve high returns, they could have less incentives to engage in risky businesses (Mohsni and Otchere 2014)[37].

As their public reliance includes a mandate to guarantee a supply of funding within their business areas, savings banks might be confronted with on average riskier borrowers than transaction-based-lenders.[38] In turn, they might on the one hand demand higher collateral values and on the other hand have a stronger link to mortgages due to their limited investment opportunities, rendering them especially prone to changes in local real estate markets.

5.4 Empirical investigation

In her empirical investigation, Cvijanovic 2014, p. 2699 makes use of the assumption that firms' real estate is in the same MSA as its headquarter. Similarly, and in accord with savings banks' official policy, I assume that mortgage lending and collateralization only take place in the savings banks' business areas and their supporting agency's area. That is, the real estate prices from the counties the bank has either branches in or which inherit cities that act as the banks' supporting agency are taken into account unweighted, as the exact spatial origins of loans and deposits are not documented.

An additional assumption is that all branches within a savings bank have the same business strategy in terms of collateralization. This assumption is not very strong, as branches are subordinated to their headquarters, they are spatially close, often exchange input factors and are co-working, not competing.

Before turning to the micro analysis using local data, I check the causality of real estate prices and loan growth and risk using aggregate national data.

[37] Mohsni and Otchere 2014, p. 137 find evidence that risk taking decreases for banks after they are privatized, implying higher risk taking before.

[38] Salas and Saurina 2002, p. 209 mention the possibility that savings banks could have higher ex post risks due to financing riskier projects in favor of local economy. Also Illueca et al. 2014, p. 1219 consider that banks under public guidance could have a bad performance due to political influences.

5.4.1 Causality

In line with previous research, I first try to determine the causality between loan volume and real estate price growth and additionally take overall economic development into account.
An extension of credit could lead to higher values of collateral, leading in turn again to higher borrowing opportunities. Feedback effects might thus enable high risk borrowers to get access to credit.
Several constellations on the risk taking and granting credit are possible. First, banks could increase the level of risk when increasing the amount of granted funds. This might be based on two different scenarios; On the one hand, banks might have to switch to risky borrowers in saturated markets. For example, a rapid growth of loan volumes including a high increase of problem loans is likely when banks try to gain market shares: The incumbent banks will try to keep their good costumers, thus their lost market shares mainly consist of risky clients (Salas and Saurina 2002, p. 210). But with increasing value of collateral, their LGD decreases and banks' expected profits might allow them to grant access to credit in the presence of sufficient collateral and increasing prices. Yet, this situation arises especially for outside collateral. Inside collateral requires higher loan amounts for low-risk borrowers. Whether this extension of credit means engaging in higher risks, depends on the creditworthiness of prior low-risk borrowers; if their ability to repay the loan and interest has increased with house prices, their creditworthiness is not affected, but if house prices increase stronger than income, creditworthiness deteriorates. Therefore, to check whether overall income has increased, it is important to keep the loan to assets ratio in mind. If loan volume has increased drastically compared to banks' overall total assets, whereas e.g. deposits remained on a constant level, as well as other assets, there has been a lot of investment, but only little savings.
Gerlach and Peng 2005 use Johansen cointegration as well as VECM models to entangle the simultaneity of loan and house price increases. Furthermore, the authors employ Hausman tests rather than Granger causality to investigate the relationship between lending and real estate prices, as the latter neglects current correlations. Similarly, Favara and Imbs 2015, p. 979 use instrumental variables to find causality between increasing loan volumes and house prices. As GMM methods, incorporating current effects, are used in the following estimations, I use Granger causality tests for the aggregate analysis.Here, I use aggregate data from the German Federal

Office of Statistics and Deutsche Bundesbank. Data for savings banks are provided quarterly[39], including value adjustments and provisions. The time span ranges between the second quarter of 2003 and second quarter of 2018, i.e. 61 periods. Due to problems with stationarity, besides growth relative to preceding year's quarter, first differences were partly used. As GDP is a commonly used indicator for economic conditions and their effects on credit risk (e.g. Salas and Saurina 2002), we check whether GDP tends to be a better predictor for past loan standards in terms of securities, future credit standards, and risk behavior of savings banks (expressed via provisions and value adjustments) than growth of land and housing prices. A summary of the results can be found in table 5.1.

As can be seen, there is no unidirectional explanation of GDP of any of the credit variables, whereas there seem to be feedback effects with loan conditions. House price growth is granger causal to all four of the credit indicators, whereas the first difference of land price growth is only causal to value adjustments of savings banks and the first difference of the increasing demand for securities indicator

Paying special attention to savings banks specific data, there is neither effect of house price or GDP growth on provisions or value adjustments. This could either be due to independence of savings banks towards those indicators or as nationally aggregated data misses out a lot of information that could be found on a local level. Thus, an empirical investigation on a micro-level is necessary not only to investigate the impact of property prices on loan risk, but also to add insights to savings banks' interference with local vs. national economy.

Additionally, yearly data on an aggregate (national) banking level has been plotted in figure 5.2, spanning from 2001 to 2015. The growth of NPLs as percentage of gross loans and credit risk provisioning of German banks as a percentage of net loans was plotted against growth of land and house prices. As can be seen, there are notable differences between house price and land price growth but none of them clearly moves in line with loan risk measures, possibly due to lagged relationships.

Overall, the results of these short investigations suggest that there could be a relationship between real estate price growth and loan portfolio risk, although this cannot be confirmed on an aggregate level for savings banks. Thus, micro data could provide additional insights.

[39] 'Value Adjustments SVB' and 'Provisions SVB' were provided for each month. Therefore, three month arithmetic means were calculated to get quarters.

Table 5.1: Results of Granger-Causality analysis

Lag length was determined using Akaike Information and Schwarz Criteria. Granger Causality was considered for significance levels of 10% or higher. Causality is indicated by $\rightarrow$ and $\rightarrow \leftarrow$ if both variables have causality on each other. Growth variables are denoted by circumflex and refer to the quarter of the preceding year. First differences are marked by Δ.

Land Prices				*House Prices*				*GDP*			
$\Delta\widehat{Landprice}$	$\rightarrow$	$\nleftarrow$	$\Delta Securities\ Firms$	$\widehat{HP}$	$\rightarrow$	$\nleftarrow$	$\Delta Securities\ Firms$	$\widehat{GDP}$	$\rightarrow$	$\leftarrow$	$\Delta Securities\ Firms$
			8				10				7
$\Delta\widehat{Landprice}$	$\nrightarrow$	$\nleftarrow$	$\Delta Securities\ Retail$	$\widehat{HP}$	$\rightarrow$	$\nleftarrow$	$\Delta Securities\ Retail$	$\widehat{GDP}$	$\rightarrow$	$\leftarrow$	$\Delta Securities\ Retail$
			3				2				12
$\Delta\widehat{Landprice}$	$\nrightarrow$	$\nleftarrow$	$\widehat{Provisions}\ SVB$	$\widehat{HP}$	$\nrightarrow$	$\leftarrow$	$\widehat{Provisions}\ SVB$	$\widehat{GDP}$	$\nrightarrow$	$\leftarrow$	$\widehat{Provisions}\ SVB$
			10				10				12
$\Delta\widehat{Landprice}$	$\rightarrow$	$\nleftarrow$	$Value\ \widehat{Adjustments}\ SVB$	$\widehat{HP}$	$\nrightarrow$	$\nleftarrow$	$Value\ \widehat{Adjustments}\ SVB$	$\widehat{GDP}$	$\nrightarrow$	$\nleftarrow$	$Value\ \widehat{Adjustments}\ SVB$
			6				1				1
$\Delta\widehat{Landprice}$	$\nrightarrow$	$\nleftarrow$	$\Delta\ Forward\ Standards$	$\widehat{HP}$	$\rightarrow$	$\nleftarrow$	$\Delta\ Forward\ Standards$	$\widehat{GDP}$	$\rightarrow$	$\leftarrow$	$\Delta\ Forward\ Standards$
			7				10				10
$\Delta\widehat{Landprice}$	$\nrightarrow$	$\nleftarrow$	$\Delta\ Forward\ Standards\ SMEs$	$\widehat{HP}$	$\rightarrow$	$\nleftarrow$	$\Delta\ Forward\ Standards\ SMEs$	$\widehat{GDP}$	$\nrightarrow$	$\leftarrow$	$\Delta\ Forward\ Standards\ SMEs$
			7				10				11

5.4.2 Dynamic panel estimation

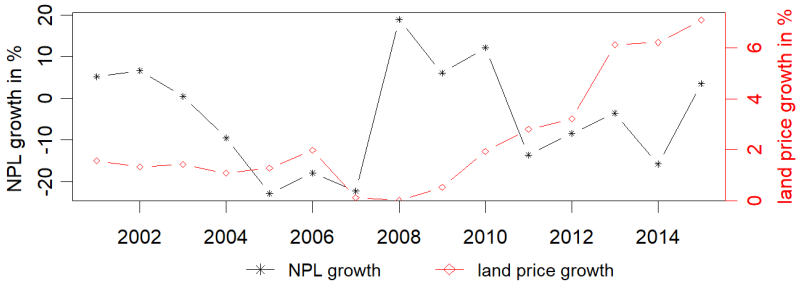
As stated above, the major part of the empirical investigation is conducted on a micro-basis to obtain evidence from individual effects of real estate price growth on lending.

I use dynamic panel data estimation as risk-taking might have some persistence, due to long-term relationships with borrowers, competition, and other external circumstances that might take some time to change their relevance for risk taking: Delis and Kouretas 2011, 846f using a Blundell-Bond estimator find that risk-taking is highly persistent for the first lag. Furthermore, savings banks often assign long-term loans, whose risk transfers from the preceding period Also, there could be autocorrelation in NPL ratios as found e.g. by Zhang et al. 2018.

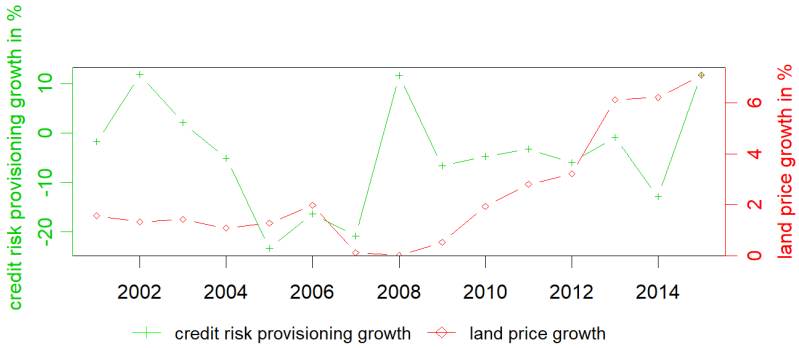
As dynamic panel data estimation is confronted with endogeneity via construction, OLS procedures would produce biased results. Endogeneity can potentially also be found in several explanatory variables, such as efficiency (s. Conrad et al. 2014), real estate prices and others. As only building first differences would result in a short panel bias, the chosen method to overcome this problem is the use of GMM estimators (Behr 2003, Flannery and Hankins 2013). To model persistence of ex ante and ex post loan risks and the impact of real estate prices, Arellano-Bond-Estimators as in Salas and Saurina 2002 as well as Blundell-Bond System-GMM are commonly used (e.g. Delis and Kouretas 2011 and Zhang et al. 2018). The use of the latter can be reasoned by persistence of the explained variable. In such cases, the first differences as employed by the Arellano-Bond estimator are rather weak instruments (Baltagi 2008, 160f). As first estimations yielded some high persistence of our measures of ex ante and ex post risk, we stick to system GMM estimator in what follows. In order to guarantee for robustness of the estimation results, Windmeijer's finite-sample correction was employed (s.a. Olszak et al. 2018).

There are several ways how endogeneity can affect results. For firm acquisitions of real estate[40], Cvijanovic 2014, 2700f uses an interaction term of real estate supply on MSA level and national real estate price index. Also, banks themselves are sometimes said to ave an impact on national macroeconomic outcomes. But as it not likely that risk-taking of single saving banks affects macroeconomic influences (s.a. Delis and Kouretas 2011, p. 846), this potential source of endogeneity is not considered further.

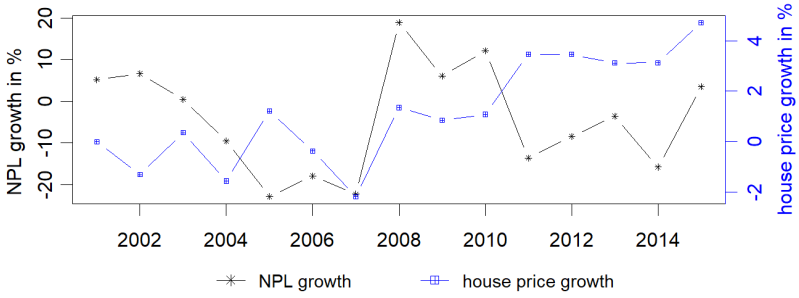
[40]Positive macroeconomic shocks might increase demand for land and, as a consequence, land prices. Firms in response must produce more output, therefore demanding more loans to finance higher production (Cvijanovic 2014, p. 2701).



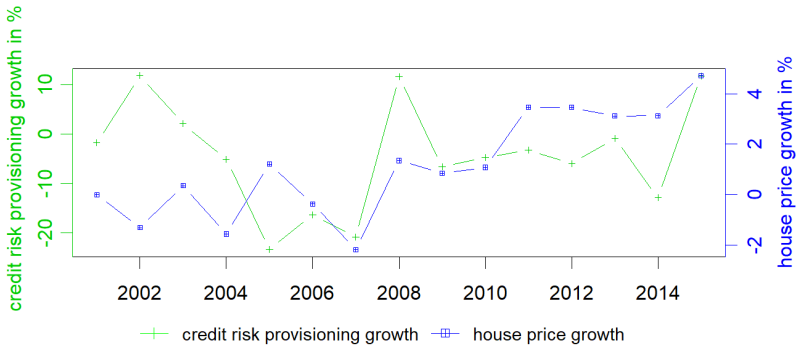
(a) NPL and land price growth



(b) Loan risk provisions and land price growth



(c) NPL and house price growth



(d) Loan risk provisions and house price growth

Figure 5.2: NPL/Loan risk provision and land/house price growth

Estimation and variables

In what follows, I shortly present the variables used in the following estimations. Loosely following Salas and Saurina 2002 and Olszak et al. 2018, the baseline estimation I use for the following estimations is

$$\begin{aligned} Problem\ Loans_{it} &= \alpha_1 Problem\ Loans_{it-1} + \sum_{k=1}^{3} \gamma_k \widehat{GCL_{it-k}} + \delta_1 LTA_{it} \\ &+ \sum_{k=1}^{3} \phi_k TCAR_{it-k} + \delta_2 Lerner_{it} + \delta_3 monitoring_{it} + \delta_5 NIM_{it-k} + \delta_4 CIR_{it} \\ &+ \sum_{k=1}^{3} \pi_k profits_{it-k} + \sum_{j=0}^{2} \beta_{j+1} Real\ Estate\ Price\ Growth_{t-j} + \eta_i + \epsilon_{it} \end{aligned} \tag{5.1}$$

Considering different points of time of ex ante and ex post risk, I vary the lags of the explanatory variables.

Several variables are employed as bank specific controls as suggested by Delis and Kouretas 2011, 845ff: Banks' equity ratios could capture the deliberations between an increase in risk when lending and hence augmenting necessary capital requirements; Furthermore, equity ratio is found to have an impact on banks' risk taking. To take account of this, I include banks' capital ratios ($TCAR_{it}$), similarly to Olszak et al. 2018.

As e.g. Reichling and Schulze 2018, p. 457 find German savings banks located in wealthier regions to be more efficient, we will include the cost income ratio (CIR_{it}). Higher real estate price growth could incur with higher income growth, thus results might rather be attributable to banks' efficiency than real estate markets.

I use net interest margins (NIM_{it}) to account for banks' ability to generate earnings by assigning new loans.

As Hott 2011 pointed out, past profits affect banks' expectations on whether they are optimistic or pessimistic. Lagged profits may impact not only lending volumes, but also riskiness of loans in several ways. On the one hand, preceding low profits might either force banks to engage in more/riskier lending or on the other hand reduce risky loans to prevent further losses. Here, $profits_{it}$ is defined as $\frac{profits\ and\ losses\ before\ taxes_{it}}{total\ assets_{it}}$.[41]

I include branch growth as explanatory variable for loan volume growth ($\widehat{branches}_{it}$, s. e.g. Illueca et al. 2014). As business areas of savings banks are defined and rather small (commonly

[41] As current earnings are potentially related to the risk level of bank lending, lagged values are used (Delis and Kouretas 2011, p. 845).

equal to one or two counties), I do not include branch growth in the further risk estimations to grasp some winner's curse effects (in fact, in unreported regressions, the coefficient was not significant).

Furthermore, changes in asset compositions of savings banks is considered. Banks with a high portion of real estate lending must be expected to have higher loan to asset ratios, which could also affect their provisions for loan losses (Blasko and Sinkey 2006). Thus, this ratio is included as well (s.a. Sinkey and Greenawalt 1991, 46f) as $loans/TA_{it}$, calculated as $\frac{Gross\ costumer\ loans_{it}}{Total\ Assets_{it}}$. Banks higher risk taking or higher losses could be consequences of less monitoring intensity. Thus, monitoring intensity, proxied by monitoring costs as $\frac{Number\ of\ employees_{it}}{Gross\ loans\ to\ costumers_{it}}$ will be included, similarly to Kick and Prieto 2015, p. 11. A further issue worth noting is a potential deterioration of monitoring activity (s. Manove et al. 2001). Thus monitoring must be considered endogenous as well, with real estate price growth having a strong impact on it.[42]

Another common explanation of bank risk taking is competition between financial intermediaries (e.g. 'winner's curse'. s. Forssbaeck and Shehzad 2015, p. 1998). For locally based savings banks, measures of competition that take into account several dimensions of local lending and borrowing, as e.g. local wealth, share of county deposits, number of branches within an area, interest income per branch, etc. would come into mind. Yet, most of those figures are either not available at all or have low explanatory power due to a variety of factors as different hierarchies of branches of commercial banks. Furthermore, 'classical' measures of market concentration, e.g. HHI on deposits on a county level, are often not bank-specific variables, but locally dependent and its effects can be proxied by e.g. county-dummies. Thus, as a common index on a bank-level, I employ a Lerner-Index based on the procedure described in Berger et al. 2009, p. 106 ($Lerner_{it}$, s. also Appendix).

Similarly, the growth rate of gross costumer loan volume ($\widehat{GCL_{it}}$) could indicate whether higher loan losses were due to a unequal growth of loan quality and quantity regarding ex post risk on the one hand. On the other hand, higher ex ante risk with higher loan growth might indicate a market expansion or confidence in future returns, possibly induced by growing real estate prices. Ex post risk is gauged using the banks' impaired loans, divided by gross costumer loans ($impaired_{it}$). This wider definition of ex post risk captures most of the credit that should be considered 'problem loans' in the spirit of Salas and Saurina 2002.

I use three different measures for real estate price growth: Two of them are growth of house

[42] Note that a mere substitution of monitoring by increasing real estate prices should not alter risk taking, thus a separation between effects is to be expected.

Table 5.2: Summary statistics for Micro-Data used for dynamic panel estimation

	Number	Mean	SD	Min	Max
$\widehat{Gross\ Loans}$	1,729	0.0383	0.0758	-0.2446	1.9493
$\frac{Loan\ Loss\ Reserves}{Gross\ Loans}$	1,997	0.0136	0.0093	0.0001	0.0897
$\frac{Impaired\ Loans}{Gross\ Loans}$	1,937	0.0263	0.0186	0.0001	0.171
$\widehat{House\ Prices}$	2,723	0.0463	0.052	-0.1483	0.3145
$\widehat{Condo\ Prices}$	2,730	0.0617	0.0766	-0.379	0.657
$Price-to-rent-ratio$	3,120	20.0995	4.1881	6.4313	51.6336

Growth variables are denoted by circumflex.

prices within counties, matched together with savings banks' business areas ($\widehat{HousePI}_{it}$) and well as growth of condo prices ($\widehat{CondoPI}_{it}$)[43].

Summary statistics for the dependent and real estate variables can be found in table 5.2. The data were not trimmed or corrected for outliers, and means are in line with those found in other studies (e.g. Balasubramanyan et al. 2017, using US-based data from 1997-2011 find that all loan loss reserves sum up to 1% of total assets on average, while here it is 0.844%). Sinkey and Greenawalt 1991 find regional economic factors, proxied by dummy variables to explain only a very small fraction of loan loss variation of banks. The authors conclude that loan loss rates are rather driven by managerial abilities. This stresses the relevance of managers' perception of real estate markets and their estimates.[44] In order to take this into account, I use price-to-rent-ratios on county level matched with business areas (PRR_{it}). Note that price-to-rent-ratios not only capture potential deviance from fundamental values, but also future expectations considering real estate prices. Price-to-rent-ratios therefore could serve as observation of local market's expectations whereas past price developments are *input* data for individual expectations. Thus, PRR_{it} could rather grasp effects of the incentive channel (i.e. a borrower's incentive to repay her loan in order not to loose her collateral with expected price growth).

In order to check to what extend real estate prices capture local economic development, I employ growth of unemployment rate in the banks' business areas ($\widehat{UNEMP}_{it}$). It should be stressed

[43] For the sake of simplicity, banks' variables as well as banks' business areas' variables are denoted by i.

[44] Contrarily, Cyree and Morris 2018, p. 182 find that banks in high income and low population counties mostly outperform those located in low income counties. Thus local economic factors seem to matter or at least attract more/less talented managers.

again, that the dynamic panel analysis focuses on local real estate price development, not on national levels. That is, overall national real estate price growth/decline is only considered within year dummies, which should control for effects of low interest rates, and higher stock market turnover, as well as general technical process in risk management (Delis and Kouretas 2011, p. 845).

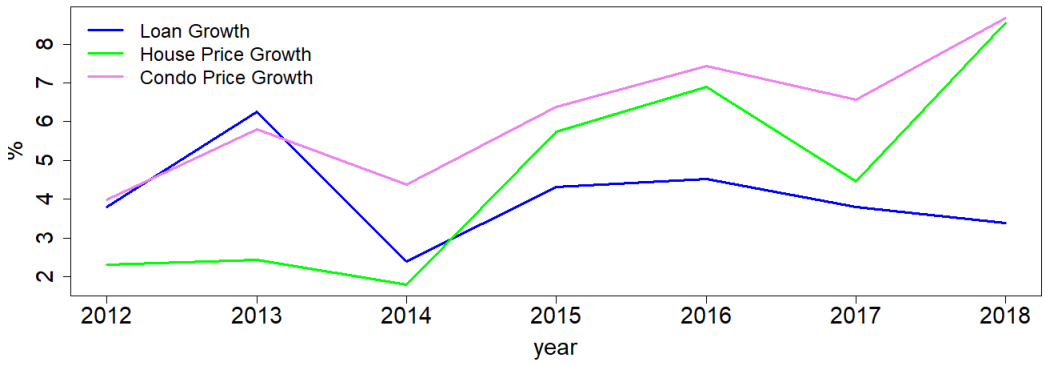
I do not use house prices in levels due to several shortcomings. Most importantly, changes can differ strongly from absolute changes, which would be an argument in favor of continuous returns. But also, the high variation in local real estate prices reflects different hierarchies of entities in terms of Central Places. Differences of banks located in central areas might thus not stem from real estate prices, but be caused by other factors, like stronger competition, a larger costumer base, etc., that would have the same origin as real estate prices. Thus, it is likely that explanatory power of location itself might be falsely attributed to real estate prices.

Loan Growth

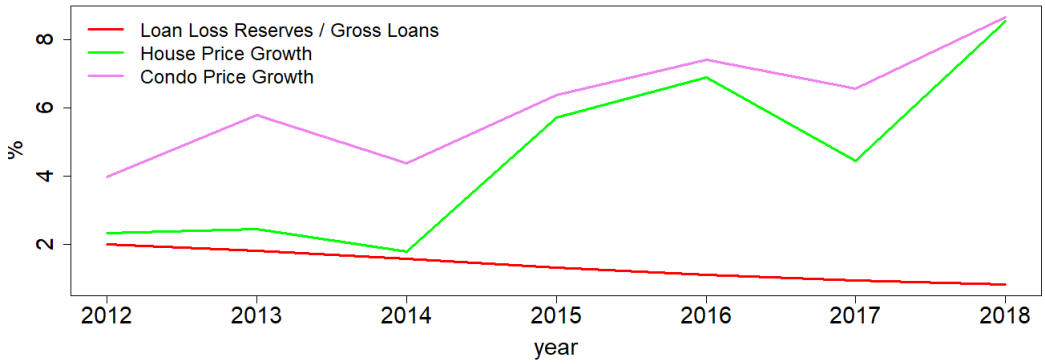
The first of the subsequent estimations is conducted as additional micro evidence to previous studies made on aggregate levels in order to detect causal relationships between loan and house price growth. With regard to the following estimations, higher loan volumes or extension of credit could forego higher loan risks if good borrowers already have obtained credit without extension of loans.

Note, that I include current real estate price growth in order to find current correlations (s. Gerlach and Peng 2005) that may be caused by the stated *current* observability of real estate price growth compared to e.g. GDP growth and the time interval in years allows for an impact of current values.[45] As additional explanatory variable, I use ex post risk of two previous periods to check whether past negative experiences concerning credits have a negative effect on current loan growth. The results can be found in table 5.3. As can be seen from the results, the major drivers of loan growth are - as could be expected - losses and impaired loans of the previous period (i.e. recently made experiences in lending), monitoring effort, the relevance of lending for the bank's business, and branch growth. Neither one of our real estate price growth variables, nor unemployment growth as other proxy for regional economic development is statistically significant in any of the estimations.

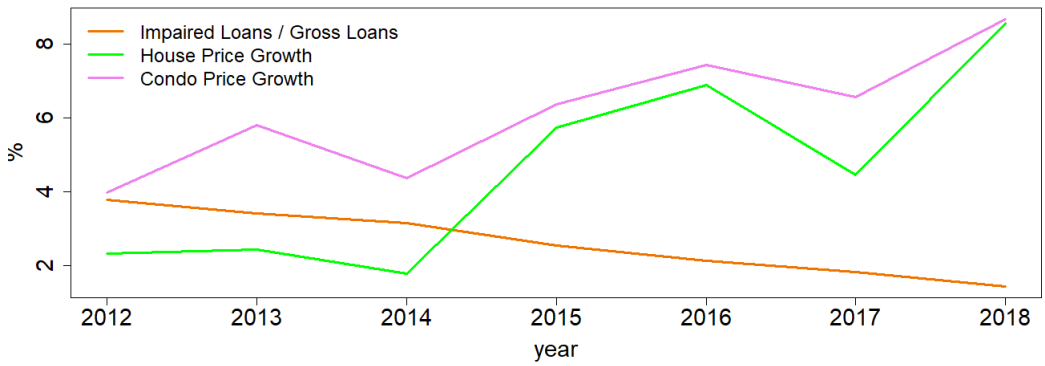
[45] Inclusion of additional lags did not produce additional significant coefficients.



(a) Loan Growth



(b) Loan loss reservations / gross costumer loans



(c) Impaired loans / gross costumer loans

Figure 5.3: Loan Growth, Loan loss reservations, and impaired loans of German savings banks
Graphic representation of variables of Micro-Dataset together with house and condo price growth;
Values represent sample averages.

Table 5.3: Results of Blundell-Bond-Estimation of loan growth

The estimation was conducted using different lag lengths for level and difference instruments and employing Windmeijer's robust standard errors. Growth variables are denoted by circumflex.

	(1) $\widehat{GCL_{it}}$	(2) $\widehat{GCL_{it}}$	(3) $\widehat{GCL_{it}}$	(4) $\widehat{GCL_{it}}$
$\widehat{GCL_{it-1}}$	0.152	0.109	0.153	0.108
	(1.05)	(0.71)	(1.02)	(0.78)
$impaired_{it-1}$	-0.00717**	-0.00561*	-0.00512	-0.00638
	(-2.11)	(-1.67)	(-1.43)	(-1.58)
$impaired_{it-2}$	0.00110	0.000137	0.0000667	-0.000434
	(0.70)	(0.08)	(0.03)	(-0.23)
$loans/TA_{it-1}$	-0.474***	-0.459***	-0.475***	-0.495***
	(-3.03)	(-3.44)	(-3.68)	(-3.16)
$loans/TA_{it-2}$	0.0467	0.0291	0.0850	0.0145
	(0.38)	(0.24)	(0.65)	(0.13)
$TCAR_{it}$	-0.00439	-0.00241	-0.00253	-0.00258
	(-1.39)	(-0.70)	(-0.69)	(-0.97)
$TCAR_{it-1}$	0.00286	0.000992	0.00141	0.00148
	(1.02)	(0.33)	(0.43)	(0.64)
$Lerner_{it}$	-0.224	-0.118	-0.131	-0.237
	(-0.96)	(-0.42)	(-0.52)	(-1.11)
$monitoring_{it}$	-0.314**	-0.337**	-0.289**	-0.368**
	(-2.12)	(-2.02)	(-2.19)	(-2.31)
CIR_{it}	-0.000549	-0.000162	-0.000351	-0.000421
	(-0.39)	(-0.10)	(-0.25)	(-0.33)
NIM	0.0174	-0.00199	-0.0146	0.0255
	(0.50)	(-0.05)	(-0.42)	(0.77)
$profits_{it-1}$	5.657*	5.911*	6.534*	7.478**
	(1.80)	(1.66)	(1.86)	(2.17)
$profits_{it-2}$	2.437	2.702	2.584	2.878
	(0.99)	(1.10)	(1.08)	(1.13)
$\widehat{branches_{it}}$	-0.0472**	-0.0420**	-0.0472**	-0.0492**
	(-2.48)	(-2.09)	(-2.06)	(-2.59)
$\widehat{branches_{it-1}}$	-0.00948	-0.0114	-0.0102	-0.00809
	(-1.24)	(-1.77)	(-1.55)	(-0.96)
$\widehat{HouseP_{it}}$	0.0273			0.00480
	(0.38)			(0.07)
$\widehat{HouseP_{it-1}}$	-0.0147			-0.0207
	(-0.36)			(-0.49)
PRR_{it}		-0.00136		
		(-0.46)		
PRR_{it-1}		0.00181		
		(0.65)		
$\widehat{CondoP_{it}}$			-0.0244	
			(-0.53)	
$\widehat{CondoP_{it-1}}$			-0.0337*	
			(-1.67)	
$\widehat{UNEMP_{it}}$				0.0554
				(0.47)
$\widehat{UNEMP_{it-1}}$				0.0761
				(1.12)
N	546	546	546	537
Number of instruments	72	72	72	78
Year dummies	Yes	Yes	Yes	Yes
First order Arellano Bond Test	-3.03***	-2.82***	-2.98***	-2.82***
Second order Arellano Bond Test	-0.10	-0.49	-0.53	0.35
Hansen Statistic	50.55	43.53	44.82	56.39
p-value	(0.298)	(0.576)	(0.522)	(0.248)

robust t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results suggest a rejection of the first hypothesis on a local short term (yearly) level. Thus, we rather would suspect that savings banks' reactions to real estate prices are not notable on an overall loan volume level, which could be due to a rather inelastic loan supply. The positive correlation on aggregate level as graphically suggested by figure 5.3a therefore cannot be confirmed. The coefficients on price-rent-ratio are not significant and change signs, indicating that market expectations on real estate price growth do not impact loan volumes; this could be reasoned as lenders have an informative advantage concerning future price developments. Note, however, that I also checked whether the reverse direction of causality would rather apply to the data and estimated the equation using loan growth as explanatory and house price growth and price-to-rent-ratio as explained variables (including their lags as right hand side variables). This did neither produce significant coefficients nor superior overall results. As loan volume is only available for savings banks, not for the whole county level, results of this estimation could be biased anyway.

For testing hypothesis two, the change of loan growth and deviance of prices from fundamental value, I conducted regressions with the same control variables and using price-to-rent-ratio growth, squared price-to-rent-ratios, a dummy, if the current and lagged price-to-rent-ratio exceeds the yearly averaged ratio by more than ten percent and interaction terms with this lagged dummy variable and house price growth.[46] None of these was significant, which does not necessarily indicate that savings banks do not react to exuberance of real estate markets; higher ratios might be justified by certain locations and thus not represent exaggerations of prices.

Ex ante risk

A clear definition of ex ante risk is hard to find as e.g. higher loan loss provisions can either indicate higher expected loan losses or lower underwriting quality (Dou et al. 2018, p. 1196). Yet, as savings banks should have similar standards and techniques in lending, loan loss reserves relative to gross costumer loans for each bank and year (LLR_{it}) are used as ex-ante risk measure to grasp how observed credit risk was priced before actual loss realizations occurred.

As Balasubramanyan et al. 2017, p. 197 point out, estimating NPLs using loan loss provisions (LLPs) can be biased as LLPs can be based on expectations for NPLs, thus LLPs are not independent from future loan performance. Hence, endogeneity has another stake in estimating

[46] Results can be found in the Appendix.

the equation.[47] I additionally include size measured as log of total assets (LTA_{it}). Olszak et al. 2018 argue that large banks are more procyclical and more prone to moral hazard due to too-big-to-fail thinking. As savings banks are supported publicly and do not have excessive size, those problems can be considered of low importance compared to analyzing full bank samples.

As can be seen from table 5.4, savings banks' loan loss reserves decrease with current house price growth and price-rent ratios, i.e. future market expectations. The effects are not highly significant, which is statistically reasoned with the robust Windmeijer correction. At a first glance, the results might seem puzzling, as one could suspect lagged house prices to have an impact on loan loss rates. Yet, as stated initially, house prices - in contrast to GDP - can be observed continuously. Thus current house price growth includes all observations during the year, technically enabling them to have a 'simultaneous' impact on end-of-the-year loan loss rates. Further lagged house prices do not have a significant impact, which can in parts be assigned to the usage of lagged loan loss rates which grasp explanatory power of the lagged house prices.
Although the results of estimation (5) indicate that banks reduce their loan loss provisioning (i.e. ex ante risk) in the presence of increasing property prices, the effect is not robust; as can be seen from estimation (8), the coefficient of unemployment growth is stronger in terms of statistical significance and local house price growth, thus not robustly affects savings banks' ex ante risk in lending. Rather, it could grasp some share of overall local economic growth effects, which is supported by the insignificance of condo price growth.
The negative coefficient of the price-rent-ratio, indicating lower ex ante risk, is small in economical significance an the changing sign for the coefficient of the preceding year indicate weak robustness. Therefore, a closer analysis of the effects of deviations of real estate prices from fundamental value will be performed in the latter sections.
Additional non-dynamic panel system GMM estimations using $\widehat{LLR_{it}}$ as dependent variable did not produce valuable insights or results different concerning real estate variables.

Ex post risk

Turning to hypothesis four, we first have to find a definition of ex post risk among available data and definitions that have already been used in literature: one ex post risk measure is $\frac{net\ charge\ offs_{it}}{net\ loans+chargeoffs_{it}}$ as used in Sinkey and Greenawalt 1991. Berger and Udell 1990, 27ff use loan risk premia as ex ante risk measure while ex post risk is gauged among others by loan

[47] Balasubramanyan et al. 2017 use a 2SLS procedure to overcome this problem by first estimating LLP using current NPLs and using the estimates when quantifying NPL.

Table 5.4: Results of Blundell-Bond-Estimation of ex ante risk

Ex ante risk is measured as $\frac{loan\ loss\ reserves_{it}}{gross\ costumer\ loans_{it}}$. The estimation was conducted using different lag lengths for level and difference instruments and employing Windmeijer's robust standard errors. Growth variables are denoted by circumflex.

	(5) LLR_{it}	(6) LLR_{it}	(7) LLR_{it}	(8) LLR_{it}
LLR_{it-1}	0.809*** (33.19)	0.814*** (29.04)	0.796*** (26.28)	0.823*** (33.02)
$\widehat{GCL_{it}}$	-1.032* (-1.93)	-0.817 (-1.37)	-0.994* (-1.75)	-0.859 (-1.57)
$\widehat{GCL_{it-1}}$	-0.0801 (-0.97)	-0.0586 (-0.63)	-0.0733 (-0.87)	-0.0496 (-0.57)
LTA_{it}	0.0512* (1.93)	0.0519* (1.82)	0.0624** (2.17)	0.0443* (1.90)
$TCAR_{it-1}$	-0.0271 (-1.39)	-0.0148 (-0.85)	-0.0121 (-0.74)	-0.0228 (-1.38)
$TCAR_{it-2}$	0.0378* (1.96)	0.0254 (1.39)	0.0229 (1.33)	0.0316* (1.81)
$Lerner_{it}$	0.513 (0.50)	0.282 (0.25)	0.838 (0.80)	0.608 (0.67)
$monitoring_{it}$	-0.313 (-1.11)	-0.174 (-0.60)	-0.310 (-1.03)	-0.319 (-1.11)
CIR_{it}	-0.00276 (-0.49)	-0.00283 (-0.47)	-0.000374 (-0.06)	-0.00239 (-0.45)
NIM	0.0405 (0.27)	0.0427 (0.30)	-0.0497 (-0.32)	0.0568 (0.45)
$profits_{it-1}$	-16.47 (-0.82)	-14.64 (-0.64)	-12.86 (-0.60)	-20.66 (-1.01)
$profits_{it-2}$	-8.820 (-0.69)	-8.350 (-0.63)	-5.458 (-0.42)	-10.65 (-0.79)
$\widehat{HouseP_{it}}$	-0.722* (-1.73)			-0.156 (-0.40)
$\widehat{HouseP_{it-1}}$	-0.0700 (-0.31)			-0.323 (-1.57)
$\widehat{CondoP_{it}}$		-0.305 (-1.24)		
$\widehat{CondoP_{it-1}}$		-0.0750 (-0.77)		
PRR_{it}			-0.0297** (-2.08)	
PRR_{it-1}			0.0176 (1.38)	
$\widehat{UNEMP_{it}}$				-0.600** (-1.96)
$\widehat{UNEMP_{it-1}}$				-0.0143 (-0.06)
N	1175	1176	1176	1154
Number of instruments	56	56	56	61
Year dummies	Yes	Yes	Yes	Yes
First order Arellano Bond Test	-4.48***	-4.17***	-4.28***	-4.42***
Second order Arellano Bond Test	1.06	0.78	0.79	0.90
Hansen Statistic	28.97	36.59	31.06	23.64
p-value	(0.668)	(0.275)	(0.564)	(0.944)

robust t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

charge-offs, overdue 30 days or 30-89 days, and renegotiated. These measures are only to be applied to savings banks' complete loan portfolios here, but not to single loans.

Here, I rather follow Delis and Kouretas 2011, p. 843 who use the ratio of risk assets[48] to total assets and the ratio of non-performing loans (NPLs) to gross loans as proxies to describe banks' risk taking. As the authors argue, these measures are better suited to describe banks' risk taking than z-score, as used e.g. in Mohsni and Otchere 2014 as risk-taking measure: z-score grasps banks' probability of insolvency rather than risk engagement. Thus, I use $\frac{impaired\ loans_{it}}{gross\ costumer\ loans_{it}}$ as variable to describe problem loans. Following the arguments of Salas and Saurina 2002, p. 212, the resulting variable $impaired_{it}$ is transformed to $ln(\frac{\frac{ImpairedLoans_{it}}{GrossLoans_{it}}}{1-\frac{ImpairedLoans_{it}}{GrossLoans_{it}}})$.

Besides efficiency, the most obvious finding is the persistence of loan portfolio riskiness (lagged dependent variable close to 100%). This variable explains a high share of the variation of the following impaired ratio, rendering at least some of the other lagged variables without explanatory power, but rather bundling their effects.

The second clear finding is that there is a robust positive impact of loan growth on loan risk. Riskier borrowers could be the consequence of the bank already having served good borrowers and being forced to lend to bad borrowers due to competitive pressure or strategy of the bank (winner's curse effect).

Banking competition is expected to have a positive impact on NPLs as in Zhang et al. 2018. This is in line with Herring and Wachter 1999 who argue that disaster myopia can be increased by competition, as non-myopic banks cannot withstand the pressure that arises if pricing is conducted with too little risk premia. This decreases returns and banks increase their leverage. In fact, there is some evidence from our estimations that savings banks with higher market power have lower ex post risk.

Finally, there does not seem to be an influence of house price growth, respective expectations on future house price growth, on the ex post risk of savings banks' loans. Unreported regressions, using $\frac{Net\ charge\ offs_{it}}{gross\ costumer\ loans_{it}}$ as dependent variable, as e.g. in Sinkey and Greenawalt 1991, confirmed that real estate price growth (expectations) does not have a significant effect on savings banks' loan portfolios' ex post risk.

[48] Under 'risk assets' the authors subsume all assets with volatile values and lead to varying profits (Delis and Kouretas 2011, p. 843).

Table 5.5: Results of Blundell-Bond-Estimation of ex post risk

Ex post risk is measured by $\frac{impaired\ loans_{it}}{gross\ costumer\ loans_{it}}$. The estimation was conducted using different lag lengths for level and difference instruments and employing Windmeijer's robust standard errors. Growth variables are denoted by circumflex.

	(9)	(10)	(11)	(12)
	$impaired_{it}$	$impaired_{it}$	$impaired_{it}$	$impaired_{it}$
$impaired_{it-1}$	0.989***	0.979***	0.983***	0.983***
	(35.92)	(32.04)	(34.03)	(33.67)
$\widehat{GCL}_{it-1}$	0.197*	0.193*	0.220**	0.205*
	(1.80)	(1.86)	(2.06)	(1.94)
$\widehat{GCL}_{it-2}$	0.301**	0.284**	0.338**	0.295*
	(2.07)	(1.99)	(2.16)	(1.96)
$TCAR_{it-2}$	-0.00595	-0.00268	-0.00290	-0.00430
	(-0.67)	(-0.30)	(-0.31)	(-0.53)
$TCAR_{it-3}$	0.00862	0.0150*	0.0114	0.00927
	(1.12)	(1.76)	(1.47)	(1.21)
$Lerner_{it-1}$	-1.542**	-1.138	-0.984	-1.470**
	(-2.00)	(-1.47)	(-1.42)	(-2.00)
$Lerner_{it-2}$	-0.0256	-0.0396	-0.0223	-0.0456
	(-0.15)	(-0.24)	(-0.13)	(-0.26)
$monitoring_{it-1}$	-0.487	-0.752	-0.776	-0.479
	(-0.88)	(-1.51)	(-1.39)	(-0.94)
$monitoring_{it-2}$	0.421	0.368	0.534	0.324
	(0.96)	(1.03)	(1.25)	(0.85)
CIR_{it}	-0.00193	-0.00127	-0.000845	-0.00248
	(-0.74)	(-0.47)	(-0.34)	(-1.02)
CIR_{it-1}	-0.00839**	-0.00635	-0.00578	-0.00809**
	(-2.14)	(-1.61)	(-1.64)	(-2.16)
$\widehat{HouseP}_{it-1}$	-0.189			-0.216
	(-0.65)			(-0.74)
$\widehat{HouseP}_{it-2}$	0.0451			-0.0118
	(0.16)			(-0.04)
PRR_{it-1}		-0.0111		
		(-1.06)		
PRR_{it-2}		-0.00207		
		(-0.26)		
$\widehat{CondoP}_{it-1}$			-0.0264	
			(-0.19)	
$\widehat{CondoP}_{it-2}$			-0.118	
			(-0.83)	
$\widehat{UNEMP}_{it-1}$				-0.235**
				(-2.51)
$\widehat{UNEMP}_{it-2}$				-0.504
				(-1.15)
N	793	793	793	781
Number of instruments	54	54	54	61
Year dummies	Yes	Yes	Yes	Yes
First order Arellano Bond Test	-2.38**	-2.40**	-2.38**	-2.37**
Second order Arellano Bond Test	0.76	0.85	1.08	0.89
Hansen Statistic	37.79	37.17	39.78	39.56
p-value	(0.222)	(0.243)	(0.162)	(0.356)

robust t statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Monitoring, ex post loan loss reserves and deviations from fundamental values

The obtained results concerning ex post risks could be the consequence of a multitude of factors, among them pure coincidence. The term *ex post loan loss reserves* used in what follows compares loan loss reserves to realized credit risk, i.e. high/low values indicate bad loan loss reserves policy which could be due to either speculations on rising values of collateral or overall economic conditions. This test of hypothesis five, i.e. how real estate price growth affects savings banks' estimation of risks and their optimism, is conducted using $LLRIMP_{it}$, defined as $\frac{loan\ loss\ reserves_{it}}{impaired\ loans_{it}}$.

With loan loss reserves and impaired loans being supposedly impacted by different lags of the explanatory variables, I include up to three periods of each variable. Again, I estimate a dynamic panel model, as the two components of the dependent variable were endogenous - loan loss reserves and impaired loans were highly persistent. Here, in order to have a look at the effects of monitoring effects without including real estate prices, I estimated parsimoniously instrumented models without considering condo price growth as before, but estimating a baseline model without real estate variables.

The results in table 5.6 suggest that monitoring has an effect on the ratio with varying signs concerning the lags. Current efficiency and market power seem to have positive impacts on loan loss reserves, which would contradict a too-big-to-fail moral hazard problem, which on the contrary, would not suit savings banks' size, systemical relevance and organization structure anyway.

Most importantly, the regression shows that local real estate prices do not lead banks to be over-optimistic. Hypothesis 5 thus is rejected. With regard to the previous estimations, this is not surprising and undermines the finding that savings banks' loan portfolio risk is not determined directly by real estate prices, but rather by economic factors which in term could determine real estate growth. E.g. in unreported estimations, I found population growth to have in places even stronger effects than unemployment rate growth.

As savings banks are backed by public entities and have less pressure than e.g. commercial banks to achieve high gains in short time, they might be less prone to engaging in riskier lending without being aware of it. Furthermore, savings banks have a strong link to local real estate markets, which provides them with local knowledge and enables them rather to notice risks stemming from real estate related lending.

Therefore, I used the aforementioned variables to check real estate price exuberance and checked whether savings banks increased their ex post loan loss reserves in response to potential bursting

Table 5.6: Results of Blundell-Bond-Estimation of ex post appropriateness of loan loss reserves

Ex post risk appropriateness of loan loss reserves is measured by $\frac{loan\ loss\ reserves_{it}}{impaired\ loans_{it}}$. The estimation was conducted using different lag lengths for level and difference instruments and employing Windmeijer's robust standard errors. Growth variables are denoted by circumflex.

	(1) $LLRIMP_{it}$	(2) $LLRIMP_{it}$	(3) $LLRIMP_{it}$	(4) $LLRIMP_{it}$
$LLRIMP_{it-1}$	0.690*** (9.33)	0.688*** (9.00)	0.681*** (7.99)	0.681*** (9.67)
$\widehat{GCL}_{it}$	-176.0 (-1.62)	-158.8 (-1.64)	-138.2 (-1.20)	-115.0 (-1.23)
$\widehat{GCL}_{it-1}$	-12.00 (-1.33)	-10.26 (-1.24)	-8.340 (-0.79)	-5.115 (-0.63)
$\widehat{GCL}_{it-2}$	-7.520 (-1.45)	-6.735 (-1.35)	-5.622 (-1.02)	-3.625 (-0.72)
$TCAR_{it-1}$	-0.0202 (-0.01)	-0.153 (-0.10)	0.421 (0.23)	0.796 (0.62)
$TCAR_{it-2}$	-0.352 (-0.30)	-0.444 (-0.38)	-0.706 (-0.54)	-1.106 (-1.05)
$TCAR_{it-3}$	-0.336 (-0.44)	-0.385 (-0.58)	-0.396 (-0.45)	-0.208 (-0.34)
$profits_{it-2}$	-460.8 (-0.52)	-136.2 (-0.14)	-368.5 (-0.38)	-502.0 (-0.56)
$profits_{it-3}$	870.2 (0.61)	1038.9 (0.71)	780.0 (0.46)	629.9 (0.45)
$Lerner_{it}$	384.0** (2.14)	375.0** (2.11)	304.4 * (1.68)	212.0 (1.36)
$Lerner_{it-1}$	-94.05 (-1.28)	-93.62 (-1.33)	-61.59 (-0.78)	-38.21 (-0.59)
$Lerner_{it-2}$	-14.04 (-1.10)	-14.77 (-1.16)	-11.52 (-0.84)	-5.460 (-0.48)
$monitoring_{it}$	-415.6* (-1.79)	-404.2 * (-1.75)	-432.7 (-1.55)	-456.4** (-2.08)
$monitoring_{it-1}$	333.6 * (1.73)	337.5 * (1.72)	358.8 (1.59)	365.9 * (1.91)
$monitoring_{it-2}$	44.32 (1.23)	33.31 (1.06)	34.05 (1.17)	37.76 (1.17)
CIR_{it}	2.246** (1.99)	2.219** (2.04)	1.802 (1.58)	1.195 (1.27)
CIR_{it-1}	-0.501 (-1.33)	-0.508 (-1.39)	-0.336 (-0.81)	-0.221 (-0.67)
$\widehat{HouseP}_{it}$		-31.95 (-0.46)		15.59 (0.29)
$\widehat{HouseP}_{it-1}$		11.54 (0.57)		0.657 (0.03)
$\widehat{HouseP}_{it-2}$		-11.14 (-0.58)		-1.862 (-0.11)
PRR_{it}			0.240 (0.09)	
PRR_{it-1}			-0.0424 (-0.01)	
PRR_{it-2}			-0.0470 (-0.04)	
$\widehat{UNEMP}_{it}$				-15.44 (-0.57)
$\widehat{UNEMP}_{it-1}$				7.065 (0.36)
$\widehat{UNEMP}_{it-2}$				4.577 (0.18)
N	774	774	774	758
Number of instruments	33	37	37	41
Year dummies	Yes	Yes	Yes	Yes
First order Arellano Bond Test	-2.05**	-2.23**	-1.89*	-1.71*
Second order Arellano Bond Test	0.53	0.52	0.27	0.36
Hansen Statistic	2.31	2.67	2.15	4.11
p-value	(0.941)	(0.953)	(0.976)	(0.904)

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

of a housing price bubble. Again, these variables are not significant, what could be due to the low time period analyzed or simply the lack of notable deviances from fundamental values.

5.5 Conclusions

This paper studies the effect of real estate prices on German savings banks' risk taking. It contributes to existing literature in several ways. First, it analyzes the impact of real estate price growth on loan risk, uses a micro-level perspective to do so and uses a forward-looking measure to investigate this question.

Overall, there is no robust evidence that real estate price growth notably affects savings banks' overall lending risk. There is only some slight evidence that loan loss reserves are affected by real estate markets, but this effect is rather dominated by overall economic development: unemployment rate as overall economic indicator is a better predictor of ex ante loan risk. Therefore, the micro-results confirm the impressions from the investigation on causality that house price growth cannot contribute notably towards an explanation of savings banks' ex ante or ex post loan portfolio risk.

This result could be due to several reasons. The observed time span could be too short to represent a real estate cycle. Additionally, since the European sovereign debt crisis, there has been a steady increase of real estate prices for virtually all German regions. Another issue is that national economic factors, like overall economic development or interest rates have higher explanatory power than regional factors. This could be due to higher relevance regarding deposit-lending in case of interests and determination of the attraction of other business areas like stock markets. Furthermore national economic development is more present in media and could serve as predictor for local economic growth. As in many of the equations time dummies were significant, this seems to be a plausible explanation.

Furthermore, overall there is a high persistence of loan factors, which has already been noticed as justification for the usage of system GMM. This underlines the relevance of loan maturities when determining NPLs and the significance of collateral in lending. Including those data might thus offer additional valuable insights into the riskiness of loans collateralized by real estate.

Two further aspects probably have a high relevance for the results: From a regulatory point of view, lending using real estate as collateral has some restrictions, that are often not considered, but are essential for banks. E.g. estimations of LGD must bear in mind that securities can

be sold only at some discount (Capital Requirements Regulations (CRR) I, Art. 181 (1) e))[49]. Furthermore, CRR I refers to the notion of ex ante and ex post risk in Art. 125 (2) b) and Art. 126 (2) b), pointing to the fact that borrower risk does not depend on the development of the value of the collateralized real estate.

Additionally, due to their spatially limited business areas, savings banks have a rather low distance towards their borrowers, allowing them the use of soft information. Although the latter cannot fully replace collateral, it might help savings banks not only to correctly forecast borrowers' future economic conditions, but also allow them to soften their lending techniques, i.e. enable them not only to lend based on collateral. Berger and Black 2011 find comparative advantages of small banks when it comes to relationship lending, which is relying commonly on soft information. This advantage, which would also meet savings banks' size, could make them less susceptible for inappropriate reliance on collateral.

Yet, the results obtained do not exclude loan losses or collectively missing precaution for savings banks, as due to the short observation period, full business cycles or long-term real estate developments could not be investigated. Furthermore, as savings banks' lending is not independent from local economic aspects, which determine real estate prices, at least some indirect link between their loan portfolio risk and real estate markets exists. This can be seen from the high explanatory power of local unemployment rate, which adds information to national levels of economic development. Further research should thus focus on the drivers of real estate markets and their effects on loan risk, using ore granular data concerning the value of recoveries and the fraction and maturities of collateralized loans.

5.6 Appendix A: Lerner Index

In this section, I shortly present choice and calculation of the measure of competition, the Lerner Index. For locally based savings banks, measures for competition that take into account several dimensions of local lending and borrowing, as e.g. local wealth, share of county deposits, number of branches within an area, interest income per branch, etc. would come into mind. Yet, most of those figures are either not available at all or have low explanatory power due to a variety of factors as different hierarchies of branches of commercial banks. Furthermore, 'classical' measures of market concentration, e.g. Herfindahl-Indices on deposits on a county level, are very sensitive to non-homogeneity of banks (s. Forssbaeck and Shehzad 2015) are often not bank-specific

[49] s. Besanko and Thakor 1987

variables, but locally dependent and its effects can be gauged by e.g. county-dummies.
Thus, as a common index on a bank-level, I employ a Lerner-Index based on the procedure described in Berger et al. 2009, p. 106 and Feldkircher and Sigmund 2017. The Lerner index is defined as

$$Lerner_{it} = \frac{Price\ of\ Total\ Assets_{it} - Marginal\ Cost\ of\ Total\ Assets_{it}}{Price\ of\ Total\ Assets_{it}} \tag{5.2}$$

where marginal costs are derived from

$$Marginal\ Cost\ of\ Total\ Assets_{it} = \frac{Cost_{it}}{TA_{it}}[\beta_1 + \beta_1 ln\ TA_{it} + \sum_{k=1}^{3} \phi_k ln\ F_{k,it}] \tag{5.3}$$

with the costs stemming from the translog function:

$$\begin{aligned} ln\ Cost_{it} = \beta_0 + \beta_1 ln\ TA_{it} + \beta_2 \frac{1}{2} ln\ TA_{it}^2 + \sum_{k=1}^{3} \gamma_k ln\ F_{k,it} + \sum_{k=1}^{3} \phi_k ln\ TA_{it} ln\ F_{k,it} + \\ + \alpha_1 ln(F_1) \cdot ln(F_2) + \alpha_2 ln(F_1) \cdot ln(F_3) + \alpha_3 ln(F_2) \cdot ln(F_3) \sum_{k=1}^{3} \alpha_{3+k} ln\ F_{k,it}^2 \end{aligned} \tag{5.4}$$

Total costs are described by TA_{it}, input costs by F_k: F_1 is labor costs, described by $\frac{staff\ expenses}{TA}$, F_2 are costs of funds ($\frac{interest\ expense}{total\ deposits}$) and F_3 are cost of fixed capital ($\frac{operating\ expenses}{TA}$). The dependent variable (total costs) is calculated as the sum of total operating expenses and total interest expenses. The results of the estimation of the equation above can be found in table 5.7 As in Berger et al. 2009, I used year fixed effects and robust standard errors (clusters on bank-level basis). At a first glance, there are two issues that would reject the use of year dummies; Firstly, F-Tests suggest that the year dummies are jointly insignificant for some specifications. Secondly, they grasp overall economic conditions which are supposed to be of lower relevance for regionally non-systemic banks. Yet, they are kept in all estimations as otherwise effects of (national) interest levels and other economic conditions would be falsely assigned to local house price growth. Many of the coefficients' values and significances are similar to the results of Feldkircher and Sigmund 2017.[50]
The obtained coefficients are then used together with the input data described above to calculate marginal costs which ten, finally, are used to calculate each bank' s Lerner-Index.

[50] The high R^2 coefficients are similar in magnitude to those found by Feldkircher and Sigmund 2017, p. 65 and Shaffer and Spierdijk 2019, p. 18

Table 5.7: Results of estimation of translog cost function in order to calculate the Lerner Index for each bank

Estimations were conducted using year fixed effects and clustered standard errors. Dependent variable is the natural logarithm of total operative expenses and interest expenses in Euro

	(17) ltc
log(Total Assets)	1.261***
	(17.12)
0.5 [log (*Total Assets*)]^2	-0.0179***
	(-3.35)
F1	0.294*
	(2.07)
F2	-0.236***
	(-4.85)
F3	1.365***
	(8.63)
log(Total Assets)·F1	-0.0213**
	(-2.72)
log(Total Assets) ·F2	0.0117***
	(4.27)
log(Total Assets) ·F3	-0.0234**
	(-3.25)
F1·F2	0.00167
	(0.35)
F1·F3	-0.0157
	(-1.50)
F2·F3	-0.0359**
	(-3.27)
F1·F1	-0.00735
	(-1.77)
F2·F2	0.000336
	(0.10)
F3·F3	0.0525***
Constant	-1.914***
	(-3.51)
Observations	8,672
R^2 (*overall*)	0.9921

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.7 Appendix B: Loan growth and deviation from fundamental value

Table 5.8: Results of Blundell-Bond-Estimation of loan growth with price-to-rent-ratio related explanatory variables

$PRR\ Dummy_{it}$ is a dummy variable, indicating whether the price rent ratio in the business area was at least ten percent higher than the average over all business areas in the respective year. The estimation was conducted using different lag lengths for level and difference instruments and employing Windmeijer's robust standard errors. Growth variables are denoted by circumflex.

	(18) $\widehat{GCL_{it}}$	(19) $\widehat{GCL_{it}}$	(20) $\widehat{GCL_{it}}$	(21) $\widehat{GCL_{it}}$
$\widehat{GCL_{it-1}}$	0.163	0.116	0.205	0.199
	(1.13)	(0.74)	(1.50)	(1.33)
$impaired_{it-1}$	-0.00687**	-0.00523	-0.00752***	-0.00551
	(-2.38)	(-1.55)	(-2.62)	(-1.58)
$impaired_{it-2}$	0.000371	0.0000857	0.00124	0.000344
	(0.24)	(0.05)	(0.89)	(0.19)
$loans/TA_{it-1}$	-0.444***	-0.469***	-0.487***	-0.480***
	(-3.57)	(-3.61)	(-3.28)	(-3.69)
$loans/TA_{it-2}$	0.0593	0.0342	0.102	0.119
	(0.54)	(0.29)	(0.89)	(0.93)
$TCAR_{it}$	-0.00259	-0.00293	-0.00534**	-0.00333
	(-0.77)	(-0.93)	(-2.27)	(-0.95)
$TCAR_{it-1}$	0.000673	0.00133	0.00309	0.00229
	(0.19)	(0.49)	(1.28)	(0.69)
$Lerner_{it}$	-0.141	-0.170	-0.250	-0.192
	(-0.61)	(-0.64)	(-1.31)	(-0.74)
$monitoring_{it}$	-0.289**	-0.336*	-0.275**	-0.260*
	(-2.30)	(-1.88)	(-2.08)	(-1.96)
CIR_{it}	-0.000472	-0.000416	-0.000999	-0.000663
	(-0.35)	(-0.28)	(-0.87)	(-0.45)
NIM_{it}	-0.00689	0.0101	0.0189	-0.00868
	(-0.22)	(0.24)	(0.65)	(-0.24)
$profits_{it-1}$	5.870**	6.394*	5.579*	6.522**
	(2.11)	(1.79)	(1.79)	(1.97)
$profits_{it-2}$	2.464	2.769	1.961	2.203
	(1.20)	(1.17)	(0.94)	(0.92)
$\widehat{branches_{it}}$	-0.0463**	-0.0445**	-0.0471**	-0.0479**
	(-2.22)	(-2.27)	(-2.25)	(-2.11)
$\widehat{branches_{it-1}}$	-0.00767	-0.0108	-0.00390	-0.00937
	(-1.14)	(-1.61)	(-0.54)	(-1.33)
$PRR\ Dummy_{it}$	-0.00459			
	(-0.31)			
$PRR\ Dummy_{it-1}$	0.000743			
	(0.08)			
PRR^2_{it}		-0.0000389		
		(-0.70)		
PRR^2_{it-1}		0.0000508		
		(1.04)		
Interaction1			-0.0444	
			(-0.58)	
Interaction2			-0.0325	
			(-0.51)	
$\widehat{PRR_{it}}$				-0.00194
				(-0.03)
$\widehat{PRR_{it-1}}$				-0.0354
				(-1.63)
N	546	546	546	546
Number of instruments	72	72	78	72
Year dummies	Yes	Yes	Yes	Yes
First order Arellano Bond Test	-2.96***	-2.84***	-3.18***	-3.11***
Second order Arellano Bond Test	-0.69	-0.65	-0.49	-0.36
Hansen Statistic	48.38	45.03	53.04	45.00
p-value	(0.498)	(0.513)	(0.434)	(0.514)

robust t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.8 Appendix C: Adequacy of estimation of losses and deviations from fundamental house prices

Table 5.9: Results of Blundell-Bond-Estimation of ex post appropriateness.

Ex post appropriateness is gauged by estimating $\frac{Loan\ Loss\ Reserves}{Impaired\ Loans}$ with price-to-rent-ratio related explanatory variables. The estimation was conducted using different lag lengths for level and difference instruments and employing Windmeijer's robust standard errors.

	(1) $LLRIMP_{it}$	(2) $LLRIMP_{it}$	(3) $LLRIMP_{it}$	(4) $LLRIMP_{it}$
$LLRIMP_{it-1}$	0.680*** (8.25)	0.685*** (8.51)	0.681*** (8.97)	0.674*** (6.83)
$\widehat{GCL_{it}}$	-99.47 (-1.01)	-138.7 (-1.42)	-124.8 (-1.38)	-202.6 (-1.26)
$\widehat{GCL_{it-1}}$	-5.254 (-0.60)	-9.138 (-1.01)	-6.701 (-1.00)	-15.37 (-1.30)
$\widehat{GCL_{it-2}}$	-4.020 (-0.86)	-6.518 (-1.23)	-5.143 (-1.23)	-7.203 (-1.04)
$TCAR_{it-1}$	0.794 (0.70)	0.483 (0.31)	0.543 (0.52)	-0.799 (-0.42)
$TCAR_{it-2}$	-1.090 (-0.99)	-0.717 (-0.66)	-0.978 (-1.02)	0.294 (0.17)
$TCAR_{it-3}$	-0.431 (-0.52)	-0.187 (-0.23)	-0.213 (-0.35)	-0.809 (-0.97)
$profits_{it-2}$	-215.3 (-0.24)	-428.4 (-0.46)	-354.2 (-0.42)	-386.1 (-0.35)
$profits_{it-3}$	873.5 (0.64)	805.4 (0.49)	943.2 (0.75)	964.6 (0.52)
$Lerner_{it}$	230.8 (1.55)	336.9** (1.99)	258.5** (2.19)	409.2 (1.73)
$Lerner_{it-1}$	-42.49 (-0.64)	-79.90 (-1.05)	-48.96 (-0.86)	-97.53 (-0.91)
$Lerner_{it-2}$	-9.358 (-0.82)	-11.34 (-0.90)	-10.64 (-0.99)	-15.42 (-0.95)
$monitoring_{it}$	-437.4** (-1.97)	-436.2 * (-1.78)	-449.8** (-2.10)	-366.8 (-1.38)
$monitoring_{it-1}$	371.6* (1.90)	349.2 * (1.73)	366.2** (1.98)	306.9 (1.32)
$monitoring_{it-2}$	26.05 (0.71)	36.23 (1.38)	35.56 (1.12)	48.11 (1.24)
CIR_{it}	1.345 (1.49)	1.902 * (1.88)	1.484** (2.02)	2.619 (1.77)
CIR_{it-1}	-0.240 (-0.68)	-0.428 (-1.09)	-0.279 (-0.93)	-0.524 (-0.96)
$PRR\ Dummy_{it}$	4.973 (0.37)			
$PRR\ Dummy_{it-1}$	-3.496 (-0.50)			
$PRR\ Dummy_{it-2}$	1.648 (0.39)			
PRR^2_{it}		0.00267 (0.06)		
PRR^2_{it-1}		-0.00215 (-0.04)		
PRR^2_{it-2}		0.00133 (0.07)		
$\widehat{HouseP_{it}} * PRR\ Dummy_{it-1}$			-13.85 (-0.49)	
$\widehat{HouseP_{it-1}} * PRR\ Dummy_{it-2}$			18.08 (0.53)	
$\widehat{HouseP_{it-2}} * PRR\ Dummy_{it-3}$			6.181 (0.19)	
$\widehat{PRR_{it}}$				-40.06 (-0.66)
$\widehat{PRR_{it-1}}$				15.03 (1.14)
$\widehat{PRR_{it-2}}$				-8.239 (-0.33)
N	774	774	774	774
Number of instruments	37	37	41	37
Year dummies	Yes	Yes	Yes	Yes
First order Arellano Bond Test	-1.99**	-1.99**	-2.08**	-1.74*
Second order Arellano Bond Test	0.38	0.55	0.54	-0.10
Hansen Statistic	3.07	2.25	3.86	1.75
p-value	(0.930)	(0.972)	(0.986)	(0.988)

Chapter 6

Conclusions

This thesis analyzes the effects of regional economics on bank relationships and banking policy. Specifically, we investigated potential effects of local industry specialization and competition, distance and real estate prices on banks. With information asymmetries and advantages being closely linked to regional economics, potential risks that stem from having less knowledge than competitors or counterparts could be mitigated by being strongly connected with regional markets.

In order to lay down the basics of the subsequent analyses, I reviewed regional economic theories and highlighted the role of information asymmetries in banking in chapter 2. The concepts illustrated not only concerned how knowledge transfers between firms can spur their productivity but also how the ability to provide credible hard information between firms and banks essentially determines the relationship types between firms and banks.

The third chapter analyzed the effects of local industrial and corporate competition on bank relationships. First I investigated which kind of external funding is preferred by firms located in competitive areas. Special attention was paid to innovative firms and potential effects of localization and industrial specialization. As a result, local overall industrial specialization seems to encourage the use of multiple bank relationships, while firms located in diversified areas have c.p. less bank relationships. This effect is even stronger for innovative firms located in diversified areas. These results underline the relevance of the availability of bank relationships for industrial and innovative characteristics of the local economy. Another finding was that firms' opacity as indicated by the positive coefficient for firm age (higher firm age allows for longer track record) and the negative coefficient for the share of intangible assets (lower availability of collateral) plays a significant firms' bank relationship type.

For opaque firms, the exchange of soft information with their lenders can be a relevant fact that allows them to achieve external funding and/or maintainable loan conditions. This demands personal contact that reduces information asymmetries. As a result, the lending bank's risk is decreased on the one hand, as additional information allows for better estimation of borrower's default risk. On the other hand, frequent exchange affords transport costs and is thus costly. Therefore, the demanded loan rate either charges higher risk premia or transport costs to distant opaque borrowers. Whether informational asymmetries between borrowers and lenders are aggravated by increasing spatial distance and priced by higher loan rates is analyzed in chapter 4. From the empirical analysis using German firm-level data I find that firms relying on relationship lending have to bear higher loan rates if their financing banks are located farther away. In line with the results in chapter 3, I find that the number of banks in the vicinity of the firm and a lower share of tangible assets increase the probability to engage in single bank relationships.

Again, these results indicate that being able to offer collateral goes in hand with using multiple bank relationships. But changing the point of view, we should consider whether banks benefit from replacing thorough monitoring of opaque borrowers by relying on collateral[51] and what risks could arise from real estate as one of the major instruments of loan collateralization. Being spatially close to real estate markets could allow superior estimation of future prices, as non-codified information (e.g. rumors about future building developments or economic regional trends) are stuck in the area. In chapter 5, I analyze whether growth of local real estate prices affects risk taking of German savings banks. Expecting future price growth from past increases in real estate prices could induce savings banks to increase the ex ante risks of their loan portfolios, as lower losses given default could be realized when real estate as collateral increases in value. On the other hand, higher ex post risks would suggest that savings banks do not estimate loan risks correctly when confronted with real estate price growth. Analyzing data of German savings banks, I do not find local real estate prices to affect risk taking of savings banks to a notable degree, whereas unemployment rate, i.e. more immediate local economic development does. Concluding, there is some dependency of savings banks on the local economy as a whole, but risk taking is not affected notably by local real estate prices.

Considering the results of the empirical analyses and putting them together, there is clearly some interdependence between banks' policies and the corporate landscape on a local level. While firms benefit from banks offering a variety of specialized financial services and granting loans to opaque

[51] see Manove et al. 2001

enterprises, banks depend on the well-being and growth of their borrowers. The reduction of information asymmetries by spatial proximity therefore seems to benefit economic development. This is emphasized by the close connection of the aspects discussed here: Externalities of local industry specialization or diversification only can happen up to some distance. If many firms try to take advantage of those externalities and try to locate within a certain area, real estate prices will increase. Consequently, the location of firms could affect their bank relationships not only via local industrial patterns or competition, but also via the distance towards lenders.

Distance thus affects informational exchange between firms when it comes to externalities related to industrial specialization and it impedes informational exchange between borrower and lender as well. While the effect of the spatial distance towards competitors on firms productivity is not clear, higher distance towards lenders virtually is always affiliated with higher information asymmetries. While firms try to stay informationally opaque to their rivals, they should be transparent for banks in order to obtain credit.

There has been much progress w.r.t. techniques for sharing information and enabling frequent communication over distances. These developments have increased distances between borrowers and lender over time (s. Brevoort and Wolken 2009). The most crucial question concerning the topics discussed here thus is to what degree technology can replace human personal interaction. E.g., non-codifiable information can be transferred using videos, rumors concerning a potential costumer can be retrieved using social media and data bases for the evaluation of smallest geographical entities for real estate valuation can be found online. Hence, the proclaimed death of distance seems to be close.

Yet, fairs and business trips still seem to matter, as well as personal exchange at workplaces, which still is a valid explanation for hardly affordable rents and firms locating in spatially close clusters. Therefore, it could as well be possible that there is no death of distance - only the type, quantity and quality of information that are exchanged in personal or impersonal ways is adapted to commercial requirements and existing technologies.

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