Essays on local banking markets

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Introduction

"Finance is, as it were, the stomach of the country, from which all the other organs take their tone."

- William Gladstone, *The former British Prime Minister*

The financial system executes the pivotal economic function of facilitating the flow of funds from those with surplus funds to those with a lack of funds. In other words, the financial system enables net spenders to borrow from net savers. Funds can be transferred directly via financial markets through issuance and trading of securities which are claims on the borrower's future income or assets (market-based finance) or indirectly via banks and other credit institutions (bank-based finance).

A large strand of literature is devoted to address the question whether the design of the financial system matters for economic growth. Some economists do not consider the role of finance in economic growth to be important. For example, Lucas (1988) states that the relation between financial development and economic growth is overstressed. Furthermore, Robinson (1952) asserts that "where enterprise leads, finance follows". This belief implies that as economy evolves it boosts demands for financial services and, therefore, the financial system reacts to these demands.

Other economists, following the influential work by Schumpeter (1911), strongly believe that one of the crucial aspects of a well-developed financial system is an effective allocation of funds that fosters economic performance. Meanwhile, such a well-functioning financial system accompanied by a well-developed legal system, should comprise features of both direct and indirect finance. Nevertheless, the underlying mechanisms that describe the beneficial effect of financial development on economic growth is still not clear.

In the interim, numerous studies of economic theory emphasize that banks offer different services to the economy compared to securities markets, indicat-

ing that market- as well as bank-based financial systems will have independent impact on economic development. Banks provide a short-maturity funding source that necessitates frequent renewal. Indeed, some economists argue that banks have a comparative advantage in mitigating the market frictions associated with financing shorter-term, well-collateralized, standardized endeavors, whereas more novel, longer-run, higher-risk projects that rely more on intangible assets are financed more effectively by selling securities on financial markets (e.g., Rajan (1992), Holmström and Tirole (1993), Acemoglu and Zilibotti (1997), Allen and Gale (1997), and Boot and Thakor (1997)). Saying differently, market-based financing is beneficial for industries characterized by continuous technological progress where there is little agreement on firms' management while bank-based financing is optimal especially for those who face strong information asymmetries such as adverse selection and moral hazard since banks have better competence in the assessment of projects and in the differentiation between good and bad borrowers. Black (1975) argues that a bank bears relatively lower costs of monitoring a borrower by observing the way the borrower manages its demand deposit accounts which are usually provided to the loan recipient. Moreover, a bank offers a wide range of other services to its clients such as managing accounts receivables or managing the asset portfolio. The aggregate of all these activities, known as "relationship lending", gives superior knowledge and yields an information power to a bank over its customers. The economic literature on "relationship lending" shows that banks can facilitate to diminish the negative impact of sudden economic shocks and financial distress on their clients (Bolton and Freixas (2000)).

The aim of this dissertation is to contribute to the literature on the financial development by providing an analysis on local banking markets, their determinants and the role in economy. Given the above considerations, I start with an investigation of the role of local banking markets itself for economic perspectives. More specifically, Chapter 1 is devoted to the importance of local banking market development on firms' conduct of R&D. Using a unique data set which comprises the KfW SME Panel and bank branches information in Germany we study the impact of local banking development on probability to perform R&D (extensive margin) by small and medium size entrepreneurs (SMEs) and then on the volume of their investments in such activities (intensive margin). Employing an instrumental variable (IV) approach which uses historical and legal features of the strongly regionally oriented German banking system, our

results suggest no or even a negative relationship between the development of a local banking system and the R&D activities of firms located in that regions. This applies to both the extensive and intensive margin.

In Chapter 2, another characteristic of local banking markets is exploited. Namely, the paper investigates whether more or less concentration on local banking markets is better for regional growth. The former is measured by the Herfindahl-Hirschman concentration index (HHI) whereas the latter is represented by the macro- as well as micro-level variables. Whereas the obtained results do not find any significant effect for East Germany the empirical evidence suggests that more vigorous banking competition in the West German banking markets that is associated with lower value of the HHI at NUTS 3 level increases labor productivity and unemployment rate as a result of more effective employers. Better banking competition also promotes firm creation while stronger concentration in regional banking markets is beneficial for firms population and their size.

Chapter 3 addresses the following questions: Why do countries differ in the development of their financial systems? What factors influence it? Chapter 3 presents a study with the focus on the effect of public debt on local banking market development in Germany. The provided analysis is distinctive in several aspects. First, the role of government borrowing for banking market development still remains underappreciated in empirical literature although its essential importance is unequivocal according to theory. Second, in comparison to other studies that mostly provide a cross-country investigation I analyze an intranational heterogeneity in the degree of financial development and public debt. Third, to the best of my knowledge this is the first study examining the determinants of financial development for Germany. The obtained results reveal an adverse effect of more government debt on local banking market development.

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Chapter 1

Does local banking market development matter for R&D? Evidence from German SMEs[1]

Guenter W. Beck and Assem Khussainova

1.1 Introduction

Research and development (R&D) activities are key ingredients for firms' innovativeness and competitiveness which in turn are essential for a country's aggregate productivity and economic growth (Solow, 1957). Interestingly, even though R&D investments are associated with considerable sunk costs and relatively larger firms are able to exploit economies of scale advantages, the contribution of smaller firms to overall R&D investment is not only large but there is also evidence that their investments are more productive than those of larger firms (see, e.g., Acs and Audretsch, 1988, and Brown and Petersen, 2010).[2] Considerable challenges for the implementation of an R&D project can arise when a firm's available internal means are not sufficient to realize it

[1]We are very grateful to the KfW for providing us with the data used in this paper. We are in particular thankful to Michael Schwartz for his invaluable assistance in dealing with the data and his very useful suggestions and comments. Guenter Beck furthermore would like to thank the Institute for Monetary and Financial Stability (IMFS) for its hospitality while part of this research was carried out. The usual disclaimer applies.

[2]A theoretical justification for this fact is, e.g., provided by Holmström (1989) who points out that the optimal mix of activities for a larger firm favors (easy to measure) routine tasks at the costs of (hard to measure) innovation activities.

and as a consequence external funds are needed. Since R&D investments are generally not only very risky but are also associated with the build-up of an intangible (knowledge) rather than a physical asset that can be more easily used as collateral (see Hall and Lerner, 2010, Section 2), asymmetric information problems and agency costs as pointed out amongst others by Leland and Pyle (1977) arise leading to potentially considerable gaps between the internal and external costs of financing R&D. Due to their generally perceived larger degree of opaqueness, this in particular applies to SMEs.

Numerous empirical studies have examined the importance of the availability of external financial funds for the conduct of R&D activities both at the extensive and intensive margins. With respect to SMEs, one strand of the literature - as represented, e.g., by Benfratello, Schiantarelli, and Sembenelli (2008) and Alessandrini, Presbitero, and Zazzaro (2009) - analyzes the impact of the development of the banking market in which a firm operates on its innovative behavior. The major rationale underlying this link is that a denser bank branch network helps to overcome asymmetric information problems (in particular by producing soft information) and thus contributes to reduce external finance cost gaps.[3] Since in particular smaller firms tend to depend relatively strongly on banks in order to obtain external financing a better developed local banking system should thus be associated with more funding and thus higher innovation activity. The evidence provided by Benfratello, Schiantarelli, and Sembenelli (2008) and Alessandrini, Presbitero, and Zazzaro (2009) supports this claim by showing that Italian firms exhibit a higher propensity to conduct process innovations in regions characterized by a higher bank branch density. The evidence for product innovation is weak though.[4]

The aim of our paper is to extend the scarce empirical literature on the relationship between banking market development and the scope of R&D

[3]This literature implicitly assumes that asymmetric information problems are positively related to the geographic distance between a bank (branch) and its firm customer. Some authors have argued that recent developments in banking lending technologies have reduced the importance of this relationship (see, e.g., Petersen and Rajan, 2002). In their overview paper, Brevoort and Wolken (2009) document, however, that distance appears to play still a prominent role in bank-firm relationships.

[4]Another, by far more comprehensive literature analyzes the extent to which a firm's financial constraints - normally measured by the sensitivity of its investment to cash flows - affects its innovation decisions. While not completely univocal in its conclusions, this type of studies tends to find a negative impact of financial constraints on R&D behavior, particular for U.S. firms. Hall and Lerner (2010, Section 4) review and discuss the empirical measures employed and the results obtained.

activities. More specifically, we follow the above referenced literature on the impact of regional financial markets going back to Guiso, Sapienza, and Zingales (2004) and use regional banking market and firm data. Our data stems from East Germany and combines information on activities of a large sample of mostly small and medium-sized firms with local bank branch information over the period 2002 - 2015. Data from Germany are very well suited for such an analysis. Germany is considered a bank-based system (see Bundesbank, 2012) where external financing in particular by SMEs strongly depends on banks. Moreover, relationship lending plays an important role, a feature that - according to evidence by Memmel, Schmieder, and Stein (2008) - has despite major innovation in the financial sector not fundamentally changed in recent years.

Unlike most related existing studies using firm-level survey data, our sample comprises both manufacturing and service-sector firms. As pointed out, e.g., by Bitran and Pedrosa (1998), Gallouj and Djellal (2011) and Ettlie and Rosenthal (2011) the peculiar nature of the production process in the service industry is likely to make asymmetric information problems more severe for these firms relative to their counterparts in the manufacturing sector. This has mostly to do with the fact that services generally represent intangible goods that are highly tied to consumers. The former feature makes it difficult to assess their value generating uncertainty for potential external investors. The latter property is associated with a threat for imitation by rivals decreasing a firm's incentives to innovate. Given these considerations, we would expect that problems to raise external funds for innovation purposes are larger for service-sector firms and thus the local banking market development should have more pronounced effects on these firms compared to their manufacturing counterparts.

An important contribution of our study is that we provide a causal identification of the link between local banking development and firms' R&D investments. One crucial challenge for empirical studies of the type we conduct relates to likely endogeneity problems resulting either from reverse causality and/or omitted variables. To overcome these problems, we employ an instrumental variable approach. To construct an appropriate instrument for the local banking system, we exploit a historical feature of the banking system of the former German Democratic Republic (GDR) which now constitutes East Germany. More specifically, we use the fact that the banking system under the former socialist government system was centrally planned and basically didn't fulfill

any major banking functions such as in particular the efficient allocation of financial resources in the economy. As we outline in more detail below, the development of the banking system in the GDR was mostly driven by centrally made decisions and mostly not related to local economic conditions. In using this instrument we follow and complement a literature that includes studies by Benfratello, Schiantarelli, and Sembenelli (2008), and Alessandrini, Presbitero, and Zazzaro (2009) that employ historical features of the banking system of a country to control for its current state.[5]

Somewhat surprising, our results suggest that the local banking development has no or even a negative impact on the R&D behavior by firms. This is true for decisions both at the extensive and in particular intensive margin. This finding suggests that negative impacts associated with a denser bank branch network quantitatively dominate its positive consequences. Such negative effects can result from higher costs of a denser branch network leading to higher borrowing costs and less investment, the potential exertion of influence of bank lenders towards undertaking relatively less risky investments compared to R&D investments in the presence of relationship lending and better screening in the presence of more information preventing relatively less promising R&D projects from being realized. Unfortunately, data limitations do not allow us to derive a conclusive assessment with respect to the relative importance of these three channels. As theoretical reasoning suggests we moreover show that the impact is particularly pronounced for smaller firms, for younger firms, limited-liability firms and service-sector firms. The results also suggest that gloomy economic prospects negatively impact the relationship.

The rest of the paper is organized as follows: Section 1.2 contains a description of our data sets and provides some descriptive statistics. The econometric approach employed and the instrument used are presented in Section 1.3. The obtained results are presented in Sections 1.4 and 1.5, while Section 1.6 summarizes and concludes.

[5]All of these cases focus on Italy. The employed instruments were first used by Guiso, Sapienza, and Zingales (2004) who also provide for an extensive discussion of their appropriateness.

1.2 Data and descriptive statistics

For the purpose of our study, we have compiled a unique data set of East German firm, regional bank branch and macroeconomic information to be described in more detail in the following. Our definition of a local market makes use of the so-called NUTS classification system of the Statistical Office of the European Union, Eurostat.[6] More specifically, we characterize local markets to correspond to the so-called NUTS 3 regions. NUTS 3 areas comprise small regions corresponding mostly to city and rural districts. Currently, East Germany (without Berlin) is split into 76 NUTS 3 regions.[7]

Our identification of local markets is motivated by a major characteristic of the German banking system according to which the activity area of by far the largest number of banks is restricted to the region in which their head office is located. More specifically, this so-called "regional principle" applies to both public savings and cooperative banks which comprise more than 70% of all banks operating in Germany. In the overwhelming majority of cases, the geographical delineation of a region corresponds to that of NUTS 3.

1.2.1 Characterizing local banking markets

Analogously to arguments raised by Benfratello, Schiantarelli, and Sembenelli (2008) or Minetti and Zhu (2011) for the case of Italy, we think that information on regional banking markets can be employed to capture local financial development in Germany. This claim is motivated by the well-established fact (see Langfield and Pagano, 2016, for a very recent exposition of this fact) that Germany is characterized by a strongly bank-based financial system where the major source of external financing for SMEs is still provided mostly by bank loans as also documented in the recent survey by European Commission (2016).

To construct our variable for the development of local banking markets

[6]NUTS is the short form for "Nomenclature of territorial units for statistics". It represents Eurostat's official classification system for dividing up the economic territory of the EU for the purpose of the collection, development and harmonization of European regional statistic and socio-economic analyses of the regions. For more detailed information, see Eurostat (2015).

[7]The NUTS classification system is made up of three hierarchical levels: Each member state is divided into so-called NUTS 1 regions, which in turn are subdivided into NUTS 2 regions and then divided further into NUTS 3 regions. In East Germany, e.g., there exist 5 NUTS 1 regions (which correspond to the German states (Länder)), 7 NUTS 2 regions and 77 NUTS 3 regions.

we compiled a unique data set which comprises the location and type of the branches of banks in East Germany. Our measure for the development of local banking markets corresponds to the number of branches per person in a given region. This measure is widely used in the literature and has, as Benfratello, Schiantarelli, and Sembenelli (2008) point out, the advantage of providing for a statistics which is robust across time and regions.

Figure 1 and Table 1 reveal that there exists considerable cross regional heterogeneity in bank branch density with a region at the 90th percentile exhibiting a branch density almost twice as large as that of a region at the 10th percentile. Over time, the distribution has somewhat shifted to the left and the overall distribution has slightly declined, however, the gap between high and low-density regions is still considerable. Moreover, the figures show that the geographically constrained savings and cooperative banks by far constitute the largest proportion of local bank branches with a share of around 50% and 30%, respectively, supporting our choice of local markets.

1.2.2 Firm data and characteristics

Our firm data stems from the SME Panel of the KfW bank (in German: *KfW-Mittelstandspanel*). The KfW SME Panel constitutes an annual representative survey of around 10,000 firms with total sales not exceeding 500 million euros. It has been conducted since 2003 and covers all sectors with the exception of the public sector, banks, and non-profit organisations. Questions asked comprise queries on general firm characteristics (such as the year of establishment, the sector or the legal form), employment, competitive environment, investment and financing activities, innovation and export behavior, and balance sheet records in the year preceeding that of the respective wave. Following the industry classification system by the German Statistical Office (WZ 2008), firms are assigned to one of the following sectors: manufacturing, services, wholesale and retail, construction. Analogously to comparable studies, we restrict our sample to the manufacturing and service sector only.[8] We employ 14 waves of the SME Panel comprising business activities for the periods 2002 to 2015.

The descriptive statistics reported in Table 2 show that around 40% of all firms included in our manufacturing sector sample report that they have

[8]For more information on the KfW SME Panel, see https://www.kfw.de/KfW-Group/KfW-Research/KfW-Mittelstandspanel.html.

conducted R&D investments in a given year. The figures for the R&D volumes indicate that manufacturing firms that conduct R&D on average spend 2.7% of total sales on this activity. However, there exists sizeable heterogeneity across firms. When grouping firms by size, we see that micro firms spend least on average, whereas small firms exhibit the largest R&D expenditures. Manufacturing firms are on average fairly small with average employment figures begin equal to around 45. While most of the firms are limited liability firms a remarkable portion of around 30% are organized in the form of fully liable partnerships.

The numbers for the service-sector sample are in general more moderate. Comparing with its manufacturing counterpart, an average service firm is younger and smaller though in the same size category. Similarly, service firms conduct less R&D and devote smaller part to the corresponding investments: Only 13% of them are involved in performance of R&D which invest 1.7% of total sales to carry out such activities. Differentiating firms by size depicts dissimilarities in innovative behavior across enterprises. Unlike the manufacturing sector the highest proportion of spendings on R&D is executed by medium-sized firms which are also mostly engaged in R&D activities.

1.3 Econometric approach

We design our empirical analysis as follows. First, we follow the simple linear probabilistic approach to explore a causal link between finance and R&D controlling for firm- and region-specific characteristics. In Section 1.3.2 we provide justifications and hypotheses with regard to the impact of control variables. Next, addressing a potential endogeneity problem we introduce the instrumental variable approach in Section 1.3.3. Before we present the empirical methodology we shortly outline major underlying theoretical considerations though.

1.3.1 Theoretical considerations

In their survey, Brevoort and Wolken (2009) provide an overview of theoretical considerations why distance might matter in banking. In doing so, they emphasize the importance of transportation and information costs both of which are positively related to the physical distance between a bank and its

customers. As a consequence, smaller distances between banks and firms should be associated with better financing conditions of the latter. Employing measures for the local branch density network as a proxy for the development of local banking systems, the empirical evidence has tended to support this view.

However, there also exist reasons why a denser branch network might be associated with less external bank-based financing leading firms to realize lower levels of R&D activities or no such activities at all. Taking into account that in the majority of cases the local banking branch network is dominated by the respective regional savings and cooperative banks, an obvious reason for a potentially negative effect is that a denser branch network is associated with higher costs which need to be borne by the borrowers. The implied higher interest rates would in turn result in less financing. Higher cost pressures might moreover strengthen negative effects which a better developed banking system can have on R&D financing and which are summarized in detail in Section 1.7.3. In particular, one can imagine that larger cost pressures increase the preference of banks' loan officers to finance lower-risk activities rather than high-risk R&D investments. Moreover, the higher level of information about the firm available in a denser branch network environment might strengthen a bank's ability to direct a firm's investment decisions towards less risky, i.e., non-R&D projects.

Cetorelli and Peretto (2012) discuss another aspect that might influence the relationship between bank branch density and credit made available to firms. The authors argue that to judge the effects of banks on investment it is important not only to look at the quantity of credit provided but also at its quality. A higher level of bank screening activity might on the one side reduce the volume of loans granted but might on the other hand lead to a better allocation of the financial funds. Following this line of argument, a denser branch network might be associated with less credit for R&D investment but this observation would not necessarily imply a negative qualitative impact on firms' R&D activities but would be just the results of a more intense screening.

The above discussion implies that theoretical considerations might imply either a positive or a negative impact of a denser local bank branch network on the scope of R&D activities of firms. Which effect dominates is an empirical question. Our analysis is intended to shed light on this question.

1.3.2 Econometric model

To examine the impact of the development of local banking markets on R&D activities by firms we employ several regression specifications which all take the following basic form:

$$RD_{ijt} = \beta * BANKDEV_{jt} + \gamma * FIRM_{ijt} + \delta * TIME_t + \theta * REG_{jt} + \varepsilon_{ijt} \quad (1.3.1)$$

where the subindex i is used to denote firms, j indicates the region in which firm i is located and t denotes the time period (year). The variable $TIME_t$ represents time dummies while the term REG_{jt} captures regional control variables given by state dummies and regional GDP.

The dependent variable RD_{ijt} represents the R&D activity of firm i in period t. In our analysis, we examine both the extensive and intensive margins of R&D investments. In the former case, the variable RD_{ijt} is binary, taking the value 1 if the firm conducted R&D investments in the year preceding the respective survey and 0 otherwise. When intensive margins of R&D are examined, investment volumes normalized by a firm's total sales are considered.

The term $FIRM_{ijt}$ represents firm-specific control variables. Variables included in this category comprise information about a firm's size, its age, its legal form, the share of high-educated employees, its export status and indicators for its financing behavior. There are several channels which might induce a relationship between a firm's size and its R&D activities, the direction of which is not clear ex ante though. Referring to Schumpeter (1942) and Galbraith (1952), Cohen (2010) lists in his survey article a variety of reasons why one might find a positive relationship between firm size and innovative behavior. These include economies-of-scale and economies-of-scope advantages, better risk-pooling abilities and improved access to external finance by larger firms. On the other hand, the loss of managerial control or excessive bureaucratism arising in large firms might make innovation processes in these firms less efficient. The empirical evidence reviewed by Cohen (2010) suggests that while R&D activities appear to be positively related to firm size, this relationship is generally less than proportional. Moreover, other factors such as the size composition of firms in a given industry, the nature of the production process and the composition of the work force determine the relative size of R&D activities by small and large firms. Confirming Acs and Audretsch (1990) who have emphasized the important role of small firms for innovation, Akcigit and Kerr (2018) provide

evidence of a negative relationship between firm size and R&D investments in new products. In our empirical specifications, firm size is measured by the number of full-time employees.

Similarly to size, a firm's age might be positively or negatively related to its R&D activities. On the one hand, referring to evidence by Acs and Audretsch (1990), Baumol, Litan, and Schramm (2007) point out that younger firms tend to be more innovative. Moreover, they argue that so-called radical (rather than incremental) innovations tend to be disproportionately developed and brought to market by single individuals or new firms. On the other hand, younger firms tend to be more credit constrained implying potential impediments to their innovation projects. Brown and Petersen (2011), e.g., show that younger firms tend to use cash holdings to smooth R&D expenditures from transitory shocks to finance whereas more mature and thus less financially constrained firms do not do so.

With respect to its legal form, we expect to find a higher degree of R&D performance for limited liability firms. The reason is that as pointed by Blankenburg, Plesch, and Wilkinson (2010) and Dignam and Hicks (2011) limited liability stimulates risk-taking, so limitations on the size of losses to bear in case of unsuccessful R&D investments might increase the willingness of entrepreneurs to undertake such investments. On the other hand, the existing limitations on loss bearing might deter external finance provider, in particular risk-averse banks. This latter effect might be somewhat muted by the publication obligations that tend to be higher for limited liability firms. A positive relationship is also anticipated to exist between a firm's share of highly educated employees and its R&D activities reflecting the implied higher skill level. Evidence supporting this conjecture was found, amongst other, by Adams, Chiang, and Jensen (2003) and Garcia and Mohnen (2010).

Exporting can positively impact innovative behavior for two reasons: First, it might induce learning by bringing the firm into contact with foreign customers. Secondly, exporting firms face increased competition in foreign markets inducing them to involve more in innovation processes. Empirical evidence as, e.g., surveyed by Wagner (2007), Keller (2010), Harris and Moffat (2011) and Love and Roper (2015), supports the existence of such a positive effect even though its quantitative size might not be large.[9]

[9]The cited survey articles also discuss the issue of reverse causality between export and innovation. It appears that the link from innovation to exports is quantitatively considerably

Since as first noted by Nelson (1959) and Arrow (1962), R&D investments exhibit characteristics of a public good and private returns from such an investment are below the social returns underinvestments can occur. Moreover, frictions in financial markets associated with asymmetric information problems can impede private financing of R&D. To counteract resulting deficits in innovation activities, public financial support programs have been globally installed. The majority of empirical studies generally finds positive effects of these programs supporting the so-called "crowding-in" or "additionality" hypothesis, see Becker (2013, Section 3.4) and Zúñiga-Vicente et al. (2014) for recent surveys of this literature.

Given that in particular smaller firms generally have larger problems in financing R&D activities employing external debt, the amount of internal financial resources available can be anticipated to positively impact R&D activities. Such a positive effect is, e.g., found by Ughetto (2008). Mixed evidence on the importance of cash flow on R&D across countries is provided amongst other by Bond, Harhoff, Van Reenen, et al. (1999). Brown and Petersen (2011) show that firms use their cash holdings to smooth R&D expenditure against liquidity shocks.

1.3.3 Instrumenting regional banking markets

Our regressions potentially suffer from two drawbacks which can bias the coefficient on the impact of local banking market development on the dependent variable. First, it is easily conceivable that unobserved variables impact both the banking market variable and the respective dependent variable. Examples of such unobserved variables include (local) tax incentives or political decisions. Secondly, there might exist a reverse causality problem in the sense that regional firm development itself may attract banks and, thus, the local banking network may be the outcome, rather than the cause of the local economic performance.[10]

To overcome these potential problems we employ an instrumental variable approach. To be valid as an instrument, a given variable needs to satisfy two requirements, namely the so-called relevance condition, which states that the instrument needs to be correlated with the local banking sector development or the supply of credit (endogenous variable of concern) and the exclusion

stronger than the one in the opposite direction.

[10]See Robinson (1952) for an early exposition of the view that the direction of causality between the real and financial side of the economy goes from the former to the latter.

restriction, which requires that the instrument needs to be uncorrelated with the regional characteristics (other than through its correlation with the banking sector development) that can affect the banking market or firms performance. Our instrument which has not been employed in the literature so far is based on information on the banking structure immediately after the break-down of the former German Democratic Republic (GDR) in 1990. In the following, an exposition of why these instruments are appropriate to address the endogeneity problem is given. In doing so, we follow Wooldridge (2010) and provide formal tests of the respective relevance condition while we underpin the not formally verifiable exclusion restriction with narrative arguments and suggestive evidence.

The banking system of the former GDR was heavily influenced by the economic system of the country.[11] As other Central and East European countries, the GDR had implemented a system of a centrally planned economy whose two major characteristics were: (i) collective ownership of the production factors and (ii) central planning and steering of the economy. The latter aspect implied that the decentralized entities of the banking system were obliged to fulfill the objectives determined in the centrally decided economic plan and had no or only extremely limited own decision powers.

The banking system of the former GDR consisted of six major groups: the national bank ("Staatsbank"), the bank for agriculture and food ("Bank für Landwirtschaft und Nahrungsgüterwirtschaft (BLN)"), savings banks ("Sparkassen"), cooperative banks for farmers ("Bäuerliche Handelsgenossenschaften"), cooperative banks for crafts and trade "Genossenschaftskassen für Handwerk und Gewerbe") and post banks ("Postbanken").[12] Of these institutions, the national bank was by far the most important one whereas the other groups only fulfilled rudimentary banking functions. Moreover, all of them were under the direct or indirect control of the national bank. The tasks of the national bank were not constrained to the conduct of monetary policy and control of the banking system but it also provided credit to the economy. More specifically, whereas the bank for agriculture and food was in charge for making loans to the agricultural and food sector, the national bank provided funds to the entities

[11] The exposition of the relationship between the economic system of the GDR and its banking sector is based on Mülhaupt and Fox (1971).

[12] See Ehlert and Dietrich (1985). Additionally, two central financial institutions (German bank for foreign trade, LTD, and German bank for trade, LTD.) existed which were involved in international transactions.

of the remaining public sector of the economy which as a whole comprised 96.5% of overall production and 94.7% of overall employment.[13] The remaining "retail" banking sector (in particular, the cooperative banks for crafts and trade) which is at the core of today's banking sector supplied - and was allowed to do so only - funds merely to a vanishing part of the economy. Moreover, these lending activities were strictly regulated including the interest rate at which a loan was made. The same was true for lending activities with respect to private households.

The major functions of the other banks, thus, were not the provision of funds to the real economy. They played an important role in the context of the payment systems and they had the task of collecting funds from households. The branch network was supposed to fulfill this function. During its existence, this network underwent three major restructurings which were very strongly (and partly exclusively) politically motivated. As a result, a branch network resulted which was on the one side very thin compared, e.g., to that in West Germany and on the other side heterogeneous across regions depending mostly on how "successful" the various restructuring waves had been in a given region. Overall, one can conclude that the branch network of the savings and cooperative banks in the GDR was determined by political motives, centrally planned decisions and local economic conditions whereas the respective local economic development did not play any major role.

To illustrate the exclusion condition, we take regional GDP as a proxy of the regional characteristic that might impact the banks and firms operations. Figure 2 plots the bank branch density in 1990 versus GDP per capita at that time. Unfortunately, reliable regional GDP data are not available for East German region for the year 1990 in the course of which the Statistical Office of the GDR ceased collecting data based on its established practices which were not harmonized with those of the West German Statistical Office. Starting from 1991 onwards data in East Germany were collected based on the West German standards, regional data were made publicly available only from 1992 onwards though. Thus, in Figure 2, GDP per capita in 1992 is used as a proxy for its value in 1990. Given the high persistence in GDP and the very short time difference, we would expect that the 1992 value is very highly correlated with its 1990 value. Figure 2 suggests that there is only a very weak and

[13] See Staatliche Zentralverwaltung für Statistik der Deutschen Demokratischen Republik (1990).

even slightly negative relationship between the number of bank branches and economic development in 1990. This impression is confirmed by the results from a formal regression analysis. When branch density is regressed solely on GDP per capita (Table 19, column 1) we obtain a small negative significant coefficient which vanishes if we include a city dummy (Table 19 column 2). Overall, these results suggest that branch density in 1990 satisfies what is very often called the "exogeneity condition" of serving as a valid instrument.

The second condition for an instrumental variable to be valid is that there is a high correlation between the instrument and the variable to be instrumented. This often denoted "relevance condition" is also obviously satisfied as Figure 3 and column 3 of Table 19 show. The graph clearly exhibits a positive relationship which is reflected in the highly significant coefficient which we obtain when we regress the average bank branch density between 2010-2012 on its value for 1990.

1.4 Base results

Following the above expositions, we now turn to our results on the impact of local banking market on firms' R&D activities considering both decisions at the extensive and intensive margins. We start by discussing results obtained from employing a logit and a linear probability model both for the manufacturing and the service sector. We then proceed by controlling for potential endogeneity problems using an IV approach.

1.4.1 Local banking markets and the propensity to conduct R&D

The results for the baseline logit and linear regression specifications for the sample of manufacturing firms are presented in columns 1–6 of Table 3. Comparing the outcomes for the logit and linear probability model we can see that marginal effects are either the same or very close for both specifications. Considering the findings for the firm-specific characteristics, we can moreover observe that, as expected, generally all of them indeed play a significant role for the decision to conduct R&D.

Consistent with the view that younger firms are more credit constrained and thus face obstacles in attracting external finance, our results indicate that

being old increases the probability to conduct R&D: All other things equal, the probability to invest in R&D is around 3% higher for these firms. As expected, the share of highly-educated employees is positively related to the decision to innovate: A 10 percentage point increase in this variable is associated with a more than 3% higher probability to perform innovative projects. A - as expected - positive effect is also obtained for the legal form indicator variable. Our estimates reveal that limited liability firms exhibit a significantly higher R&D tendency than their unlimited liability counterparts.

Concerning firm size, our results suggest that the relationship between this variable and the propensity to innovate tends to be positive supporting the view that firm size improves conditions for conducting innovation projects. More specifically, the likelihood to conduct R&D is smallest for micro firms followed by small firms. The highest probability is found for medium-sized firms while the largest firms contained in the sample rank second. The obtained results are highly significant and robust across specifications. Considering the pattern of the reported figures, the findings are moreover indicative for a reverse U-shaped form of the link between a firm's size and its tendency to carry out R&D with the highest value applying for medium-sized firms (number of FTEs between 50 and 250). The finding of a slightly declining innovation propensity in the largest firm category hints at the existence of potentially negative innovation forces in these firms discussed in Section 1.3.2.

In our second regression specification (columns 2 and 5), we add information on the export and public-funding status of a firm. As expected, a positive export status is associated with a higher probability to conduct R&D: According to our results, firms that export have a 30% higher tendency to invest in R&D than those that do not. Unfortunately, we cannot determine whether this finding is caused by learning from export or the implication of the reverse causality effect discussed above. Receiving public support also inclines firms to perform R&D. Ceteris paribus, firms that are publicly funded have an around 10% higher probability to undertake R&D activities than those that do not.

In a third regression specification (columns 3 and 6), we include a measure of the availability of internal funds, given by the ratio of cash flow to total sales. Unfortunately, information on this variable is available only for a subsample such that no full comparability with the so far reported results is possible. Unlike expected, the value of the coefficient on internal funds turns out to be negative indicating that firms with higher amounts of internal cash are

characterized by lower probabilities to conduct R&D.

Summarizing, the results for the firm-specific variables are qualitatively and quantitatively mostly consistent throughout specifications and are - with some caveats - in line with the theoretical considerations outlined in Section 1.3.2.

A qualitatively similar conclusion can be drawn for our banking variable. Unlike Benfratello, Schiantarelli, and Sembenelli (2008) in their study on the relationship between local banking markets and firm innovations in Italy, we find a negative rather than a positive relationship. Our results thus suggest that the deliberations outlined in Section 1.3.1 indeed play a role and tend to counterbalance the positive effects on firm activities that are generally attributed to a better developed banking sector, in particular on those other than R&D. There are two aspects that need to be noted though. First of all, the documented effects tend to be fairly small quantitatively. An increase in the number of banks per 10,000 inhabitants by one standard deviation (measure for the year 2002) decreases the likelihood to conduct R&D on average only by about 1%. Secondly, while the sign of the estimated coefficient is negative and robust over specifications the reported values are mostly statistically not significant.

The results for our service-sector sample, reported in Table 4, are qualitatively broadly comparable to those for the manufacturing sector, there exist some quantitative differences though. As for manufacturing firms, both the share of highly-educated employees and the legal structure in the form of limited liability are positively associated with the tendency of a firm to engage in R&D. However, the sizes of the coefficients are considerably smaller than reported above implying quantitative effects that are around 1/3 lower. Similar conclusions apply to both the export and the public subsidy variables. Both variables have a significantly positive effect supporting the learning by export or the competitiveness effects from international markets for the former and the potentially benign effect of public finance in the presence of underinvestment in R&D in the latter case. Introducing internal finance into the regression leads to a positive but insignificant estimate for this coefficient within the resulting smaller subsample.

The patterns for the relationship between firm size and R&D activities reflect those for the sample of manufacturing firms qualitatively, however, again there exist some noteworthy quantitative differences. Most notably, we again observe a reverse U-shaped pattern with medium-sized firms exhibiting the

highest propensity to conduct R&D followed by small SMEs whose figures are only slightly higher than those for large ones. Moreover, estimates for large firms are not robust across specifications in the sense that some values are not statistically significant, and sometimes even negative (though not significant) results are obtained. Again, this observation is consistent with the view that size does not only provide advantages but also disadvantages concerning the conditions for conducting R&D.

Unlike in the manufacturing firm sample , the age variable now has a - statistically significant - negative sign indicating that firms older than 8 years have an around 2 to 3% lower probability to conduct R&D than their younger counterparts. This result suggests that the observation by Baumol, Litan, and Schramm (2007) according to which in particular young firms engage in innovative activities appears to outweigh the informational disadvantages of these firms in the German service sector whereas the opposite is the case in the manufacturing sector.

Concerning the impact of the regional banking market development the results mirror those of the manufacturing sample indicating a negative though statistically not universally significant relationship between the two variables. However, significance seems to be somewhat more pronounced compared to the case of manufacturing firms providing support for our intuition that banks consider R&D projects in the service sector as riskier. Summarizing our results both for the manufacturing and service sector, while not being coherently negatively statistically significant nevertheless fairly unanimously refute the hypothesis of a positive effect of a denserly local banking market on the tendency of firms to engage in R&D.

1.4.2 Local banking markets and the size of R&D investments

Following the same approach as above, we now examine the question to which extent bank branch density affects the volume of R&D investments, given that a firm conducts R&D. Previous studies have provided evidence that the effects of the local banking market development might be asymmetric in the sense that there is an impact on the intensive margin, i.e., the decision to conduct R&D, but no or only a weak effect on the extensive margin, i.e., the size of the investment in R&D, once a positive decision to do so had been made. These

findings imply that external finance appears to be more important for the decision to conduct R&D than for the volume of investments once the decision for R&D is made. The results for linear OLS models are provided in Tables 5 and 6.[14] The dependent variable in both cases corresponds to the ratio of R&D investments to total sales.

For the manufacturing sector (Table 5), our results suggest that the volume of R&D investments raises with the share of highly educated employees. More specifically, a 10 percentage point increase in the proportion of highly educated coworkers is associated with an increase in R&D spending by around 0.8 percentage points. Likewise, having adopted the legal form of a limited liability firm is associated with a higher R&D expenditures of around 1.5 to 2 percentage points. Both of these values are highly significant and to a large extent consistent across specifications.

Interestingly, a firm's age that tends to increase the likelihood of R&D in the manufacturing sector has a negative effect on the extent of R&D activities where the coefficient is sometimes not significant though. This finding might be related to the view that older firms tend to implement incremental rather than radical innovations which might be associated with comparably larger investment volumes.

Likewise, the results for the coefficients on firm size reveal some patterns providing for interesting complementary insights relative to the findings obtained for the extensive margin. Whereas we found a reverse U-shaped relationship for the tendency to perform R&D our results for the intensive margin suggest that R&D investment volumes decline with firm size where medium- and large-size companies exhibit an R&D investment ratio that is up to 10 or slightly more percentage points below that of small and micro firms. This finding might point to the negative effects of a more pronounced bureaucratism in larger firms which in the case of medium-sized firms does not seem to affect the tendency to invest in R&D but their volume. On the other hand, it might be the case that due to economies of scale and scope effects, the innovation process of relatively larger firms is more efficient and thus relatively less investment is needed.

Regarding the impact of international trade on R&D expenditures, our results document a highly significant positive effect suggesting that firms that export have an R&D investment ratio which is between 1.3 and 2 percentage points higher than that of non-exporting firms. Public support also positively

[14]Results employing logistic regressions are presented in the Appendix.

affects the R&D investment volumes of manufacturing firms. The obtained numbers are also economically significant implying that publicly supported firms have on average a 0.7 percentage points higher R&D investment ratio. As for the propensity to involve in R&D, our findings for the internal finance variable, reported in Column 3 of Table 5, tend out to be negative but not significant.

Turning to the estimate of the regional banking variable, our results not only reveal a negative but this time also statistically highly significant relationship suggesting a diluting effect of banks as discussed in Section 1.3.1. However, the economic significance of the impact is again muted: An increase in the banking density by around 1 standard deviation (year 2002) leads to a decrease in R&D expenditures by only about 0.3 or 0.4 percentage points

Considering our service-sector firm sample, Table 6 presents results that are qualitatively widely consistent with those obtained for the manufacturing firms. There again exist some quantitative differences though. The effect of both the share of higher educated employees and the legal form of a limited liability firm are positive, but around 30% smaller. On the other hand, the negative effect of age is larger. The same is true for firm size where in particular for larger firms a stronger negative effect is found. Exporting and publicly funded firms not only show higher R&D investment ratios but the quantitative effects are considerably more pronounced.

As for the manufacturing sector, the coefficients on the banking variable are negative, however, they are statistically not significant.

Overall, our results for both the extensive as well as intensive margins definitely do not support the idea that the development of the local banking sector has a positive impact on R&D activities but rather indicate that there is no relationship or a slightly negative one. However, it is to be noted that the results reported so far are subject to potential endogeneity problems which are addressed in the next section.

1.4.3 Instrumental variables approach

As Roberts and Whited (2013) emphasize, endogeneity problems are not only likely present in almost any study in empirical corporate finance but can also considerably undermine the credibility of obtained results when not properly addressed. In our case, endogeneity problems might arise as a consequence

of omitted variables which affect both the development of a region's banking sector and the willingness of a firm located in this region to conduct R&D. Examples of such factors are local policies. Moreover, unobserved personal characteristics of members in the management board of a firm might both be related to the R&D behavior of a firm and its ability to raise external funds from banks.

To overcome problems associated with this potential endogeneity bias we apply an instrumental variables (IV) approach. In doing so, we make use of historical and legal characteristics of the German banking system as described in Section 1.3.3 and follow a standard two-step estimation procedure. In the first of the two steps we regress the endogenous variable, i. e., the banking variable, on the instrument plus all other explanatory variables as follows:

$$BANK_{jt} = \mathfrak{b} * INSTRUMENT_{ijt} + \mathfrak{c} * FIRM_{ijt} + \mathfrak{d} * TIME_t + \mathfrak{e} * REG_{jt} + e_{ijt} \tag{1.4.1}$$

In the second step, the fitted, i.e., "cleaned", values $\widehat{BANK}_{jt}$ are used as explanatory variable and equations of the following form are examined:

$$RD_{ijt} = \beta * \widehat{BANK}_{jt} + \gamma * FIRM_{ijt} + \delta * REG_{jt} + \theta * TIME_t + \varepsilon_{ijt} \tag{1.4.2}$$

Extensive margin

The IV results for the linear probability model are presented in columns 7–9 of Table 3 for the manufacturing and Table 4 for the service sector firms. The first observation to notice is that the coefficients on the firm-specific variables change neither qualitatively nor quantitatively in any case. Moreover, their significance levels are mostly unaffected. There are, however, notable changes with respect to the estimated values of the local banking variable. For manufacturing, the coefficients remain negative but the obtained values increase sizeably in absolute terms. An increase in the local bank branch density of about one standard deviation (2002 value) now decreases the likelihood of conducting R&D by 2% to around 3% which corresponds to a doubling of the effect obtained in the OLS/logit case. For the service sector, similar changes are obtained. Coefficients increase notably in absolute terms and turn out to be statistically significant even at the 1% level. Their economic importance increases distinctly suggesting that a one-unit increase in the bank branch density (which corresponds to one standard deviation in 2002) reduces the

tendency to perform innovation projects by 4 to 5% (ceteris paribus). This supports the argument that banking has stronger effects on the financing of R&D of service firms compared to their manufacturing counterparts.

Intensive margin

Regarding the IV estimates for the intensive margin, columns 4–6 of Table 5 for the manufacturing and Table 6 for the service sector firms again indicate no major changes concerning the findings for the firm-specific variables. As for the extensive margin, we can observe noteworthy modifications for the coefficients on the local banking market variable though. These concern the significance and sizes of the coefficients but leave the previously obtained negative signs unaffected. The IV results in both cases suggest that local banking markets have a statistically significant effect which is larger than that obtained for the OLS case. For the manufacturing sector, the reported values imply that an increase in the banking density by one unit implies a decrease in the R&D investment ratio by about 0.7 percentage points. For the service sector, this number tends to be - as expected - slightly greater and ranges between 0.6 and 0.9 percentage points.

Overall, our logit, OLS and IV estimations suggest the existence of a slightly negative relationship between the banking density variable and R&D activities at the extensive and intensive margin for both manufacturing and service sector firms. In our discussion of the included firm-specific variable, we have seen that some of them are expected to impact R&D via influencing the respective firm's ability to attract external finance and thus enabling it to realize a planned innovative project. The same is true for the macro environment that firms face. In the next section, we explore these potential channels further by analyzing their interactions with our banking variable.

1.4.4 Shedding some light on the role of having a bank relationship

One of the reasons why a higher branch density of a local banking market might have a potentially negative effect on R&D activities that we outlined above was that in such an environment the increased amount of information available and the greater closeness to the borrower might strengthen the impact of the bank lender on a firm's investment decisions towards less riskier, i.e.,

non-R&D activities. Underlying this argument is the implicit assumption that firms engage in relationship banking which we justified by empirical evidence on this topic. In this subsection we aim to address this issue in somewhat more detail by employing a variable in our firm survey which contains information on whether a firm had a banking relationship or not in the past. In case a negative impact of banks as described above exists, we should observe that firms exhibiting a banking relationship show lower R&D activities and this impact should even be larger in a relative high-branch-density environment.

To proxy for the existence of a banking relationship we employ a variable which indicates whether a firm used bank credit in a given year to finance its investments. If that was the case the variable take the value one and zero otherwise. It is to be noted that this variable only is indicative for the existence of a long run bank relationship since it could also capture one-time-only loans and loans from a bank which is not the relationship bank of the firm. As an implicit consequence, a negative sign on the banking relationship variable could result from the fact that this dummy variable captures firms in a relatively weaker financial position, e.g., because they have relatively less internal means or their relationship bank rejected a loan request.

Our results for the manufacturing sector support the view that firms having obtained external finance from a bank for investment purpose in the past exhibit less R&D activities. This is true both the extensive and intensive margin. However, it is to be noted that most of the results are not statistically significant. On the other hand, the interaction terms mostly exhibit positive signs suggesting that the positive informational effect associated with a denser bank branch network dominates its negative effect. Results are again mostly not statistically significant though.

For the service sector results are mixed. Coefficients are positive for the existence of a banking relationship at the extensive margin and negative at the intensive margin. The opposite is true for the interaction with the branch density variable. However, again most coefficients are not statistically significant preventing us from drawing unequivocal conclusions on this topic.

1.5 The relationship between local banking density and firm-specific variables

In this section, we examine to which extent the size of a firm, its age, its legal form, and macro-related conditions in which it operates play a role for the impact of the local banking market on a firm's R&D behavior, considering again both decisions at the extensive and intensive margins. As pointed out in Section 1.3.2, such links are suggested in the presence of financial frictions.

1.5.1 Firm size

As is widely acknowledged and was intensively discussed above, the ability of a firm to attract external finance depends on its size with small firms having more difficulties to raise external resources because they are characterized by a larger degree of opaqueness. As a consequence, smaller firms are generally less capable to raise external capital in the form of bonds or stocks and generally have to rely on bank credits or internal means to finance activities. These considerations imply that the development of the regional banking market is particularly important for relatively smaller firms. We thus would expect the channels discussed in Section 1.3.1 to be more important for these firms and thus to find larger effects for the banking market variable when we differentiate firms according to their size. The results presented in Tables 9 and 10 partly provide support for this hypothesis. For the manufacturing sector, the results indicate that in particular small firms are affected by a denser bank branch network. According to the reported figures, an increase of the bank branch density by one unit decreases their propensity to do R&D by around 4% (OLS) and up to around 10% (IV). Similarly, R&D volumes of these firms decrease by almost 2 percentage points when bank branch density raises by one unit. Small service sector firms are likewise strongly affected by the banking variable. The obtained coefficient values for this size class are comparable to those for the manufacturing sector.

In line with our intuition, we also find no statistically significant effect in any of the considered cases for the largest firms included in our sample. Interestingly, the values of the coefficient are moreover not unanimously negative for these firms suggesting that the impact of banks on their activities is distinctly different than that for small firms. Concerning medium-sized firms our results differ

across the manufacturing and the service sector. While the interaction terms are mostly positive but not significant in the former case they turn out to be mostly statistically negative in the latter case. Moreover, the reported coefficients for the service sector are comparable to those for the smaller firms (or are even somewhat larger in absolute terms) suggesting that the bank branch network plays a similar role for these firms as for their smaller counterparts.

Unlike expected, the effects of the banking variable on the micro firms in our sample are only mildly statistically significant or even insignificant. Interestingly, the obtained coefficients very often turn out to be positive suggesting a benign impact of the banking branch density on their willingness to conduct R&D and the corresponding investment volumes. An explanation for this finding might be that micro firms, being aware that they will have problems being able to obtain a bank loan to finance their R&D activities, will primarily rely on internal means or equity instead. As a consequence, the development of the local banking market might be of less importance for the financing of their R&D activities.

1.5.2 Firm age

A firm's age can play an important role in the process of obtaining external finance and thus financing R&D activities. As emphasized in Section 1.3.1, the existence of asymmetric information between banks and firms generally represents an obstacle for the credit relationship between these two parties. Being older might mitigate these problems given that an older firm can build up reputation and might therefore be seen as more creditworthy. Moreover, establishing long-run ties in the form of relationship lending is associated with the generation of firm-specific information on the side of the bank helping to constitute lending terms more appropriate for the concrete situation of the respective firm. As a consequence, we expect the impact of the development of the banking market to depend on the age of a firm. Since the establishment of relationships might not only have positive effects but can also be associated with the extraction of informational rents the sign of this relationship is not clear ex ante.

The results for the manufacturing sector, presented in Table 11, provide only weak support for an interaction between a firm's age and the development of the banking sector. In general, the results confirm a negative impact of the

development of the local banking sector on both old and young firm. However, the effect is statistically significant only for young firms when the intensive margin is considered. While not being statistically significant, the results for the interaction term indicate that the negative effect of bank branch density is somewhat muted for the intensive margin while the results for the extensive margin are mixed.

For the service sector, the findings are somewhat plainer. Considering the extensive margin, the reported figures suggest that the impact of the banking variable is particularly strong for young firms while considerably less sizeable for older firms. According to our results, an increase in the local banking density by one unit decreases the probability of a young firm to carry out R&D by approximately 8% to 10% while the same effects amounts to around 2 to 4% for old firms only. These impacts are more substantial in comparison with the manufacturing sector, thus again providing evidence for a stronger impact of the banking environment on service firms. Concerning the R&D investment volumes, the differences between the two groups are not statistically significant and appear to be negligible in terms of size.

Overall, the results of this section indicate that a firm's age indeed plays a role for obtaining external funds with older firms facing less constraints than their younger counterparts.

1.5.3 Legal form

Concerning the legal form, our findings so far suggest that being organized as a limited liability firm has a positive impact on the R&D activities of a firm. This finding is potentially due to the fact that entrepreneurs become more willing to undertake risky R&D activities when the maximum loss that they can occur is limited. On the other hand, limited liability might pose a problem for obtaining external finance, in particular from banks which tend to be risk averse. Given our discussion from Section 1.3.1, we thus might expect the impact of the banking variable to be particularly pronounced for these firms.

The results provided in Table 13 and Table 14 fairly strongly support this conjecture. The results for the manufacturing sector indicate that the development of the local banking sector is benign for the propensity to conduct R&D for non-limited liability firms whilst it is strongly negative for limited-liability firms. Whereas the coefficient on the former is not statistically significant, it

is strongly so for the latter. Similarly, the existence of a dense bank branch network positively influences the volume of R&D given that R&D is conducted by non-limited liability firms. The opposite is true for limited-liability firms.

Comparable - but in line with our intuition slightly more pronounced - findings are obtained for the service sector. While the effect of the banking variable for non-limited liability firms is close to zero for both the intensive and extensive margin and mostly not significant, it is sizeably negative and highly significant for the limited-liability firms. The reported figures suggest that a one-unit increase in the banking variable reduces the likelihood of limited-liability firms to conduct R&D by about 6%

1.5.4 The impact of macro conditions

Our data sets covers a fairly extended time period including the recent global financial crisis and the post-crisis period characterized by a considerably tightened banking regulation and a very benign macroeconomic development (in Germany). There are several reasons why the impact of the development of the local banking market might differ across the various subperiods included in our sample. Referring to Allen and Gale (1997), we might expect to find a positive impact of the banking market development during the recession due to an intertemporal smoothing effect associated with the activities of these institutions. On the other hand, increased macroeconomic uncertainty might hinder credit awarding by banks implying the opposite effect. Concerning the post-crisis period, the considerations outlined in Section 1.3.1 would imply a stronger negative effect of the banking variable due to the tighter regulatory framework. This effect might be dampened, however, by the fairly prosperous overall economic development in this period.

The results in Table 15 and Table 16 reveal commonalities and differences concerning the effect of the banking variable on the innovative behavior of firms in the manufacturing and the service sample across the subperiods. In case of the former, the regression results suggest that the negative effect of a higher risk aversion of banks in times of an economic slowdown dominates any existing intertemporal smoothing effect. For the post-crisis period, the obtained numbers are not only very small but also inconclusive concerning their sign overall suggesting no major difference in the value of this coefficient relative to the pre-crisis period and being consistent with the notion that the positive

impact of an expanding economy is counteracted by the negative implications of a tightened banking regulation. The subperiod results for the volume of R&D conducted are statistically not significant and negligible in size.

For the service sector, we find that the adverse effect of local banking market on the decision to conduct R&D is found to be mitigated during both the crisis and post-crisis periods suggesting a strong intertemporal smoothing effect and economic recovery effect. It is to be noted though that the overall effects are still negative and the coefficients on the interaction terms are not statistically significant. The findings for the volume of R&D undertaken (reported in columns 7 and 8 of Table 16) show that while the propensity to conduct R&D is positively impacted by the local banking market development the volumes invested are somewhat reduced. This suggests that the banking sector on the one side tended to dampen negative impacts on the propensity of service firms to conduct innovation projects during the great recession and afterwards, but on the other side protected itself by restricting volumes of investments and thus limiting potential losses.

To explain the partially contradictary results for the manufacturing and service samples, Figure 4 plots the economic developments of these sectors over sample period. It clearly reveals that the downturn in the service sector has been much less severe during the recession likely implying considerably smaller risk concerns.

1.5.5 The role of group membership

Being member of a group cannot only strongly influence the R&D activities of a company, but it might also impact the role of the local external financing conditions on these activities. The former is the case because efficiency considerations tend to lead to concentration of R&D efforts within a group such that these activities are normally - but not necessarily - conducted at the parent company. However, the centralization of R&D activities within a group implies that local external financing conditions become less important for a firm. To capture the effects of being a member of a group we employ a variable in our data set which asks for the degree of concentration in ownership. We classify a company to be a member of a group if more than 25% of the firm's capital or more than 25% of its voting shares are held by one or more outside firm(s) in a given year.

The results are presented in Tables 17 and 18. Concerning the relationship between ownership concentration and R&D activities we obtain an inconclusive picture for the manufacturing sector with all coefficient estimates not being significant. Likewise, the signs of the coefficients do not exhibit a consistent pattern. On the other hand, the results for the service sector suggest that firms which we classify to be part of a group tend to exhibit significantly lower R&D activities both at the extensive and intensive margins. The above outlined reasonings are therefore supported for the service sector.

For the interaction of the ownership concentration and the local banking density variable we obtain a similarly divided picture. While the findings for the manufacturing sector do not allow us to draw any solid conclusions, the obtained figures for the service sector are not only mostly statistically significant but also imply that the negative effect of the local banking sector on R&D activities are almost neutralized - at both margins - for firms whose concentration dummy variable equals one. The results are thus in line with the hypothesis that group membership weakens the importance of the local banking market for the R&D behavior of a firm.

1.6 Summary and conclusions

Employing unique banking and firm-level data sets for East Germany, we examine the extent to which the development of local banking markets affects firms' R&D activities. Such a link is suggested by economic considerations that root in the observation that the external financing of R&D activities poses large challenges given the intangible nature of these activities and the large uncertainties associated with their returns. These problems in particular apply to smaller and medium-sized firms. Recent trends in the development of local bank branch networks which generally show a - partly drastic - thinning of these networks might therefore impact the provision of these firms with financial funds.[15] On the other hand, previous studies on this topic employing European data have produced inconclusive evidence which was traced back, amongst others, to the important role that banks play in Europe for the external financing of firms.

Employing an IV approach which uses historical and legal features of the

[15]For a recent discussion on the development of German local banking markets, see Schwartz et al. (2017).

strongly regionally oriented German banking system, our results suggest no or even a negative relationship between the development of a local banking system and the R&D activities of firms located in that regions. This applies to both the extensive and intensive margin. The analysis of firm- and macroeconomic-specific factors which theory relates to a firm's ability to raise external credit suggest that the relationship between the local bank branch network and a firm's R&D activities tends to be negatively related to a firm's age, its size and the fact that a firm is organized as a limited-liability firm. A weak overall economic development that is associated with higher default risk appears to have a negative impact. Notably, our findings are generally more pronounced for the service sector where the frictions underlying potential problems to attract external finance are larger.

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1.7 Appendix

1.7.1 Tables

Table 1: Local banking markets

	Mean	Std. dev.	10%	25%	50%	75%	90%
				1990			
Branches	65.421	42.037	19.000	38.500	57.500	82.000	136.000
Branch density	3.404	1.373	1.604	2.637	3.320	4.161	4.986
	% of savings banks			% of cooperative banks			
	59.832			40.168			
				2002			
Branches	55.605	34.422	21.000	33.000	45.000	75.000	97.000
Branch density	3.141	0.990	2.150	2.490	2.961	3.604	4.262
	% of commercial banks		% of savings banks		% of cooperative banks		
	17.041		50.537		32.422		
				2015			
Branches	43.816	22.926	20.000	27.500	37.000	58.000	77.000
Branch density	2.810	0.784	1.900	2.294	2.679	3.237	3.731
	% of commercial banks		% of savings banks		% of cooperative banks		
	14.667		52.173		33.160		

Notes: Table 1 reports descriptive statistics for the distribution of bank branches across regions. "Branches" refers to the total number of branches in a given region, "branch density" refers to the total number of branches per 10,000 inhabitants. Reported statistics of the cross-regional distribution are the mean, the standard deviation and the 10th, 20th, 50th (median), 75th and 90% percentiles. Numbers are reported for the first (2002) and last (2015) year of our data sample. Moreover, numbers for 1990 are reported. There are 77 regions in East Germany.

Table 2: Major firm characteristics

Manufacturing sector: All firms								
	Mean		Median		Std. dev.		10%	90%
Age	31.170		17.000		40.405		5.000	90.000
Employment	45.804		20.000		80.619		3.500	112.000
Higher education	17.873		8.000		27.161		0.000	56.000
R&D volume	2.690		0.000		7.382		0.000	9.000
Discrete variables	R&D		Limited liability		Export		Public subsidy	
Share of firms	39.491		65.872		46.162		23.643	
By firm size								
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
	Mean				Standard deviation			
Age	30.210	30.166	35.998	18.159	38.167	39.548	45.333	26.348
Employment	4.701	23.469	102.064	421.371	2.422	10.767	47.732	264.214
Higher education	18.370	17.498	17.849	18.578	33.514	25.418	21.356	25.505
R&D volume	2.100	3.049	2.731	2.682	7.823	7.727	5.927	8.628
% R&D=1	18.802	40.746	60.137	51.039				
Service sector: All firms								
	Mean		Median		Std. dev.		10%	90%
Age	18.318		15.000		18.229		4.000	26.000
Employment	37.019		13.000		81.200		2.000	90.000
Higher education	23.447		5.000		33.408		0.000	90.000
R&D volume	1.689		0.000		8.331		0.000	2.000
Discrete variables	R&D		Limited liability		Export		Public subsidy	
Share of firms	13.406		53.469		22.998		14.337	
By firm size								
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
	Mean				Standard deviation			
Age	15.256	19.997	22.842	10.563	14.692	18.347	22.334	19.617
Employment	4.430	22.111	99.035	462.684	2.501	10.913	46.686	325.199
Higher education	24.980	23.533	20.403	21.790	38.119	31.311	26.560	32.926
R&D volume	1.366	1.905	1.911	1.528	7.667	8.253	9.449	9.196
% R&D=1	8.191	15.395	19.553	15.899				

Notes: Table 2 reports descriptive statistics for the firm-level data employed in our analysis. Numbers are reported for the overall sample and subsamples consisting of firms belong to different size groups (where a firm's size is measured by the number of full-time equivalent employees). The terms "Micro", "Small", "Medium" and "Large" refer to firms up to 9, between 10 and 49, between 50 and 249 and more than 249 employees. The statistics reported are indicated in the respective column heads (for continuous variables) or in the first rows (for discrete variables). Numbers for the variable "Higher eduction" correspond to the proportion of highly educated people (i.e., those with a university or comparable degree) in the overall employment. R&D volume figures represent ratios of spending for R&D relative to total sales.

Table 3: Local banking market development and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.
Branch dens.	-0.004	-0.009	-0.013	-0.005	-0.011	-0.014	-0.020	-0.028	-0.035
	(0.010)	(0.009)	(0.015)	(0.010)	(0.009)	(0.015)	(0.018)	(0.018)	(0.026)
Old	0.028	0.030*	0.080**	0.028	0.032*	0.078**	0.028*	0.033*	0.079**
	(0.017)	(0.017)	(0.038)	(0.017)	(0.017)	(0.037)	(0.017)	(0.017)	(0.036)
Higher educ.	0.336***	0.308***	0.458***	0.335***	0.317***	0.453***	0.332***	0.312***	0.445***
	(0.030)	(0.032)	(0.080)	(0.031)	(0.035)	(0.076)	(0.031)	(0.035)	(0.077)
Ltd. firm	0.215***	0.128***	0.064	0.206***	0.115***	0.055	0.205***	0.114***	0.053
	(0.025)	(0.023)	(0.041)	(0.022)	(0.020)	(0.038)	(0.022)	(0.020)	(0.038)
Small	0.146***	0.096***	0.095**	0.129***	0.078***	0.074**	0.131***	0.080***	0.078**
	(0.022)	(0.022)	(0.041)	(0.022)	(0.020)	(0.034)	(0.021)	(0.020)	(0.033)
Medium	0.275***	0.142***	0.145***	0.271***	0.139***	0.134***	0.272***	0.140***	0.136***
	(0.027)	(0.025)	(0.042)	(0.025)	(0.024)	(0.037)	(0.025)	(0.023)	(0.036)
Large	0.246***	0.131***	0.177***	0.234***	0.125***	0.165***	0.234***	0.125***	0.164***
	(0.041)	(0.036)	(0.054)	(0.041)	(0.037)	(0.053)	(0.041)	(0.037)	(0.053)
Export dummy=1		0.284***	0.291***		0.296***	0.295***		0.297***	0.297***
		(0.016)	(0.027)		(0.016)	(0.026)		(0.015)	(0.026)
Public funding=1		0.096***	0.105***		0.104***	0.107***		0.104***	0.106***
		(0.013)	(0.021)		(0.014)	(0.021)		(0.014)	(0.022)
Int. fin.			-0.130*			-0.106			-0.109
			(0.079)			(0.072)			(0.071)
N	11175	10373	3407	11175	10373	3407	11175	10373	3407
R2	0.142	0.216	0.179	0.172	0.261	0.219	0.171	0.260	0.218
F-stat							10.896	11.216	11.688
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Logit	Logit	Logit	Linear	Linear	Linear	Linear IV	Linear IV	Linear IV

Table 3 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 3), a logit model (columns 4 - 6) and a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 7-9, see Section 1.3.3 for more details on the employed instrument). In each specification the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. Values in brackets denote standard errors. Reported values are either estimated coefficients (linear probability model specifications) or marginal effects (logit specifications).

Table 4: Local banking market development and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.
Branch dens.	-0.009	-0.011	-0.011	-0.008	-0.012	-0.014	-0.030*	-0.040**	-0.053**
	(0.011)	(0.011)	(0.015)	(0.010)	(0.010)	(0.014)	(0.017)	(0.017)	(0.027)
Old	-0.016	-0.025	-0.096***	-0.020	-0.027*	-0.095***	-0.019	-0.027*	-0.094***
	(0.016)	(0.017)	(0.030)	(0.015)	(0.015)	(0.028)	(0.014)	(0.015)	(0.028)
Higher educ.	0.183***	0.181***	0.285***	0.213***	0.223***	0.386***	0.211***	0.219***	0.383***
	(0.018)	(0.018)	(0.034)	(0.023)	(0.024)	(0.052)	(0.023)	(0.024)	(0.052)
Ltd. firm	0.097***	0.084***	0.084***	0.092***	0.079***	0.062***	0.092***	0.078***	0.062***
	(0.013)	(0.012)	(0.024)	(0.014)	(0.013)	(0.022)	(0.013)	(0.012)	(0.021)
Small	0.047***	0.029**	0.026	0.041***	0.021	0.016	0.040***	0.021	0.014
	(0.013)	(0.015)	(0.032)	(0.013)	(0.014)	(0.028)	(0.012)	(0.013)	(0.027)
Medium	0.072***	0.049**	0.051	0.069***	0.044**	0.047	0.068***	0.043**	0.042
	(0.019)	(0.020)	(0.034)	(0.021)	(0.021)	(0.030)	(0.021)	(0.020)	(0.029)
Large	0.044*	0.022	-0.015	0.039	0.012	-0.034	0.038	0.011	-0.041
	(0.025)	(0.025)	(0.042)	(0.026)	(0.027)	(0.053)	(0.026)	(0.027)	(0.053)
Export dummy=1		0.131***	0.179***		0.143***	0.186***		0.145***	0.190***
		(0.016)	(0.024)		(0.019)	(0.026)		(0.019)	(0.026)
Public funding=1		0.062***	0.073***		0.075***	0.082***		0.076***	0.084***
		(0.014)	(0.021)		(0.018)	(0.025)		(0.018)	(0.024)
Int. fin.			0.022			0.023			0.019
			(0.047)			(0.041)			(0.040)
N	9646	8860	2629	9646	8860	2629	9646	8860	2629
R2	0.118	0.163	0.189	0.090	0.131	0.173	0.088	0.128	0.169
F-stat							19.351	19.308	20.046
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Logit	Logit	Logit	Linear	Linear	Linear	Linear IV	Linear IV	Linear IV

Table 4 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 3), a logit model (columns 4 - 6) and a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 7-9, see Section 1.3.3 for more details on the employed instrument). In each specification, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. Values in brackets denote standard errors. Reported values are either estimated coefficients (linear probability model specifications) or marginal effects (logit specifications).

Table 5: Local banking market development and R&D: manufacturing sector

	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.003***	-0.003***	-0.004**	-0.006**	-0.007**	-0.007*
	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)
Old	-0.005	-0.003	-0.003	-0.005*	-0.003	-0.003
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)
Higher educ.	0.074***	0.080***	0.124***	0.074***	0.080***	0.122***
	(0.012)	(0.013)	(0.022)	(0.011)	(0.013)	(0.022)
Ltd. firm	0.022***	0.014***	0.008***	0.022***	0.014***	0.008***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Small	0.003	-0.001	0.006	0.003	-0.000	0.006
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)
Medium	-0.005	-0.014***	-0.008	-0.005	-0.014***	-0.008
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)
Large	-0.004	-0.013**	-0.012**	-0.004	-0.013**	-0.012**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Export dummy=1		0.020***	0.013***		0.021***	0.014***
		(0.003)	(0.004)		(0.003)	(0.004)
Public funding=1		0.007***	0.010**		0.007***	0.009***
		(0.002)	(0.004)		(0.002)	(0.004)
Int. fin.			-0.001			-0.001
			(0.014)			(0.014)
N	9742	9020	3091	9742	9020	3091
R2	0.111	0.145	0.186	0.110	0.144	0.185
F-stat				10.120	10.449	11.355
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear	Linear IV	Linear IV	Linear IV

Table 5 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear OLS regression model (columns 1 - 3) and a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 4-6, see Section 1.3.3 for more details on the employed instrument). In each specification, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 6: Local banking market development and R&D: service sector

	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.001	-0.003	-0.010**	-0.006	-0.009**	-0.013**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)
Old	-0.007	-0.006	-0.007	-0.007	-0.006	-0.007
	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)
Higher educ.	0.048***	0.048***	0.089***	0.048***	0.048***	0.089***
	(0.008)	(0.008)	(0.019)	(0.008)	(0.007)	(0.019)
Ltd. firm	0.016***	0.012***	0.007	0.016***	0.012***	0.007
	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.006)
Small	0.001	-0.003	-0.000	0.001	-0.003	-0.000
	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.006)
Medium	-0.001	-0.007	0.004	-0.001	-0.008	0.004
	(0.005)	(0.005)	(0.008)	(0.005)	(0.005)	(0.008)
Large	-0.009**	-0.017***	-0.021**	-0.010**	-0.017***	-0.022**
	(0.005)	(0.006)	(0.010)	(0.005)	(0.006)	(0.010)
Export dummy=1		0.031***	0.037***		0.032***	0.037***
		(0.008)	(0.008)		(0.008)	(0.008)
Public funding=1		0.020***	0.025**		0.020***	0.025**
		(0.006)	(0.010)		(0.006)	(0.010)
Int. fin.			0.016			0.015
			(0.015)			(0.015)
N	7940	7257	2291	7940	7257	2291
R2	0.053	0.087	0.152	0.052	0.085	0.151
F-stat				17.775	17.829	18.731
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear	Linear IV	Linear IV	Linear IV

Table 6 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear OLS regression model (columns 1 - 3) and a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 4-6, see Section 1.3.3 for more details on the employed instrument). In each specification, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 7: Local banking markets, bank relationship and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.010	-0.014	-0.032	-0.037*	-0.005***	-0.004***	-0.009***	-0.009***
	(0.012)	(0.011)	(0.022)	(0.022)	(0.001)	(0.001)	(0.003)	(0.003)
Bankcreditrelationship=1 × Branch dens.	0.016	0.012	0.036	0.028	0.004**	0.003*	0.007	0.006
	(0.015)	(0.015)	(0.034)	(0.034)	(0.002)	(0.002)	(0.005)	(0.004)
Bankcreditrelationship=1	-0.007	-0.027	-0.071	-0.078	-0.014*	-0.014**	-0.024	-0.024*
	(0.053)	(0.054)	(0.114)	(0.114)	(0.008)	(0.007)	(0.017)	(0.014)
Old	0.030*	0.033*	0.030*	0.033*	-0.005	-0.003	-0.005	-0.003
	(0.017)	(0.017)	(0.017)	(0.017)	(0.003)	(0.003)	(0.003)	(0.003)
Higher educ.	0.337***	0.317***	0.334***	0.313***	0.074***	0.080***	0.073***	0.079***
	(0.031)	(0.035)	(0.031)	(0.035)	(0.011)	(0.013)	(0.011)	(0.013)
Ltd. firm	0.206***	0.115***	0.205***	0.114***	0.022***	0.014***	0.022***	0.014***
	(0.022)	(0.020)	(0.022)	(0.020)	(0.002)	(0.002)	(0.002)	(0.002)
Small	0.123***	0.077***	0.125***	0.079***	0.003	-0.001	0.003	-0.000
	(0.022)	(0.020)	(0.021)	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)
Medium	0.260***	0.137***	0.261***	0.138***	-0.005	-0.013***	-0.005	-0.013***
	(0.025)	(0.024)	(0.025)	(0.023)	(0.004)	(0.003)	(0.003)	(0.003)
Large	0.224***	0.123***	0.224***	0.123***	-0.004	-0.013**	-0.004	-0.013**
	(0.041)	(0.037)	(0.041)	(0.036)	(0.005)	(0.005)	(0.005)	(0.005)
Export dummy=1		0.296***		0.297***		0.020***		0.021***
		(0.016)		(0.016)		(0.003)		(0.003)
Public funding=1		0.100***		0.100***		0.009***		0.009***
		(0.014)		(0.014)		(0.003)		(0.003)
N	11175	10373	11175	10373	9742	9020	9742	9020
R2	0.173	0.261	0.173	0.260	0.112	0.146	0.111	0.144
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 7 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 8: Local banking markets, bank relationship and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.006	-0.009	-0.023	-0.034*	-0.002	-0.003	-0.008*	-0.010**
	(0.010)	(0.010)	(0.018)	(0.017)	(0.005)	(0.005)	(0.005)	(0.005)
Bankcreditrelationship=1 × Branch dens.	-0.007	-0.008	-0.021	-0.021	0.002	0.001	0.006	0.005
	(0.013)	(0.013)	(0.022)	(0.025)	(0.005)	(0.005)	(0.005)	(0.005)
Bankcreditrelationship=1	0.034	0.017	0.078	0.056	-0.012	-0.015	-0.021	-0.025
	(0.038)	(0.038)	(0.065)	(0.072)	(0.014)	(0.015)	(0.014)	(0.016)
Old	-0.020	-0.027*	-0.020	-0.027*	-0.007	-0.006	-0.007	-0.006
	(0.014)	(0.015)	(0.014)	(0.015)	(0.006)	(0.005)	(0.006)	(0.005)
Higher educ.	0.214***	0.222***	0.212***	0.219***	0.047***	0.047***	0.047***	0.046***
	(0.023)	(0.024)	(0.023)	(0.024)	(0.008)	(0.007)	(0.008)	(0.007)
Ltd. firm	0.093***	0.078***	0.093***	0.078***	0.015***	0.012***	0.015***	0.012***
	(0.014)	(0.013)	(0.013)	(0.012)	(0.004)	(0.004)	(0.004)	(0.004)
Small	0.038***	0.022	0.038***	0.022*	0.002	-0.002	0.002	-0.002
	(0.012)	(0.013)	(0.012)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Medium	0.065***	0.045**	0.064***	0.044**	-0.000	-0.005	-0.000	-0.006
	(0.021)	(0.021)	(0.020)	(0.020)	(0.005)	(0.005)	(0.005)	(0.005)
Large	0.036	0.013	0.035	0.011	-0.008*	-0.015***	-0.009**	-0.015***
	(0.026)	(0.027)	(0.026)	(0.027)	(0.004)	(0.005)	(0.004)	(0.005)
Export dummy=1		0.144***		0.145***		0.032***		0.033***
		(0.019)		(0.019)		(0.008)		(0.008)
Public funding=1		0.077***		0.078***		0.023***		0.023***
		(0.018)		(0.018)		(0.006)		(0.006)
N	9646	8860	9646	8860	7940	7257	7940	7257
R2	0.090	0.131	0.088	0.127	0.054	0.090	0.052	0.087
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 8 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 9: Local banking markets, firm size and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	0.008	0.000	0.023	0.010	-0.001	-0.001	0.001	0.001
	(0.014)	(0.012)	(0.024)	(0.023)	(0.002)	(0.002)	(0.004)	(0.004)
Small × Branch dens.	-0.041**	-0.036***	-0.112***	-0.098**	-0.005	-0.006*	-0.017**	-0.017**
	(0.019)	(0.014)	(0.039)	(0.039)	(0.003)	(0.003)	(0.007)	(0.008)
Medium × Branch dens.	0.015	0.016	0.040	0.031	0.002	0.001	0.003	0.003
	(0.023)	(0.019)	(0.057)	(0.048)	(0.003)	(0.003)	(0.007)	(0.006)
Large × Branch dens.	0.062	0.044	0.011	0.027	-0.012	-0.010	-0.012	-0.003
	(0.048)	(0.048)	(0.089)	(0.085)	(0.009)	(0.008)	(0.012)	(0.008)
Old	0.027	0.032*	0.028	0.033*	-0.005	-0.003	-0.005	-0.003
	(0.017)	(0.017)	(0.017)	(0.017)	(0.003)	(0.003)	(0.003)	(0.003)
Higher educ.	0.333***	0.315***	0.326***	0.307***	0.074***	0.080***	0.073***	0.079***
	(0.031)	(0.034)	(0.033)	(0.036)	(0.011)	(0.013)	(0.011)	(0.013)
Ltd. firm	0.206***	0.116***	0.207***	0.116***	0.022***	0.015***	0.022***	0.015***
	(0.022)	(0.020)	(0.022)	(0.020)	(0.002)	(0.002)	(0.002)	(0.002)
Small	0.260***	0.193***	0.484***	0.389***	0.018*	0.018*	0.057***	0.053**
	(0.060)	(0.045)	(0.116)	(0.116)	(0.010)	(0.010)	(0.022)	(0.024)
Medium	0.222***	0.087	0.143	0.040	-0.012	-0.018*	-0.016	-0.022
	(0.074)	(0.061)	(0.179)	(0.148)	(0.010)	(0.009)	(0.022)	(0.021)
Large	0.049	-0.008	0.204	0.048	0.031	0.018	0.031	-0.003
	(0.161)	(0.157)	(0.286)	(0.273)	(0.031)	(0.029)	(0.039)	(0.027)
Export dummy=1		0.295***		0.293***		0.020***		0.020***
		(0.015)		(0.015)		(0.003)		(0.002)
Public funding=1		0.103***		0.103***		0.008***		0.007***
		(0.014)		(0.014)		(0.002)		(0.002)
N	11175	10373	11175	10373	9742	9020	9742	9020
R2	0.174	0.262	0.168	0.258	0.113	0.147	0.107	0.140
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 9 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details). In columns 1 - 4, the dependent

Table 10: Local banking markets, firm size and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.003	-0.006	0.021	0.012	0.006	0.005	0.007	0.003
	(0.013)	(0.014)	(0.020)	(0.022)	(0.007)	(0.008)	(0.005)	(0.006)
Small × Branch dens.	-0.010	-0.011	-0.075***	-0.075***	-0.013*	-0.013*	-0.021***	-0.020***
	(0.015)	(0.017)	(0.022)	(0.025)	(0.007)	(0.008)	(0.006)	(0.006)
Medium × Branch dens.	-0.016	-0.014	-0.126**	-0.123**	-0.015*	-0.015	-0.025*	-0.022*
	(0.024)	(0.026)	(0.059)	(0.058)	(0.008)	(0.009)	(0.013)	(0.013)
Large × Branch dens.	0.018	0.025	0.011	0.014	-0.002	-0.002	-0.001	0.000
	(0.034)	(0.034)	(0.044)	(0.045)	(0.010)	(0.009)	(0.010)	(0.008)
Old	-0.019	-0.027*	-0.017	-0.025*	-0.007	-0.006	-0.007	-0.006
	(0.014)	(0.015)	(0.014)	(0.015)	(0.006)	(0.005)	(0.006)	(0.005)
Higher educ.	0.213***	0.223***	0.210***	0.219***	0.048***	0.048***	0.047***	0.048***
	(0.023)	(0.024)	(0.023)	(0.023)	(0.008)	(0.008)	(0.008)	(0.007)
Ltd. firm	0.093***	0.079***	0.094***	0.080***	0.016***	0.013***	0.016***	0.013***
	(0.014)	(0.013)	(0.013)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Small	0.068	0.053	0.258***	0.237***	0.040*	0.036	0.064***	0.054***
	(0.044)	(0.049)	(0.065)	(0.072)	(0.020)	(0.023)	(0.016)	(0.017)
Medium	0.113	0.085	0.427**	0.390**	0.043*	0.035	0.071*	0.055
	(0.080)	(0.080)	(0.173)	(0.168)	(0.025)	(0.026)	(0.041)	(0.039)
Large	-0.010	-0.057	0.013	-0.022	-0.004	-0.011	-0.006	-0.017
	(0.091)	(0.093)	(0.117)	(0.120)	(0.029)	(0.026)	(0.027)	(0.024)
Export dummy=1		0.143***		0.143***		0.031***		0.032***
		(0.019)		(0.019)		(0.007)		(0.007)
Public funding=1		0.075***		0.078***		0.020***		0.021***
		(0.018)		(0.018)		(0.006)		(0.006)
N	9646	8860	9646	8860	7940	7257	7940	7257
R2	0.090	0.131	0.079	0.120	0.057	0.091	0.054	0.088
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 10 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 11: Local banking markets, age and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.004	-0.015	-0.009	-0.036	-0.010***	-0.009***	-0.014*	-0.014*
	(0.020)	(0.021)	(0.040)	(0.038)	(0.003)	(0.003)	(0.008)	(0.008)
Old × Branch dens.	-0.001	0.005	-0.013	0.009	0.008***	0.007**	0.008	0.009
	(0.020)	(0.022)	(0.041)	(0.038)	(0.003)	(0.003)	(0.008)	(0.008)
Old	0.032	0.017	0.068	0.005	-0.030***	-0.024**	-0.032	-0.032
	(0.067)	(0.071)	(0.132)	(0.122)	(0.010)	(0.010)	(0.024)	(0.026)
Higher educ.	0.335***	0.317***	0.332***	0.312***	0.074***	0.081***	0.074***	0.080***
	(0.031)	(0.035)	(0.031)	(0.035)	(0.012)	(0.013)	(0.011)	(0.013)
Ltd. firm	0.206***	0.115***	0.205***	0.114***	0.022***	0.014***	0.022***	0.014***
	(0.022)	(0.020)	(0.022)	(0.020)	(0.002)	(0.002)	(0.002)	(0.002)
Small	0.129***	0.078***	0.131***	0.080***	0.003	-0.001	0.003	-0.001
	(0.022)	(0.020)	(0.021)	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)
Medium	0.271***	0.139***	0.272***	0.140***	-0.005	-0.014***	-0.005	-0.014***
	(0.025)	(0.024)	(0.025)	(0.023)	(0.003)	(0.003)	(0.003)	(0.003)
Large	0.234***	0.124***	0.235***	0.124***	-0.005	-0.014**	-0.005	-0.014**
	(0.041)	(0.037)	(0.041)	(0.037)	(0.006)	(0.006)	(0.006)	(0.006)
Export dummy=1		0.296***		0.297***		0.020***		0.021***
		(0.016)		(0.016)		(0.003)		(0.003)
Public funding=1		0.104***		0.104***		0.008***		0.008***
		(0.014)		(0.014)		(0.002)		(0.002)
N	11175	10373	11175	10373	9742	9020	9742	9020
R2	0.172	0.261	0.171	0.260	0.112	0.146	0.111	0.145
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 11 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 12: Local banking markets, age and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.026	-0.026	-0.075**	-0.095***	-0.000	-0.001	-0.006	-0.009
	(0.016)	(0.019)	(0.032)	(0.036)	(0.007)	(0.007)	(0.011)	(0.009)
Old × Branch dens.	0.021	0.017	0.054*	0.065*	-0.001	-0.002	-0.001	-0.000
	(0.015)	(0.017)	(0.032)	(0.034)	(0.008)	(0.006)	(0.013)	(0.011)
Old	-0.081*	-0.076	-0.175*	-0.214**	-0.003	0.001	-0.006	-0.006
	(0.049)	(0.053)	(0.092)	(0.099)	(0.027)	(0.022)	(0.043)	(0.035)
Higher educ.	0.213***	0.223***	0.210***	0.219***	0.048***	0.048***	0.048***	0.048***
	(0.023)	(0.024)	(0.023)	(0.024)	(0.008)	(0.008)	(0.008)	(0.008)
Ltd. firm	0.092***	0.078***	0.092***	0.078***	0.016***	0.012***	0.016***	0.012***
	(0.014)	(0.013)	(0.013)	(0.012)	(0.004)	(0.004)	(0.004)	(0.004)
Small	0.040***	0.021	0.040***	0.020	0.001	-0.003	0.001	-0.003
	(0.013)	(0.014)	(0.012)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Medium	0.068***	0.044**	0.067***	0.043**	-0.001	-0.007	-0.001	-0.008
	(0.021)	(0.021)	(0.021)	(0.020)	(0.005)	(0.005)	(0.005)	(0.005)
Large	0.040	0.013	0.040	0.013	-0.009**	-0.017***	-0.010**	-0.017***
	(0.026)	(0.027)	(0.025)	(0.027)	(0.005)	(0.006)	(0.005)	(0.006)
Export dummy=1		0.143***		0.145***		0.031***		0.032***
		(0.019)		(0.019)		(0.008)		(0.008)
Public funding=1		0.075***		0.075***		0.020***		0.020***
		(0.018)		(0.018)		(0.006)		(0.006)
N	9646	8860	9646	8860	7940	7257	7940	7257
R2	0.090	0.131	0.088	0.126	0.053	0.087	0.051	0.084
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 12 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 13: Local banking markets, legal form and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	0.020	0.004	0.021	0.002	0.002	0.001	0.006*	0.004
	(0.014)	(0.012)	(0.025)	(0.026)	(0.002)	(0.002)	(0.003)	(0.003)
Ltd. firm × Branch dens.	-0.038**	-0.022	-0.059**	-0.043	-0.008***	-0.007***	-0.017***	-0.015***
	(0.019)	(0.016)	(0.028)	(0.029)	(0.002)	(0.002)	(0.005)	(0.005)
Old	0.029*	0.033*	0.029*	0.034*	-0.005	-0.003	-0.005	-0.003
	(0.017)	(0.017)	(0.017)	(0.017)	(0.003)	(0.003)	(0.003)	(0.003)
Higher educ.	0.332***	0.315***	0.327***	0.308***	0.073***	0.080***	0.072***	0.078***
	(0.030)	(0.034)	(0.030)	(0.035)	(0.011)	(0.013)	(0.011)	(0.013)
Ltd. firm	0.327***	0.186***	0.392***	0.252***	0.048***	0.036***	0.077***	0.064***
	(0.062)	(0.050)	(0.092)	(0.093)	(0.007)	(0.007)	(0.016)	(0.015)
Small	0.128***	0.077***	0.130***	0.078***	0.002	-0.001	0.002	-0.001
	(0.022)	(0.020)	(0.021)	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)
Medium	0.270***	0.138***	0.270***	0.138***	-0.005	-0.014***	-0.006*	-0.015***
	(0.025)	(0.024)	(0.025)	(0.023)	(0.003)	(0.003)	(0.003)	(0.003)
Large	0.233***	0.124***	0.232***	0.124***	-0.005	-0.014**	-0.005	-0.014**
	(0.041)	(0.037)	(0.041)	(0.037)	(0.006)	(0.006)	(0.006)	(0.006)
Export dummy=1		0.296***		0.296***		0.020***		0.020***
		(0.016)		(0.015)		(0.003)		(0.003)
Public funding=1		0.104***		0.103***		0.007***		0.007***
		(0.014)		(0.014)		(0.002)		(0.002)
N	11175	10373	11175	10373	9742	9020	9742	9020
R2	0.173	0.261	0.172	0.260	0.113	0.146	0.110	0.143
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 13 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 14: Local banking markets, legal form and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	0.001	-0.002	0.009	-0.006	0.008	0.008	0.007	0.005
	(0.011)	(0.011)	(0.019)	(0.019)	(0.006)	(0.006)	(0.006)	(0.006)
Ltd. firm × Branch dens.	-0.018	-0.018	-0.073**	-0.064**	-0.017***	-0.019***	-0.025***	-0.025***
	(0.015)	(0.017)	(0.031)	(0.029)	(0.006)	(0.006)	(0.007)	(0.006)
Old	-0.020	-0.027*	-0.019	-0.027*	-0.007	-0.006	-0.007	-0.006
	(0.015)	(0.015)	(0.015)	(0.015)	(0.006)	(0.005)	(0.006)	(0.005)
Higher educ.	0.213***	0.223***	0.211***	0.220***	0.048***	0.049***	0.048***	0.048***
	(0.023)	(0.024)	(0.023)	(0.024)	(0.008)	(0.007)	(0.008)	(0.007)
Ltd. firm	0.145***	0.132***	0.303***	0.261***	0.066***	0.068***	0.090***	0.085***
	(0.042)	(0.044)	(0.091)	(0.085)	(0.017)	(0.017)	(0.021)	(0.019)
Small	0.041***	0.021	0.041***	0.021	0.001	-0.003	0.001	-0.003
	(0.013)	(0.014)	(0.013)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Medium	0.069***	0.044**	0.068***	0.043**	-0.001	-0.007	-0.001	-0.008
	(0.021)	(0.021)	(0.021)	(0.021)	(0.005)	(0.005)	(0.005)	(0.005)
Large	0.039	0.012	0.037	0.010	-0.010**	-0.017***	-0.010**	-0.018***
	(0.026)	(0.027)	(0.026)	(0.028)	(0.005)	(0.006)	(0.005)	(0.006)
Export dummy=1		0.143***		0.144***		0.031***		0.032***
		(0.019)		(0.019)		(0.007)		(0.007)
Public funding=1		0.075***		0.076***		0.020***		0.020***
		(0.018)		(0.018)		(0.006)		(0.006)
N	9646	8860	9646	8860	7940	7257	7940	7257
R2	0.090	0.131	0.085	0.126	0.059	0.095	0.057	0.092
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 14 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 15: Local banking markets, time period and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	0.001	-0.012	-0.009	-0.029	-0.003*	-0.003**	-0.006*	-0.007*
	(0.012)	(0.011)	(0.023)	(0.024)	(0.002)	(0.002)	(0.004)	(0.004)
Crisis period × Branch dens.	-0.019*	-0.010	-0.026	-0.019	0.000	0.001	-0.000	0.002
	(0.011)	(0.011)	(0.024)	(0.022)	(0.002)	(0.002)	(0.004)	(0.004)
After crisis × Branch dens.	-0.006	0.006	-0.014	0.009	-0.001	-0.000	-0.001	0.000
	(0.011)	(0.010)	(0.019)	(0.022)	(0.002)	(0.002)	(0.004)	(0.004)
Old	0.028	0.033*	0.028*	0.033*	-0.005	-0.003	-0.005*	-0.003
	(0.017)	(0.017)	(0.017)	(0.017)	(0.003)	(0.003)	(0.003)	(0.003)
Higher educ.	0.335***	0.317***	0.332***	0.312***	0.074***	0.081***	0.074***	0.080***
	(0.031)	(0.035)	(0.031)	(0.035)	(0.012)	(0.013)	(0.011)	(0.013)
Ltd. firm	0.206***	0.115***	0.205***	0.113***	0.022***	0.014***	0.022***	0.014***
	(0.022)	(0.020)	(0.022)	(0.020)	(0.002)	(0.002)	(0.002)	(0.002)
Small	0.129***	0.078***	0.131***	0.080***	0.003	-0.001	0.003	-0.000
	(0.022)	(0.020)	(0.021)	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)
Medium	0.271***	0.139***	0.272***	0.140***	-0.005	-0.014***	-0.005	-0.014***
	(0.025)	(0.024)	(0.025)	(0.023)	(0.003)	(0.003)	(0.003)	(0.003)
Large	0.234***	0.124***	0.234***	0.124***	-0.004	-0.013**	-0.004	-0.013**
	(0.041)	(0.037)	(0.041)	(0.037)	(0.006)	(0.006)	(0.006)	(0.006)
Export dummy=1		0.296***		0.297***		0.020***		0.020***
		(0.016)		(0.015)		(0.003)		(0.003)
Public funding=1		0.104***		0.104***		0.008***		0.007***
		(0.014)		(0.014)		(0.002)		(0.002)
N	11175	10373	11175	10373	9742	9020	9742	9020
R2	0.172	0.261	0.171	0.260	0.111	0.145	0.110	0.144
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 15 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 16: Local banking markets, time period and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.011	-0.012	-0.051*	-0.056**	0.003	0.002	0.000	-0.001
	(0.015)	(0.016)	(0.027)	(0.028)	(0.005)	(0.007)	(0.005)	(0.005)
Crisis period × Branch dens.	0.006	0.001	0.017	0.012	-0.005	-0.007	-0.013*	-0.015**
	(0.013)	(0.012)	(0.027)	(0.030)	(0.004)	(0.004)	(0.007)	(0.007)
After crisis × Branch dens.	0.003	-0.000	0.039	0.028	-0.008*	-0.009	-0.009**	-0.011*
	(0.013)	(0.015)	(0.025)	(0.027)	(0.005)	(0.006)	(0.005)	(0.006)
Old	-0.020	-0.027*	-0.018	-0.026*	-0.008	-0.007	-0.008	-0.007
	(0.015)	(0.015)	(0.015)	(0.015)	(0.006)	(0.005)	(0.006)	(0.005)
Higher educ.	0.213***	0.223***	0.211***	0.220***	0.048***	0.048***	0.047***	0.047***
	(0.023)	(0.024)	(0.023)	(0.024)	(0.008)	(0.008)	(0.008)	(0.007)
Ltd. firm	0.092***	0.079***	0.092***	0.078***	0.016***	0.012***	0.016***	0.012***
	(0.014)	(0.013)	(0.013)	(0.012)	(0.004)	(0.004)	(0.004)	(0.004)
Small	0.041***	0.021	0.039***	0.020	0.001	-0.003	0.001	-0.003
	(0.013)	(0.014)	(0.012)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Medium	0.069***	0.044**	0.067***	0.042**	-0.001	-0.007	-0.001	-0.007
	(0.021)	(0.021)	(0.021)	(0.020)	(0.005)	(0.005)	(0.005)	(0.005)
Large	0.039	0.012	0.039	0.011	-0.010**	-0.017***	-0.010**	-0.017***
	(0.026)	(0.027)	(0.026)	(0.027)	(0.005)	(0.006)	(0.005)	(0.006)
Export dummy=1		0.143***		0.145***		0.031***		0.032***
		(0.019)		(0.019)		(0.008)		(0.008)
Public funding=1		0.075***		0.076***		0.020***		0.020***
		(0.018)		(0.018)		(0.006)		(0.005)
N	9646	8860	9646	8860	7940	7257	7940	7257
R2	0.090	0.131	0.087	0.127	0.054	0.088	0.052	0.085
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 16 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

Table 17: Local banking markets, group membership and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.009	-0.015	0.008	-0.013	-0.006*	-0.005	-0.007	-0.006
	(0.022)	(0.022)	(0.041)	(0.042)	(0.003)	(0.003)	(0.008)	(0.008)
Group member × Branch dens.	0.004	0.005	-0.035	-0.019	0.003	0.002	0.001	-0.000
	(0.025)	(0.025)	(0.048)	(0.047)	(0.004)	(0.004)	(0.008)	(0.008)
Group member	-0.034	-0.008	0.089	0.067	-0.011	-0.006	-0.004	0.002
	(0.080)	(0.079)	(0.148)	(0.147)	(0.012)	(0.013)	(0.028)	(0.029)
Old	0.029*	0.033*	0.029*	0.033**	-0.006*	-0.003	-0.006*	-0.003
	(0.017)	(0.017)	(0.017)	(0.017)	(0.003)	(0.003)	(0.003)	(0.003)
Higher educ.	0.333***	0.316***	0.333***	0.314***	0.074***	0.080***	0.073***	0.079***
	(0.031)	(0.035)	(0.031)	(0.036)	(0.012)	(0.013)	(0.011)	(0.013)
Ltd. firm	0.203***	0.116***	0.202***	0.114***	0.022***	0.015***	0.022***	0.014***
	(0.022)	(0.020)	(0.022)	(0.020)	(0.002)	(0.002)	(0.002)	(0.002)
Small	0.129***	0.078***	0.131***	0.080***	0.002	-0.001	0.003	-0.001
	(0.022)	(0.021)	(0.022)	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)
Medium	0.267***	0.140***	0.268***	0.141***	-0.005	-0.014***	-0.005	-0.014***
	(0.026)	(0.024)	(0.026)	(0.024)	(0.003)	(0.003)	(0.003)	(0.003)
Large	0.230***	0.126***	0.230***	0.126***	-0.006	-0.015***	-0.006	-0.015***
	(0.041)	(0.038)	(0.041)	(0.037)	(0.005)	(0.005)	(0.005)	(0.005)
Export dummy=1		0.296***		0.297***		0.021***		0.021***
		(0.016)		(0.016)		(0.003)		(0.003)
Public funding=1		0.105***		0.104***		0.008***		0.008***
		(0.014)		(0.014)		(0.002)		(0.002)
N	11091	10300	11091	10300	9684	8971	9684	8971
R2	0.172	0.261	0.170	0.260	0.112	0.147	0.111	0.146
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 17 reports results for our manufacturing firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

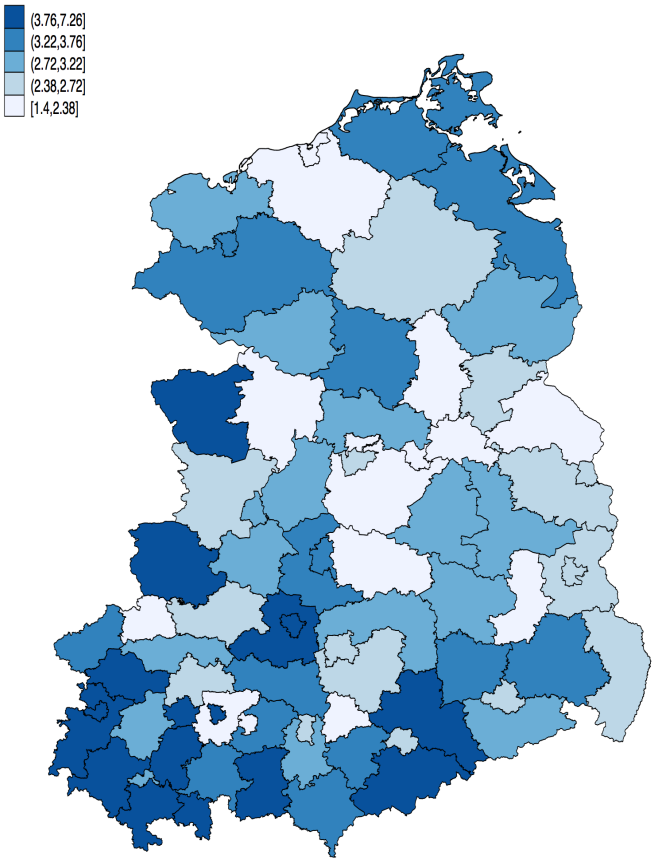
Table 18: Local banking markets, group membership and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.028	-0.023	-0.092***	-0.099***	-0.009	-0.011	-0.020**	-0.025***
	(0.017)	(0.019)	(0.035)	(0.035)	(0.006)	(0.006)	(0.009)	(0.009)
Group member × Branch dens.	0.023	0.014	0.072**	0.068*	0.009	0.009	0.016*	0.018**
	(0.016)	(0.018)	(0.035)	(0.036)	(0.006)	(0.006)	(0.009)	(0.009)
Group member	-0.086**	-0.061	-0.222**	-0.210**	-0.026	-0.027	-0.044	-0.053*
	(0.042)	(0.047)	(0.104)	(0.106)	(0.018)	(0.018)	(0.028)	(0.027)
Old	-0.020	-0.027*	-0.020	-0.027*	-0.008	-0.006	-0.008	-0.006
	(0.015)	(0.015)	(0.015)	(0.015)	(0.006)	(0.005)	(0.006)	(0.005)
Higher educ.	0.213***	0.223***	0.211***	0.220***	0.048***	0.048***	0.048***	0.048***
	(0.024)	(0.024)	(0.023)	(0.024)	(0.008)	(0.008)	(0.008)	(0.007)
Ltd. firm	0.090***	0.077***	0.090***	0.076***	0.016***	0.012***	0.016***	0.012***
	(0.014)	(0.013)	(0.014)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Small	0.040***	0.021	0.040***	0.020	0.001	-0.003	0.001	-0.003
	(0.013)	(0.014)	(0.012)	(0.013)	(0.004)	(0.004)	(0.004)	(0.004)
Medium	0.068***	0.043**	0.067***	0.042**	-0.001	-0.008	-0.001	-0.008
	(0.021)	(0.021)	(0.020)	(0.020)	(0.005)	(0.005)	(0.005)	(0.005)
Large	0.037	0.010	0.037	0.010	-0.010**	-0.017***	-0.010**	-0.017***
	(0.025)	(0.027)	(0.026)	(0.027)	(0.005)	(0.006)	(0.005)	(0.006)
Export dummy=1		0.143***		0.145***		0.031***		0.032***
		(0.019)		(0.019)		(0.008)		(0.008)
Public funding=1		0.075***		0.077***		0.020***		0.021***
		(0.018)		(0.018)		(0.006)		(0.006)
N	9579	8802	9579	8802	7892	7217	7892	7217
R2	0.091	0.131	0.088	0.127	0.054	0.088	0.052	0.085
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear IV	Linear IV	Linear	Linear	Linear IV	Linear IV

Table 18 reports results for our service firm sample from estimating Equation (1.3.1) employing a linear probability model (columns 1 - 2), a linear probability model where the local banking market variable is instrumented for by its 1990 value (columns 3 - 4, see Section 1.3.3 for more details on the employed instrument), a linear OLS regression model (column 5 - 6) or a linear regression model where the local banking market variable is instrumented for by its 1990 value (columns 7 - 8, see Section 1.3.3 for more details on the employed instrument). In columns 1 - 4, the dependent variable corresponds to 1 if a given firm has conducted R&D investments and 0 otherwise. In columns 5 - 8, the dependent variable corresponds to the volume of undertaken R&D investments (normalized by a firm's turnover). Values in brackets denote standard errors.

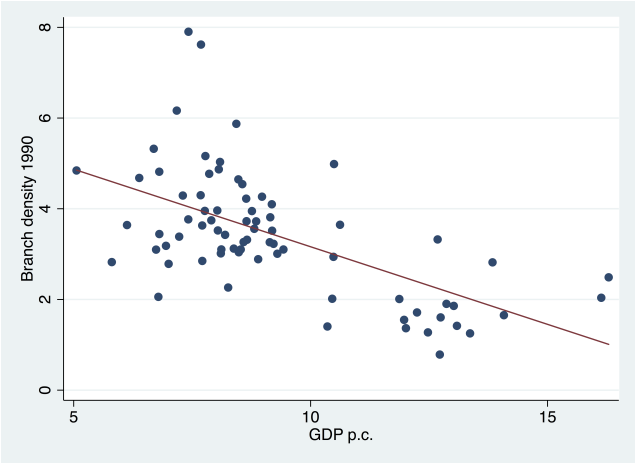
1.7.2 Figures

Figure 1: Bank branch density



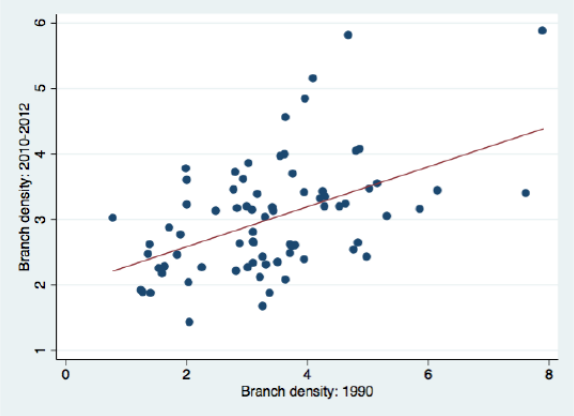
Notes: Regional units correspond to German NUTS 3 regions. Bank branch density is measured by the number of bank branches per 10,000 inhabitants in a given region. Number are reported for the year 2002.

Figure 2: East Germany: Number of bank branches in 1990 vs. GDP per capita



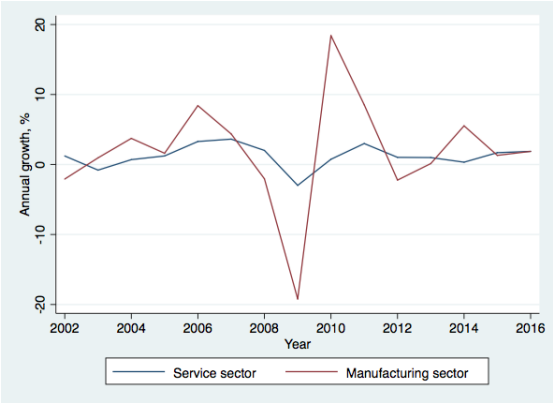
Notes: Figure 2 plots the branch density in 1990 versus GDP per capita in 1992 for East Germany. For GDP, the value of the year 1992 was taken given that no reliable information for the year 1990 was available.

Figure 3: Number of bank branches in 1990 vs. 2010

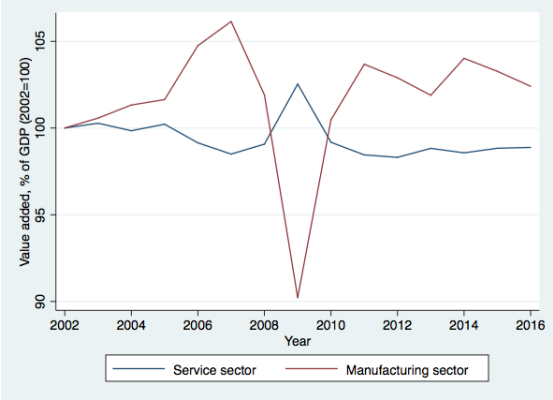


Notes: Figure 3 plots the branch density in 1990 versus the branch density in 2010 for East German regions.

Figure 4: Value added by sectors in Germany, % of GDP



(a) Annual growth rates



(b) Share in GDP

Notes: Figure 4 is from World Bank DataBank and plots value added of German manufacturing and service sectors in percent of GDP between 1991 and 2016.

1.7.3 Bank-based financing and R&D activities of firms

In their survey, Brevoort and Wolken (2009) provide an overview of theoretical considerations why distance might matter in banking. In doing so, they emphasize the importance of transportation and information costs both of which are positively related to the physical distance between a bank and its customers. As a consequence, smaller distances between banks and firms should be associated with better financing conditions of the latter. Employing measures for the local branch density network as a proxy for the development of local banking systems, the empirical evidence has tended to support this view.

Referring to the specific nature of R&D investments, Hsu, Tian, and Xu (2014) argue that there are several aspects why a better developed banking system will either not increase R&D financing or might even harm it. To the extent that regions with a higher bank branch density can be considered as having better developed banking markets the arguments raised by these authors therefore also apply to our study. The considerations underlying their assessment can be summarized as follows. Firstly, as Holmström (1989) points out, innovation investments are "hard to measure activities" for the outcome of which normally little or difficult-to-process information is available. As a consequence, there is likely a considerable dispersion of beliefs about the investment's potential outcomes. Following Allen and Gale (1999), such a situation favors market-based financing though because in such a system the optimistic investors will end up financing the project whereas in a bank-based system investors will abstain from investing into the information collection. The reason for doing so is that they anticipate potential conflicts with the delegated intermediary who makes the investment decision. Moreover, while prevailing prices in market-based systems contain valuable information guiding the decisions by managers (see Bond, Edmans, and Goldstein, 2012) and thus making investors willing to invest (Levine, 2005), no such public information is available in a bank-based system. As a consequence of the missing feedback effects resulting from the lack of public prices, bank-based systems are even prone to misallocation of funds , as, e.g., pointed out by Rajan and Zingales (2001) and Rajan and Zingales (2003).

A second major argument with a potentially even impeding effect of bank-based financing systems on the realization of R&D projects relates to the risk

attitudes of bank decision makers and the risk characteristics of innovation projects. Referring to Hall and Lerner (2010, Section 2) and Scherer (1998), Hsu, Tian, and Xu (2014) point out that returns to R&D projects are not only highly risky but that they are also characterized by distributions taking non-standard forms for which standard risk-management procedures do not work well. Given that, as e.g., Beck and Levine (2002) point out, bankers tend to be risk-averse and are therefore strongly concerned with not making losses, they might aim to execute control over customer firms to scale down or even completely avoid risky innovation investments (see Stiglitz, 1985 and Morck and Nakamura, 1999).[16] To the extent that denser branch networks induce more closeness to borrowers - and thus more information about and control above them - these considerations suggest a potentially negative relationship between bank branch density and R&D investments.

A third aspect making R&D projects not well suited for bank-based financing pertains to an incompatibility between a widely employed requirement of standard loan contracts with the nature of this type of investment. To avoid losses, bank-based financing is regularly tight to the provision of collateral (Berger and Udell, 1990). Whereas an investment in physical capital is generally associated with the built-up of deployable collateral, R&D investments mostly generate an intangible asset which is largely embedded in the firm's human capital (Hall and Lerner, 2010, Section 2) and therefore cannot be used to secure the underlying loan.

Finally, work by Hellwig (1991) and Rajan (1992) suggests that banks might exploit the power they derive from building up a relationship with a firm to extract rents and therefore dilute its R&D investments. The source of the bank's monopolistic margin emanates from the information which it receives in the context of an existing credit relation and which is generally hard to convey to outsiders, i.e., which is mostly "soft" in nature. Smaller firms are stronger affected by this mechanism. Again, this effect might be more pronounced in an environment characterized by a denser bank branch network due to the larger

[16] Another issue related to the distribution of returns to innovation projects emphasized by Hsu, Tian, and Xu (2014) concerns the asymmetric participation of different types of external financiers in the potentially enormous, but also very risky profits of such an investment. Whereas equity market investors are able to share upside returns and - according to Pástor and Veronesi (2009) - are willing to take the higher risk associated with them, loan contracts do not offer the opportunity to participate in extraordinary returns but only share in downside risks. In combination with their risk profile this might dissuade bank managers from engaging in R&D financing.

amount of information that banks have available about their customers.

Cetorelli and Peretto (2012) discuss another aspect that might influence the relationship between bank branch density and credit made available to firms. The authors argue that to judge the effects of banks on investment it is important not only to look at the quantity of credit provided but also at its quality. A higher level of bank screening activity might on the one side reduce the volume of loans granted but might on the other hand lead to a better allocation of the financial funds. Following this line of argument, a denser branch network might be associated with less credit for R&D investment but this observation would not necessarily imply a negative qualitative impact on firms' R&D activities but would be just the results of a more intense screening.

1.7.4 Additional tables

Table 19: Relationship between branch density (1990) and GDP (1992)

	Branch density 1990	Branch density 1990	Branch density 2010-12
GDP p.c. (1992)	-0.342***	-0.0615	
	(0.0536)	(0.0894)	
City		-1.917***	
		(0.510)	
Branch density (1990)			0.305***
			(0.0642)
Constant	6.583***	4.425***	1.971***
	(0.511)	(0.742)	(0.235)
R^2	0.359	0.464	0.234
F	40.82	31.16	22.63
Observations	75	75	76

Notes: Column 1 and 2 of Table 19 report results from regressing bank branch density in 1990 on GDP per capita in 1992 in this region. Coefficients in column 3 results from regressing bank branch density in 2012 on its 1990 values.

Sensitivity analyses: alternative econometric approaches

Table 20: Local banking markets and R&D: manufacturing sector

	R&D d.	R&D d.	R&D v.	R&D v.
Branch dens	-0.019	-0.028	-0.006**	-0.006**
	(0.021)	(0.020)	(0.003)	(0.003)
Old	0.028	0.033**	-0.005	-0.003
	(0.018)	(0.017)	(0.003)	(0.003)
Higher educ.	0.332***	0.313***	0.074***	0.080***
	(0.030)	(0.034)	(0.012)	(0.013)
Ltd. firm	0.205***	0.114***	0.022***	0.014***
	(0.023)	(0.021)	(0.002)	(0.002)
Small	0.131***	0.080***	0.003	-0.001
	(0.021)	(0.020)	(0.003)	(0.003)
Medium	0.272***	0.139***	-0.005	-0.014***
	(0.027)	(0.025)	(0.003)	(0.003)
Large	0.234***	0.125***	-0.004	-0.013**
	(0.043)	(0.035)	(0.006)	(0.006)
Export dummy=1		0.297***		0.021***
		(0.016)		(0.003)
Public funding=1		0.104***		0.007***
		(0.014)		(0.003)
N	14204	14204	14204	14204
R2	0.172	0.261	0.111	0.145
StateDummies	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes
Type	Manual IV	Manual IV	Manual IV	Manual IV

Table 21: Local banking markets and R&D: service sector

	R&D d.	R&D d.	R&D v.	R&D v.
Branch dens	-0.027	-0.037*	-0.006	-0.009
	(0.019)	(0.020)	(0.006)	(0.006)
Old	-0.019	-0.027*	-0.007	-0.006
	(0.015)	(0.015)	(0.006)	(0.005)
Higher educ.	0.211***	0.220***	0.048***	0.048***
	(0.025)	(0.024)	(0.008)	(0.007)
Ltd. firm	0.092***	0.078***	0.016***	0.012***
	(0.015)	(0.012)	(0.004)	(0.004)
Small	0.040***	0.021	0.001	-0.003
	(0.014)	(0.013)	(0.004)	(0.004)
Medium	0.068***	0.043**	-0.001	-0.008
	(0.022)	(0.019)	(0.005)	(0.005)
Large	0.038	0.011	-0.010*	-0.017***
	(0.026)	(0.028)	(0.005)	(0.006)
Export dummy=1		0.145***		0.032***
		(0.019)		(0.007)
Public funding=1		0.076***		0.020***
		(0.019)		(0.005)
N	12459	12459	12459	12459
R2	0.091	0.132	0.054	0.088
StateDummies	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes
Type	Manual IV	Manual IV	Manual IV	Manual IV

Table 22: Local banking markets and R&D: manufacturing sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.
Branch dens.	-0.003	-0.016*	0.001	-0.003	-0.024***	-0.031***
	(0.011)	(0.009)	(0.012)	(0.002)	(0.002)	(0.007)
Old	-0.001	0.008	0.053*	-0.001	0.008***	0.052***
	(0.017)	(0.020)	(0.031)	(0.003)	(0.003)	(0.008)
Higher educ.	0.305***	0.281***	0.517***	0.305***	0.280***	0.506***
	(0.034)	(0.029)	(0.081)	(0.005)	(0.006)	(0.019)
Ltd. firm	0.220***	0.128***	0.051	0.220***	0.128***	0.047***
	(0.018)	(0.015)	(0.031)	(0.002)	(0.003)	(0.007)
Small	0.124***	0.075***	0.074**	0.124***	0.076***	0.078***
	(0.014)	(0.016)	(0.035)	(0.002)	(0.003)	(0.008)
Medium	0.284***	0.138***	0.130***	0.284***	0.139***	0.132***
	(0.022)	(0.024)	(0.037)	(0.004)	(0.004)	(0.008)
Large	0.219***	0.120***	0.165***	0.219***	0.119***	0.166***
	(0.050)	(0.039)	(0.059)	(0.006)	(0.006)	(0.012)
Export dummy=1		0.312***	0.325***		0.312***	0.327***
		(0.018)	(0.031)		(0.002)	(0.006)
Public funding=1		0.109***	0.109***		0.109***	0.108***
		(0.019)	(0.034)		(0.003)	(0.006)
Int. fin.			-0.205***			-0.213***
			(0.064)			(0.014)
N	11175	10373	3407	11175	10373	3407
N firms	3874	3526	1389	3874	3526	1389
R2	0.209	0.315	0.293	0.209	0.314	0.291
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear BE	Linear BE	Linear BE	Linear IV-BE	Linear IV-BE	Linear IV-BE

Table 23: Local banking markets and R&D: service sector

	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.
Branch dens.	-0.015**	-0.020***	-0.010	-0.032***	-0.039***	-0.043***
	(0.007)	(0.007)	(0.013)	(0.002)	(0.002)	(0.007)
Old	-0.029**	-0.041***	-0.090***	-0.028***	-0.040***	-0.088***
	(0.013)	(0.014)	(0.028)	(0.002)	(0.003)	(0.008)
Higher educ.	0.178***	0.194***	0.341***	0.176***	0.191***	0.335***
	(0.019)	(0.019)	(0.045)	(0.003)	(0.003)	(0.012)
Ltd. firm	0.110***	0.091***	0.074***	0.109***	0.090***	0.073***
	(0.009)	(0.011)	(0.017)	(0.002)	(0.002)	(0.006)
Small	0.029***	0.011	0.015	0.029***	0.011***	0.016**
	(0.011)	(0.012)	(0.025)	(0.002)	(0.002)	(0.007)
Medium	0.049***	0.030	0.051*	0.049***	0.030***	0.048***
	(0.016)	(0.019)	(0.029)	(0.003)	(0.003)	(0.008)
Large	0.044	0.010	0.004	0.043***	0.009**	-0.000
	(0.029)	(0.032)	(0.060)	(0.005)	(0.004)	(0.012)
Export dummy=1		0.174***	0.179***		0.175***	0.180***
		(0.014)	(0.025)		(0.003)	(0.006)
Public funding=1		0.102***	0.107***		0.103***	0.109***
		(0.021)	(0.037)		(0.004)	(0.010)
Int. fin.			0.034			0.032**
			(0.041)			(0.014)
N	9646	8860	2629	9646	8860	2629
N firms	3570	3246	1130	3570	3246	1130
R2	0.095	0.158	0.172	0.094	0.157	0.169
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear BE	Linear BE	Linear BE	Linear IV-BE	Linear IV-BE	Linear IV-BE

Table 24: Local banking markets and R&D: manufacturing sector

	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.004**	-0.003*	-0.001	-0.004***	-0.005***	-0.005***
	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.001)
Old	-0.013***	-0.009**	-0.012	-0.013***	-0.009***	-0.012***
	(0.004)	(0.004)	(0.008)	(0.001)	(0.001)	(0.002)
Higher educ.	0.069***	0.078***	0.136***	0.068***	0.078***	0.135***
	(0.010)	(0.010)	(0.026)	(0.001)	(0.002)	(0.006)
Ltd. firm	0.028***	0.021***	0.009**	0.028***	0.021***	0.009***
	(0.004)	(0.003)	(0.004)	(0.000)	(0.000)	(0.001)
Small	-0.004	-0.006*	0.005	-0.004***	-0.006***	0.005***
	(0.004)	(0.003)	(0.006)	(0.001)	(0.001)	(0.002)
Medium	-0.010**	-0.018***	-0.012**	-0.010***	-0.018***	-0.012***
	(0.004)	(0.004)	(0.006)	(0.001)	(0.001)	(0.001)
Large	-0.011	-0.019**	-0.019***	-0.011***	-0.019***	-0.019***
	(0.009)	(0.009)	(0.007)	(0.001)	(0.002)	(0.002)
Export dummy=1		0.020***	0.014***		0.021***	0.014***
		(0.003)	(0.005)		(0.001)	(0.001)
Public funding=1		0.004	0.009*		0.004***	0.009***
		(0.004)	(0.005)		(0.001)	(0.001)
Int. fin.			-0.007			-0.008**
			(0.012)			(0.003)
N	9742	9020	3091	9742	9020	3091
N firms	3530	3201	1304	3530	3201	1304
R2	0.105	0.140	0.207	0.105	0.140	0.206
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear BE	Linear BE	Linear BE	Linear IV-BE	Linear IV-BE	Linear IV-BE

Table 25: Local banking markets and R&D: service sector

	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.001	-0.003	-0.007**	-0.005***	-0.007***	-0.010***
	(0.002)	(0.002)	(0.003)	(0.000)	(0.000)	(0.001)
Old	-0.009**	-0.009**	-0.005	-0.009***	-0.009***	-0.005***
	(0.004)	(0.005)	(0.006)	(0.001)	(0.001)	(0.001)
Higher educ.	0.041***	0.044***	0.076***	0.040***	0.043***	0.075***
	(0.006)	(0.006)	(0.011)	(0.001)	(0.001)	(0.004)
Ltd. firm	0.019***	0.014***	0.007	0.018***	0.014***	0.007***
	(0.003)	(0.003)	(0.006)	(0.000)	(0.000)	(0.001)
Small	-0.000	-0.003	-0.000	-0.000	-0.003***	-0.000
	(0.003)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
Medium	-0.006	-0.009**	0.004	-0.006***	-0.010***	0.004**
	(0.004)	(0.004)	(0.007)	(0.001)	(0.001)	(0.002)
Large	-0.012***	-0.016**	-0.016**	-0.012***	-0.016***	-0.016***
	(0.004)	(0.007)	(0.007)	(0.001)	(0.001)	(0.002)
Export dummy=1		0.032***	0.038***		0.033***	0.038***
		(0.005)	(0.006)		(0.001)	(0.002)
Public funding=1		0.019***	0.025***		0.019***	0.025***
		(0.006)	(0.009)		(0.001)	(0.003)
Int. fin.			0.016			0.016***
			(0.024)			(0.006)
N	7940	7257	2291	7940	7257	2291
N firms	3121	2816	1034	3121	2816	1034
R2	0.050	0.087	0.146	0.048	0.086	0.146
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear BE	Linear BE	Linear BE	Linear IV-BE	Linear IV-BE	Linear IV-BE

Table 26: Local banking markets and R&D

	R&D d.	R&D d.	R&D d.	R&D d.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.021	-0.036*	-0.029*	-0.039**	-0.006***	-0.007***	-0.006	-0.009**
	(0.020)	(0.020)	(0.017)	(0.017)	(0.002)	(0.002)	(0.004)	(0.004)
Old	0.029	0.037*	-0.014	-0.023	-0.005	-0.003	-0.007	-0.006
	(0.020)	(0.021)	(0.015)	(0.016)	(0.003)	(0.003)	(0.006)	(0.005)
Higher educ.	0.374***	0.382***	0.173***	0.171***	0.074***	0.080***	0.048***	0.047***
	(0.036)	(0.042)	(0.018)	(0.018)	(0.011)	(0.013)	(0.008)	(0.007)
Ltd. firm	0.227***	0.147***	0.093***	0.079***	0.022***	0.014***	0.015***	0.012***
	(0.024)	(0.026)	(0.013)	(0.012)	(0.002)	(0.002)	(0.004)	(0.004)
Small	0.153***	0.112***	0.040***	0.023*	0.003	-0.000	0.001	-0.003
	(0.023)	(0.025)	(0.012)	(0.014)	(0.003)	(0.003)	(0.004)	(0.004)
Medium	0.294***	0.169***	0.065***	0.044**	-0.005	-0.014***	-0.001	-0.008
	(0.027)	(0.028)	(0.019)	(0.019)	(0.003)	(0.003)	(0.005)	(0.005)
Large	0.259***	0.153***	0.041*	0.017	-0.004	-0.013**	-0.010**	-0.017***
	(0.045)	(0.044)	(0.024)	(0.024)	(0.006)	(0.006)	(0.005)	(0.006)
v2	0.022	0.030	0.030	0.040**	0.004	0.004	0.007	0.009**
	(0.020)	(0.022)	(0.020)	(0.020)	(0.003)	(0.003)	(0.004)	(0.004)
Export dummy=1		0.315***		0.131***		0.021***		0.032***
		(0.016)		(0.017)		(0.003)		(0.008)
Public funding=1		0.123***		0.063***		0.007***		0.020***
		(0.016)		(0.015)		(0.002)		(0.006)
N	11175	10373	9646	8860	9742	9020	7940	7257
R2	0.141	0.217	0.118	0.161	0.111	0.145	0.053	0.088
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	RV	RV	RV	RV	RV	RV	RV	RV
Sample	Mnf East	Mnf East	Sv East	Sv East	Mnf East	Mnf East	Sv East	Sv East

Table 27: Local banking markets and R&D

	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.
Branch dens.	0.002	0.010	-0.021	-0.029*	-0.006	0.002	0.002	-0.002
	(0.014)	(0.009)	(0.020)	(0.017)	(0.013)	(0.008)	(0.007)	(0.005)
Old	0.007	0.033***	0.029	-0.014	0.036*	0.001	-0.006	0.016***
	(0.013)	(0.010)	(0.020)	(0.015)	(0.018)	(0.010)	(0.008)	(0.006)
Higher educ.	0.228***	0.311***	0.374***	0.173***	0.505***	0.249***	0.190***	0.284***
	(0.019)	(0.015)	(0.036)	(0.018)	(0.036)	(0.012)	(0.013)	(0.010)
Ltd. firm	0.193***	0.161***	0.227***	0.093***	0.167***	0.091***	0.121***	0.108***
	(0.014)	(0.010)	(0.024)	(0.013)	(0.018)	(0.010)	(0.008)	(0.005)
Small	0.104***	0.089***	0.153***	0.040***	0.126***	0.047***	0.078***	0.063***
	(0.014)	(0.009)	(0.023)	(0.012)	(0.015)	(0.009)	(0.007)	(0.005)
Medium	0.207***	0.236***	0.294***	0.065***	0.346***	0.103***	0.204***	0.185***
	(0.017)	(0.013)	(0.027)	(0.019)	(0.019)	(0.015)	(0.013)	(0.009)
Large	0.152***	0.199***	0.259***	0.041*	0.318***	0.084***	0.125***	0.161***
	(0.034)	(0.021)	(0.045)	(0.024)	(0.030)	(0.021)	(0.022)	(0.014)
v2	0.008	-0.010	0.022	0.030	0.006	-0.014	0.005	-0.000
	(0.014)	(0.010)	(0.020)	(0.020)	(0.015)	(0.009)	(0.008)	(0.005)
N	20821	31260	11175	9646	15097	16163	41859	72895
R2	0.127	0.119	0.141	0.118	0.130	0.120	0.123	0.106
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	RV	RV	RV	RV	RV	RV	RV	RV
Sample	All East	All West	Mnf East	Sv East	Mnf West	Sv West	All sectors East	All sectors West

Table 28: Local banking markets and R&D

	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.005**	-0.000	-0.006***	-0.006	-0.001	-0.000	-0.003**	-0.001
	(0.002)	(0.001)	(0.002)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)
Old	-0.006*	-0.007***	-0.005	-0.007	-0.010***	-0.006**	-0.006***	-0.005***
	(0.003)	(0.002)	(0.003)	(0.006)	(0.003)	(0.002)	(0.002)	(0.001)
Higher educ.	0.056***	0.054***	0.074***	0.048***	0.086***	0.044***	0.043***	0.045***
	(0.007)	(0.005)	(0.011)	(0.008)	(0.010)	(0.005)	(0.006)	(0.003)
Ltd. firm	0.020***	0.013***	0.022***	0.015***	0.010***	0.012***	0.012***	0.007***
	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)	(0.002)	(0.001)	(0.001)
Small	0.002	-0.000	0.003	0.001	0.003	-0.003	0.002*	0.001
	(0.002)	(0.001)	(0.003)	(0.004)	(0.002)	(0.002)	(0.001)	(0.001)
Medium	-0.002	-0.000	-0.005	-0.001	0.004**	-0.006***	0.003*	0.002*
	(0.003)	(0.002)	(0.003)	(0.005)	(0.002)	(0.002)	(0.002)	(0.001)
Large	-0.007**	0.001	-0.004	-0.010**	0.007**	-0.004	0.000	0.003***
	(0.003)	(0.002)	(0.006)	(0.005)	(0.003)	(0.003)	(0.002)	(0.001)
v2	0.004	-0.000	0.004	0.007	0.001	-0.002	0.003**	0.000
	(0.002)	(0.001)	(0.003)	(0.004)	(0.001)	(0.002)	(0.001)	(0.001)
N	17682	26163	9742	7940	12934	13229	35221	60367
R2	0.074	0.065	0.111	0.053	0.098	0.055	0.055	0.053
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Type	RV	RV	RV	RV	RV	RV	RV	RV
Sample	All East	All West	Mnf East	Sv East	Mnf West	Sv West	All s East	All s West

All sample

Table 29: Local banking markets and R&D: all sample

	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.	R&D d.
Branch dens.	0.001	-0.004	-0.009	-0.040**	-0.041**	-0.050**
	(0.011)	(0.009)	(0.015)	(0.019)	(0.018)	(0.025)
Sector=2 × Branch dens.	0.001	0.007	0.020	0.043**	0.039**	0.064**
	(0.010)	(0.009)	(0.017)	(0.020)	(0.019)	(0.029)
Sector=3 × Branch dens.	-0.001	0.003	0.023	0.062***	0.061***	0.082**
	(0.014)	(0.013)	(0.017)	(0.023)	(0.022)	(0.034)
Sector=4 × Branch dens.	-0.003	0.002	-0.010	0.043	0.042	0.006
	(0.018)	(0.017)	(0.031)	(0.030)	(0.027)	(0.044)
Sector=5 × Branch dens.	-0.014	-0.014	-0.009	0.005	-0.008	-0.008
	(0.015)	(0.013)	(0.021)	(0.022)	(0.021)	(0.029)
Sector=6 × Branch dens.	0.004	0.001	0.012	0.008	-0.005	-0.033
	(0.020)	(0.019)	(0.033)	(0.040)	(0.041)	(0.071)
Sector=2	-0.274***	-0.201***	-0.265***	-0.404***	-0.302***	-0.402***
	(0.032)	(0.029)	(0.053)	(0.065)	(0.059)	(0.096)
Sector=3	-0.266***	-0.229***	-0.324***	-0.461***	-0.409***	-0.511***
	(0.041)	(0.036)	(0.054)	(0.069)	(0.063)	(0.108)
Sector=4	-0.195***	-0.172***	-0.167*	-0.338***	-0.295***	-0.219*
	(0.055)	(0.049)	(0.090)	(0.090)	(0.081)	(0.131)
Sector=5	-0.204***	-0.155***	-0.201***	-0.268***	-0.180***	-0.211**
	(0.046)	(0.042)	(0.065)	(0.068)	(0.065)	(0.093)
Sector=6	-0.219***	-0.134**	-0.216**	-0.236*	-0.119	-0.085
	(0.067)	(0.064)	(0.106)	(0.133)	(0.134)	(0.229)
Old	-0.009	-0.006	0.009	-0.009	-0.005	0.010
	(0.007)	(0.007)	(0.016)	(0.007)	(0.007)	(0.016)
Higher educ.	0.198***	0.205***	0.340***	0.194***	0.201***	0.334***
	(0.014)	(0.014)	(0.029)	(0.014)	(0.014)	(0.029)
Ltd. firm	0.096***	0.065***	0.041***	0.095***	0.064***	0.040***
	(0.007)	(0.007)	(0.011)	(0.007)	(0.007)	(0.011)
Small	0.059***	0.035***	0.035***	0.060***	0.035***	0.037***
	(0.008)	(0.007)	(0.012)	(0.007)	(0.007)	(0.012)
Medium	0.166***	0.097***	0.084***	0.166***	0.096***	0.083***
	(0.012)	(0.012)	(0.017)	(0.012)	(0.011)	(0.016)
Large	0.100***	0.054***	0.086**	0.098***	0.052***	0.083**
	(0.018)	(0.017)	(0.034)	(0.018)	(0.017)	(0.035)
Export dummy=1		0.216***	0.236***		0.217***	0.238***
		(0.010)	(0.012)		(0.010)	(0.011)
Public funding=1		0.112***	0.103***		0.113***	0.103***
		(0.009)	(0.014)		(0.009)	(0.014)
Int. fin.			0.020			0.018
			(0.023)			(0.022)
N	41859	38517	11422	41859	38517	11422
R2	0.192	0.262	0.287	0.189	0.259	0.283
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear	Linear IV	Linear IV	Linear IV

Table 30: Local banking markets and R&D: all sample

	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.	R&D v.
Branch dens.	-0.004***	-0.005***	-0.007***	-0.011***	-0.012***	-0.014***
	(0.001)	(0.001)	(0.002)	(0.004)	(0.004)	(0.005)
Sector=2 × Branch dens.	0.004***	0.005***	0.009***	0.013***	0.013***	0.018***
	(0.001)	(0.001)	(0.002)	(0.005)	(0.005)	(0.007)
Sector=3 × Branch dens.	0.006***	0.006***	0.011***	0.016***	0.016***	0.026***
	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.006)
Sector=4 × Branch dens.	0.004*	0.005**	0.004	0.010*	0.010*	0.006
	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)	(0.006)
Sector=5 × Branch dens.	0.002	0.002	-0.000	0.003	0.002	0.001
	(0.004)	(0.004)	(0.003)	(0.005)	(0.005)	(0.007)
Sector=6 × Branch dens.	0.001	0.001	0.007	0.002	0.000	0.003
	(0.004)	(0.003)	(0.004)	(0.008)	(0.009)	(0.015)
Sector=2	-0.034***	-0.026***	-0.034***	-0.063***	-0.052***	-0.064***
	(0.005)	(0.005)	(0.007)	(0.015)	(0.015)	(0.021)
Sector=3	-0.037***	-0.033***	-0.045***	-0.071***	-0.065***	-0.092***
	(0.007)	(0.006)	(0.009)	(0.014)	(0.014)	(0.020)
Sector=4	-0.029***	-0.028***	-0.022**	-0.047***	-0.044**	-0.030
	(0.008)	(0.007)	(0.009)	(0.018)	(0.018)	(0.021)
Sector=5	-0.019*	-0.015	-0.006	-0.023	-0.015	-0.011
	(0.012)	(0.012)	(0.011)	(0.015)	(0.015)	(0.023)
Sector=6	-0.019	-0.013	-0.028**	-0.022	-0.011	-0.018
	(0.014)	(0.011)	(0.013)	(0.027)	(0.028)	(0.049)
Old	-0.006***	-0.004***	-0.005*	-0.006***	-0.004***	-0.005*
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Higher educ.	0.042***	0.046***	0.079***	0.041***	0.045***	0.078***
	(0.005)	(0.006)	(0.012)	(0.005)	(0.005)	(0.012)
Ltd. firm	0.011***	0.007***	0.003*	0.011***	0.007***	0.003*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Small	0.001	-0.001	0.002	0.001	-0.001	0.003
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Medium	-0.001	-0.008***	-0.004**	-0.001	-0.008***	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Large	-0.002	-0.007***	-0.015***	-0.002	-0.008***	-0.015***
	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
Export dummy=1		0.020***	0.020***		0.020***	0.020***
		(0.002)	(0.002)		(0.002)	(0.002)
Public funding=1		0.012***	0.014***		0.012***	0.014***
		(0.002)	(0.003)		(0.002)	(0.003)
Int. fin.			0.007			0.007
			(0.007)			(0.007)
N	35221	32224	10066	35221	32224	10066
R2	0.071	0.101	0.142	0.066	0.096	0.135
StateDummies	Yes	Yes	Yes	Yes	Yes	Yes
CountyGDP	Yes	Yes	Yes	Yes	Yes	Yes
YearDummies	Yes	Yes	Yes	Yes	Yes	Yes
Type	Linear	Linear	Linear	Linear IV	Linear IV	Linear IV

Chapter 2

The effect of local bank competition on regional growth

2.1 Introduction

Starting from the work by Schumpeter (1911) a large body of literature have been devoted to investigate the link between financial development and economic growth. While some emphasize the importance of financial markets development, in general, and of banking markets, inter alia, for economic growth at the macro- and microeconomic level (Gurley and Shaw (1955), Goldsmith (1969), King and Levine (1993a), King and Levine (1993b), Levine and Zervos (1998), Beck, Levine, and Loayza (2000), Guiso, Sapienza, and Zingales (2004), Levine (2005), Loayza and Rancière (2006), and Hasan, Koetter, and Wedow (2009), among others), others, like Lucas (1988), argue that this finding is "over-stressed" or, as Robinson (1952), witness that there is a reverse relationship, i.e. economies with good growth prospects encourage development of financial markets to support further growth.

On a par with the significance of financial development, another point of concerns that obtained much less consideration is the effect of market competition in the financial sector on economic development. In the last two decades, the research community as well as policymakers have opened a discussion on the economic role of bank rivalry which as indicated by Love and Martínez Pería (2014), has intensified in the light of the recent global financial crisis as many have debated whether fierce banking rivalry had somewhat contributed to the economic downturn (see, for example, Dell'Ariccia, Igan,

and Laeven (2008)). Indeed, the question of competition is of substantial concerns for several reasons. The degree of competition in the banking industry influences the supply of credit and has a considerable outcome on borrowers who are dependent on external finance. The extent of competition in the banking industry can affect the degree of effectiveness of the produced products and services, their quality, and the level of innovation in that sector. Peculiar to the financial sector is the relationship between competition and financial stability that has been acknowledged in a number of theoretical and empirical investigations.[1]

The common sense would advise that any constraints on banking competitive intensity should yield welfare losses. Banks with market power would employ their ability to retrieve rents by charging higher interest rates on loans from their borrowers and by paying lower deposit rates. The former would alter entrepreneurs' investing behavior producing a distortion toward the conducting risky projects which, in turn, would jeopardize financial stability and enhance the chance of systemic risk. Higher lending rates would also restrain incentives to undertake research and development investment leading to a braking in technological progress and productivity growth. In the meantime, capital formation would be also slow downed, thus hindering the convergence of income per capita to its highest levels. However, some researchers (e.g., Petersen and Rajan (1995)) find additional aspects in the question of banking competition which underline possibly negative implication of intense rivalry as a consequence of less incentives to invest in close lending relationship (Section 2.2 provides detailed representation). So, the link is not so trivial as one could consider.

Analogous to the theory, those limited numbers of empirical papers that study the importance of the degree of banking competition for economic activity provide conflicting evidence. Pagano (1993) demonstrates that firms' access to credit is limited as a consequence of inefficiencies created by imperfect competition on credit markets. Thus, this dampens economic growth. Similarly, Shaffer (1998) shows for the case of the U.S. that markets with a larger number of banks are characterized by a higher growth rate of household income. Using industry-level cross-country data Claessens and Laeven (2005) find a positive effect of strong competition in banking markets on industrial growth on the sample of 16 countries. While Black and Strahan (2002) show a negative impact of banking market power on the number of new businesses in the

[1] Allen and Gale (2004) present a review of these studies.

U.S., Bonaccorsi di Patti and Dell'Ariccia (2004) using cross-industry and cross-province Italian data discover that banking concentration is favorable for firms from informationally opaque sectors. The similar conclusion is drawn by Cetorelli and Gambera (2001) although, in general, they document a depressing effect of banking concentration on growth. The recent study by Guevara and Maudos (2011) analyzing the cross-sector and cross-country sample document an inverted U-shaped impact of bank market power on economic growth, implying the highest growth effect at its intermediate levels and therefore supporting the hypothesis of beneficial effect of concentrated banking market.

Obviously, the shortage of available empirical evidence hitherto restrains comprehensive understanding of the issue. Therefore, the aim of this paper is possibly to fill this gap and further shed light on the relationship between banking market competitive conditions and economic growth. More precisely, similarly to Bonaccorsi di Patti and Dell'Ariccia (2004) I use local banking market and regional data focusing on within-country heterogeneity. The data represents a combination of information on bank branches and on economic activity at the county level in Germany. The German case serves very well the purpose of the analysis. Germany is the bank-based system (see Deutsche Bundesbank (2012)) the most significant and striking characteristic of which is that it still represents a three-pillar system where privately owned banks coexist with banks under direct government involvement. Moreover, during the last years the German banking system has gone through a continuous consolidation process with a considerable drop in the number of credit institutions (Deutsche Bundesbank (2016)).

An important contribution of this study is that it provides a causal identification of the link between the intense of competition in local banking market and economic development. One crucial challenge for a conduct of such kind of empirical studies is related to likely endogeneity problems resulting either from reverse causality and/or omitted variables. To overcome these problems, an instrumental variable approach is employed. To construct an instrument for the current local banking system two historical features of the German banking system are exploited. As discussed in Section 1.3.3, the former East German banking system was more or less independently evolving from the economic development of the respective region. For Western German regions, I use the instrument proposed by Beck, Bernhardt, and Schwerdt (2016). There is the fact that one of the major sectors of the local banking market was not

primarily acting in a profit maximizing manner but was intended to provide public services. Moreover, this sector, namely the savings banks sector, was (and still is) publicly owned, making its decisions depending on local politicians. It is shown below that both of these instruments fulfill the necessary criteria to a sufficient degree to be used in an instrumental variable regression setup.

The obtained results provide the following evidence. For the West German regions, more fierce banking competition increases labor productivity and unemployment rate as a result of more effective employers. Furthermore, better banking competition promotes firm creation while stronger concentration in regional banking markets is beneficial for number of firms and their size. Significantly, this effect is more pronounced for small and medium enterprises which makes sense given their information opaqueness and, thus, limited options to rise external funds from other sources apart bank finance. However, the results do not indicate any significant effect of local banking competitive conditions on economic growth for East Germany.

After this introduction, the structure of the paper is as follows. Section 2.2 discusses theoretical considerations which propose contrasting arguments on the influence of baking rivalry on economic development. In Section 2.3, a description of the data sets as well as some descriptive statistics are illustrated. Section 2.4 describes the empirical approach and the employed instruments. The obtained results are demonstrated in Section 2.5. Section 2.6 summarizes and concludes.

2.2 Theoretical considerations

Theoretical contributions propose an equivocal relationship between the extent of banking market competition and economic activity. On the one hand, the standard result from market theory implies the negative impact of banking concentration. Banks with market power would charge higher interest rates and provide a less amount of loans in equilibrium compared to the perfect competition case. So, systems with such banking structure would exhibit evidently lower investment and weak economic growth. Whereas less external funds harm all firms, smaller firms as well as newcomers will suffer more since given their nature they rely more heavily on bank credit than larger and more

established businesses.[2] Additionally, as Claessens and Laeven (2005) point out, intense competition very likely stimulates supply of a wider range of financial services with better quality. On the other hand, monopolistic banks may channel a larger quantity of loanable funds since they are more inclined to invest in lending relationships with firms making possible the acquisition of soft and informal information to mitigate informational asymmetries. This, in turn, improves screening and monitoring procedures and allows the exchange of credit funds which otherwise might not have occurred. This idea was first introduced by Mayer (1988) and later framed and examined by Rajan (1992) and Petersen and Rajan (1995). As discussed in some studies, lasting relationships between a bank and its customers will facilitate funding availability (Cole (1998), Elsas and Krahnen (1998), and Harhoff and Körting (1998)) and/or relax guarantee assets for the clients (Degryse and Van Cayseele (2000) and Chakraborty and Hu (2006)) although, as Boot (2000) argues, interest rates charged are higher than in the competitive banking market. Following, Petersen and Rajan (1995), a bank will establish long-term lending relationships with young unknown firms if it can extract future profits once they become successful. In markets with more intensive competition, however, a bank has a risk to loose the successful start-ups because as they are established they will search for lower-cost financing. Those banks that did not invest funds in firms with no record of performance have a cost advantage in supplying better loan conditions with respect to those that strive to retrieve the initial cost. Given the presence of this free-riding issue, competition among banks can cause credit rationing in the way that potentially high quality projects of young and unknown entrepreneurs may not raise funds.[3] Hence, as Petersen and Rajan (1995) point out, competitive banking markets have fewer incentives to establish a lasting relationship. Meanwhile, the persistent lending relationship enables the bank to obtain market power over its clients due to a monopoly of information, leading to a hold-up problem (see Sharpe (1990) and Rajan (1992)).

[2]For more evidence on access to finance by small and medium-sized enterprises see, e.g., Berger and Udell (1998) and Beck and Demirgüc-Kunt (2006).

[3]See also Lang and Nakamura (1989) and Cetorelli and Peretto (2000) for similar expositions of information externalities and credit market competition.

2.3 Data and descriptive statistics

The provided study is based on a unique data set of German regional bank branch and economic development between 2000 and 2015. Identifying the local market I follow the so-called NUTS classification system of the Statistical Office of the European Union, Eurostat, and characterize it at NUTS 3 level.[4] According to Nomenclature of territorial units of 2013, Germany consists of 402 NUTS 3 regions. The motivation for such an identification is provided in Chapter 1. In terms of the competitive conditions, the "regional principle" implies that the local banks from one network are supposed not to compete with each other. Whereas intra-pillar competition is restricted, the degree of inter-pillar competition is fierce (Behr and Schmidt (2015)).

2.3.1 Characteristics of local banking competition

To construct the variable that characterizes the local banking market competition the unique data set on bank branches in Germany has been compiled. The current banking data (2000-2015) is collected from the Hoppenstedt Banken-Ortslexikon (HBO) that is published by Bisnode Deutschland GmbH.[5] This is a monthly collected database which includes all German credit institutions (headquarters and branches) in accordance with the classification of the Bundesbank. The main advantage of the data is that it allows to know an exact location of a branch which is not possible with the Bundesbank statistics (see Deutsche Bundesbank (2016)). So, one can obtain and observe the branch distribution at a district/region level. For purpose of this study, I focus on so called "three pillars" of the German banking system and, thus, only branches of credit, cooperative, and savings banks are relevant.

The data for the period between 2000 and 2015 has been collected according to the following criteria. The subject of interest is full-time employed branches since they are involved in main activity of an institution (credit supply, deposit demand, etc.). Such "representatives" as bank bus stops, SB center, Servicestellen/Zahlstellen and/or similar to them are excluded because they are not likely to influence lending/credit activities. Additionally, there are credit institutions which are situated in Tirol (Austria) (e.g., Tiroler Sparkasse, Raiffeisenbank Reutte eG); they are also removed. Unfortunately, data on

[4]For more details, see Eurostat (2015).

[5]For more details, see `http://banken-ortslexikon.de`.

Deutsche Postbank AG is presented not fully thus it has not been included. Sometimes it might be that under the same address a credit institution has different branch types: for example, Immobiliencenter, Firmenkundencenter and/or Hauptgeschäftsstelle. In order to avoid double counting, the branch has been reported only once.

There are differences between the presented data and the statistics by the Bundesbank. Variations can be explained by the criteria during the collection process mentioned above. Another reason is different target dates. The Bundesbank statistics are based on information available to the 31st of December of each year. On contrary, the applied HBO data was from June (No. 6) of each year (except 2013 where only 07/2013 was available). Moreover, there were mergers of institutions in each year and because of different reference date numbers on branches are likely to differ: the Bundesbank reports an already merged institution, while HBO refers to midyear statistics, so, represents institutions under a merge procedure.

Local banking competitive conditions are measured by the Herfindahl-Hirschman index (HHI) which is widely used in the literature (e.g., D'Auria, Foglia, and Reedtz (1999), Bonaccorsi di Patti and Dell'Ariccia (2004), Cetorelli and Strahan (2006), and Diallo and Koch (2018)). In comparison to others, here, the HHI is based on an actual branch network of each bank in a given region. The data allows to identify to which bank a particular branch belongs, so the HHI is determined by the sum of squared market shares of each bank in a given region, or:

$$HHI_i = \sum_{b=1}^{B_i} \left(\frac{Branches_{i,b}}{\sum_{b=1}^{B_i} Branches_i} \right)^2 \tag{2.3.1}$$

where HHI_i is the concentration index in region i, $Branch_{i,b}$ is the number of branches of bank b in region i. The HHI would approach zero in the case of a large number of firms with a very small market share each, while the maximum value of one would mean an existence of monopoly.

One needs, however, to emphasize that lower concentration and higher competition are synonyms only if one accepts structure-conduct-performance (SCP) paradigm. This framework considers that there is a trade-off between market concentration and the extent of rivalry, where the latter is in direct ratio to the number of firms and inversely proportional to the average market share. Alternatively, the efficiency hypothesis suggests that an increase in market

share may be explained by improvements in bank efficiency. In their study, Barros, Ferreira, and Williams (2007) examine the performance of European banks and show that the German market has become more competitive while being lower concentrated. Thus, applying the SCP paradigm in this study is reasonable. So, from here on lower (higher) competition is associated with higher (lower) market power in a banking market.

Table 31 presents the descriptive statistics of average values over 2000-2006 and 2010-2015. The average region possesses around 81 branches among which those that correspond to geographically-constrained cooperative and savings banks prevail with a market share of about 33% and 35%, respectively. Differentiating by regions shows that, on average, the West German district is characterized by almost 88 bank branches that is considerably larger in comparison to 52 in the East part. Moving to the concentration index the mean country value of the HHI is equal to 0.236, while comparing West and East Germany indicates that local banking markets are slightly more concentrated in the latter (0.222 vs. 0.296). Moreover, Figure 5 demonstrates that there is significant cross-sectional heterogeneity in the level of banking competition across German districts.

2.3.2 Measures of regional growth

To proxy the regional economic development I follow Guiso, Sapienza, and Zingales (2004) and employ two types of measurements. First, macroeconomic variables such as GDP per capita, GDP per person employed, income per capita, and unemployment rate are used. Second, I also examine the effect of banking market competition on more narrowly defined measurements of regional growth such as business registrations and deregistrations, a number of manufacturing firms, and employment in the manufacturing sector. These data are provided by the German Statistical Office.

The second part of Table 31 illustrates the descriptive statistics of regional economic indicators which are averaged over 2000-2006 and 2010-2015. The mean East German region is characterized by the lower level of GDP per capita which is by around 36% and 45% smaller than the countrywide mean and the correspondent value for West German, respectively. Moreover, the productivity which is described by GDP per person employed is also significantly higher in the West German districts: While the average corresponding number is equal

to 47,027 euro in the East German regions this measure in the West German regions comprises 58,830 euro. Income per capita also indicates the similar patterns of difference between West and East Germany. Turning to the next macroeconomic variable - unemployment rate - its mean value across the East German counties is twice as large as across the West German ones. Moving to more narrowly defined indicators of regional economic activity Table 31 shows that, on average, 96.22 (80.10) new firms per 10,000 inhabitants in West (East) Germany are registered over the given time period. The number of manufacturing firms per 10,000 inhabitants is almost the same in West and East Germany whereas they are larger in size in the former.

2.4 Econometric model

Following Bonaccorsi di Patti and Dell'Ariccia (2004) to investigate the effect of local banking competition on regional economic growth the following model is employed:

$$GROWTH_i = \alpha + \beta HHI_i + \gamma REG_i + \varepsilon_i \tag{2.4.1}$$

where $GROWTH_i$ is the measurements of growth in region i, HHI_i is the HHI in region i, REG_i is the regional controls for region i. More specifically, this comprises a measure of the size of a region and an indicator whether a region corresponds to rural or urban areas. Furthermore, the initial level of GDP is included in order to give evidence of any convergence effect. The averages of dependent as well as independent variables over 2000-2006 and 2010-2015 are taken, so that the time periods where the financial crisis took place are excluded since they are characterized by unusual economic development.

The estimation model potentially suffers from two drawbacks which can bias the coefficient on the effect of local banking market competition on the dependent variable. First, there might be an unobserved variable that influences both the bank competition measurement and the respective dependent variable. Second, the issue of reverse causality might exist which would apply that regional economic development itself may impact the rivalry at local banking market and, thus, the latter may be the outcome rather the cause of the local economic activity.

To overcome the above-described issues the instrumental variable (IV) approach is employed. To be valid as an instrument, a given variable needs

to satisfy two requirements, namely the so-called relevance condition, which states that the instrument needs to be correlated with the measurement of local banking competition or the supply of credit (endogenous variable of concern) and the exclusion restriction, which requires that the instrument needs to be uncorrelated with the regional characteristics (other than through its correlation with the banking competition) that can affect the banking market or firms performance. I use separate instruments for East and West Germany: For the former, information on the banking structure immediately after the reunification is employed, whereas for the latter the number of savings bank branches in the year 1982 is used.[6] In the following, an exposition of why these instruments are appropriate to address the endogeneity problem is given. In doing so, we follow Wooldridge (2010) and provide formal tests of the respective relevance condition while we underpin the not formally verifiable exclusion restriction with narrative arguments and suggestive evidence.

2.4.1 The East-German banking system as an instrument

As discussed in Chapter 1 information on the historic banking system in the former German Democratic Republic (GDR) is applied and branch network in 1990 is used to instrument the banking concentration index.[7]

The exclusion condition is illustrated in Chapter 1 and shows that branch density in 1990 can serve as a valid instrument.

The second condition for an instrumental variable to be valid is that there is a high correlation between the instrument and the variable to be instrumented. This often denoted "relevance condition" is also obviously satisfied as Figure 6 and column 3 of Table 19 show. The graph clearly exhibits a positive relationship which is reflected in the significant coefficient which is obtained regressing the average HHI between 2010-2012 on branch density in 1990.

[6]The fact that Berlin was divided until 1990 such that a part of it was in the former GDR and another part belonged to West makes it difficult to construct an adequate instrument. Therefore, this district is excluded from the analysis.

[7]The detailed exposition of the East German banking system and the employed instrument is provided in Chapter 1 of this dissertation.

2.4.2 Historic West-German public banking system as an instrument

To instrument for the degree of competition in the regional banking system in West Germany, I follow Beck, Bernhardt, and Schwerdt (2016) and employ historical branch data of the (public) savings banks in this part of the country. The German banking system has been and still is characterized by a "three-pillars" structure, consisting of private, public sector, and cooperative banks. The public sector is relatively large, accounting to around one third of total assets of the banking sector (see IMF (2011)). It consists of savings banks and their associated centralized institutions (so-called "Landesbanken") where the retail banking is done almost exclusively by the former ones. Making use of regulatory measures governing the activities of savings bank sit is possible to construct an instrumental variable for the HHI. More specifically, savings bank branches in 1982 are used to control for potential endogeneity biases in our regressions for this region.

To be valid instrument, one first has to provide convincing arguments that the exclusion restriction is satisfied, i.e., that the savings bank branch density in 1982 is only related to the economic development in our sample period via its correlation to the given banking variable. Whilst a long time difference between the sample period and the year in which an instrument variable is collected certainly mitigates any existinsg confounding effects it is not enough to ensure a highly sufficient degree of plausibility for the validity of the exclusion restriction. Concerning the number of savings banks in a given region there are, however, two additional factors which make it reasonable to assume that any contemporary shock to economic development has at best a very week effect on savings banks density. These reasons are rested in the regulatory framework governing the business activities of savings banks in Germany.[8] Almost all savings banks are public institutions which are (effectively) owned by an independent city or a county (or several of these). They are subject to the so-called regional principle implying that their activities are restricted by the boundaries of the administrative unit(s) to which they belong. They are not purely profit oriented but their mandate includes an obligation to provide certain not solely economically, but also socially motivated services

[8]For a more comprehensive exposition of these issues, see, e.g., Güde (1981) and Ashauer (1991). IMF (2011) contains a shorted English exposition.

to the region where they operate. The latter contains the requirement to ensure a comprehensive and region-wide provision of bank-related services to the residents of the region in which they operate. Amongst others, this is ensured by the setup of a branch network which is more dense than purely economic reasoning would imply.[9] Moreover, the closing of any branch has to be approved by a supervisory board which is composed of local "expert" representatives almost always including local politicians, civil servants and firm owners. Given its unpopularity, this board regularly examines each closing decision very carefully. This is very likely one of the reasons to explain the still very dense branch density of savings banks in West Germany which had expanded dramatically until the 1980s but which has - as will become clear below - declined only relatively moderately since then despite considerable technological progress. Overall, these considerations make it plausible to assume that the savings bank branch density in 1982 is very likely unrelated to shocks driving the economic dynamics of a region more than 20 years.

Whereas the exclusion restriction cannot formally be tested, a regression of the savings bank density in 1982 on per-capita GDP at that time can provide supportive evidence with respect to the just outlined deliberations. Figure 7 clearly suggests that there is indeed no positive relationship between these two variables. If at all, a slightly negative correlation exists. This impression is confirmed in Table 32 columns 1 and 2 which show that regressing savings bank density in 1982 on GDP per person in that year either yields a slightly significantly negative or insignificantly positive (when a city dummy is included) coefficient. Both results, thus, provide evidence in favor of the exclusion restriction.

To test the relevance condition I follow Wooldridge (2010) and regress the sample period's HHI on the number of savings banks branches per 10,000 inhabitants in 1982. Column 3 of Table 32 reflects the evidence of a positive relationship between the competition measurement and the potential instrument from Figure 8 by obtaining the highly significant coefficient on savings bank branch density in 1982.

The positive relationship between branch density in 1990 and the HHI for East Germany as well as between savings bank branch density in 1982 and the HHI for West Germany might be explained if one looks back at the

[9]The latter point was, amongst others, made by Handwörterbuch der Sparkassen (HWS) (1982) (Zweigstellen (Branches)), Handschuh (2010) and IMF (2011).

banking development in Germany since 1990s. Koetter (2013) reports that the number of banks declined by 55% between 1993 and 2012. Most mergers and acquisitions took place prior to 2003 and occurred foremost among regional savings and cooperative banks. Branch presence fell by 23% during 1993 and 2004 which is the half of the overall reduction in the number of banks for the same period. The entire banking sector has been severely hit during the global financial crisis negatively affecting profitability and changing the focus to cost optimization by closing branches. Koetter (2013) emphasizes that whereas the mean bank size increased in German banking sector over 1993-2012, the banking system as a whole ceased to grow after a considerable compression by 13% between 2008 and 2009. As a result, regions with more branches per capita might have experienced heavier contraction in terms of number of banks and branches which might have led to strengthening market concentration in the banking sector.

2.5 Results

In this section, I present the results from estimating Equation (2.4.1). First, the evidence on the impact of local banking competition on macroeconomic variables is reported. Then, I investigate the effect of local banking competition on more narrowly defined growth measurements as firms entries and exits, number of firms in manufacturing sector and their employment.

2.5.1 Local banking competition and macroeconomic dynamics

Table 34 shows the effect of the degree of competition in local banking markets on GDP per capita.[10] Column 1 suggests that greater concentration in the local banking markets leads to lower GDP per capita for West German regions. More specifically, counties with the HHI being one standard deviation above the West-wide average demonstrate a 0.04% (-0.543*0.073) lower level of per capita GDP compared to the mean region. However as discussed in Section 2.4 the OLS results do not allow to determine the direction of causality due to the endogeneity problem. Hence, the IV approach is applied. First, let us have a

[10]For illustrative purposes, the coefficient of HHI is multiplied by 10,000 over all specifications.

look at the results from the first stage. Column 2 indicates a positive statistically significant relationship between the instrumental variable and the HHI. This finding provides evidence on the validity of the instrument's relevance condition while capturing the effects of other exogenous controls. Instrumenting the HHI also implies a negative impact of local banking concentration on GDP per capita although no longer statistically significant. Turning to East Germany, the estimation from the first stage reveals a highly significant negative correlation between the instrument, i.e. branch density in 1990, and the measurement of local banking competition. Similarly to West Germany, the evidence suggests that the instrument is valid. The IV estimation for GDP per capita is alike to that for West German regions in terms of a negative relationship and statistical insignificance however, the economic impact is even smaller: Regions with the concentration index one standard deviation above the mean value for East illustrates a per-capita GDP which is, on average, 0.02% (-0.209*0.089) lower in comparison with the mean regions.

In order to get a broader evidence I examine the role of local banking structure employing other macroeconomic variables. While GDP per capita proxies the living standards a level of GDP per person employed stays for productivity measurement. The OLS result for West Germany in Table 35 are similar to those for GDP per capita while in the IV estimation the negative and statistically significant coefficient not only remains but also implies greater (although, in general, still small) economic effect compared to a per-capita GDP. More precisely, regions characterized by local banking concentration being one standard deviation above the West German average exhibit a level of productivity that is 0.12% (-1.674*0.073) below that of the mean region. For East Germany, both the results from OLS and IV are insignificant however differ in signs. The simple regression suggests a negative effect of more intense competition in the local banking markets on productivity measure whereas after taking into account possible endogeneity problem the estimation turns to be positive.

Another important variable is per capita disposable income, a direct measure of amount of money received by people. The obtained OLS estimation demonstrates that in the case of West German regions the coefficient for the HHI is negative and statistically significant. However as controlling for the endogeneity issue the estimate turns to be statistically insignificant. For East Germany, there is mixed evidence: The linear regression suggests a positive -

neither statistically nor economically significant - relationship between local banking concentration and household income however, the two-stage regression does not confirm this finding.

The next broader measure of economic growth which is examined is an unemployment rate. Given the above evidence one would expect that more concentrated banking markets experience higher unemployment, *ceteris paribus*. The estimations from the linear regression, indeed, detect positive impact of more monopolistic banking market on unemployment rate for both West and East regions. While this statistically insignificant result holds for the latter even after instrumenting the HHI by branch density in 1990 (the first stage supports the relevance condition) it turns to be negative and statistically significant at a 5% level for the former. Furthermore, the correspondent economic influence is also quite substantial: a 1.19% lower unemployment rate is observed in regions where banking concentration index is one standard deviation above the West German average. This result might be seen surprising. However, Gatti, Rault, and Vaubourg (2011) find that the effect of financial liberalization depends on the labour market conditions. As the authors point out, on the one hand, more competitive banking market favors employment if the labour market regulation, union density, and wage bargaining coordination are low. On the other hand, banking concentration curbs unemployment rate if the labour market regulation, union density, and wage bargaining power are at high levels. Following these arguments, the obtained results for unemployment rate in the case of West German regions do not seem to be unexpected. Indeed, OECD (2017) reports that Germany is characterized by highly coordinated wage bargaining process which is predominantly centralized at higher levels. Although union density has declined during the last decades, it is still at the level of OECD average. Moreover, Ruoff (2016) says that compared to West Germany East part is characterized by lower levels of both wage bargaining coverage and union density. This may explain the contrasting signs of HHI coefficient for West and East Germany since the latter is described by weaker collective bargaining. Given the positive outcome of higher competition on productivity measurement for West regions, this finding is also in line with, e.g. Galí (1999) and Manuelli (2000), who document that a positive productivity shock leads to a decline in working hours and, consequently, results in lower employment and larger unemployment rate. So, as each employed produces more units fewer workers are needed to produce the same amount of output.

Overall, the empirical results demonstrate ambiguous outcome. For West Germany, there is strong evidence of positive effect of more intense rivalry among local banks on regional productivity while the corresponding economic impact is moderate. Likewise, Shaffer (1998) and Cetorelli and Gambera (2001) document for household income and industry value added, respectively, that banking concentration hinders growth. On the other hand, tougher competition at the local banking market in West Germany promotes higher unemployment rate. Concerning the East regions, the corresponding results do not allow to draw explicit conclusion on the role of banking market structure for regional macroeconomic activity.

The above presented analysis is focused on the effect of banking competitive conditions on broad macroeconomic variables. The next section illustrates the analysis on more narrowly defined variables that mirror regional economic activity.

2.5.2 Local banking competition and firm entries/exits

Competition within the banking sector alters supply of funds and, thus, has a crucial direct implication on borrowers and their decisions concerning external finance. For the bank-based system as Germany the credit availability plays an essential role serving as a prerequisite for firm establishments and their progress that in turn influence employment and economic sustainability. Klapper, Laeven, and Rajan (2006) demonstrate that business environment influences economic growth through the establishment of new firms. The conventional theories of industrial organization argue that bank competition induces borrowers to take advantage of cheaper and more accessible credits (the market power hypothesis). For example, Pagano (1993) demonstrates that banking concentration implies higher loan rates and lower deposit rates which result in a drop in the equilibrium amount of funds and, consequently, limiting the economic growth. Cetorelli (2004) proposes an alternative representation of the Petersen and Rajan (1995) model based on the same premises but with opposite outcome. He argues that the new entries will affect the profitability of the older bank borrowers and hence the bank's own profitability. The less fierce rivalry in the banking market will result in less stimulus for lenders to support start-ups which in turn leads to higher concentration in product markets. Rice and Strahan (2010) and Ryan, O'Toole, and McCann (2014) provide empirical

evidence that fierce rivalry in the banking markets softens financing constraints for SMEs. By contrast, there are models that predict a decrease in a supply of external funds to opaque borrowers under highly competitive banking market since adverse selection, moral hazard, and hold-up problems deteriorate (the information hypothesis). Petersen and Rajan (1995) consider the effect of banking market power on new businesses and show that banking competition dilutes establishment of relationship lending by discouraging a bank from the investment in learning the soft information. Thus, more credits are available in less competitive banking markets. Given these arguments, this section is aimed to provide an investigation on the role of the banking market power for firm creation and shutdowns.

The first five rows of Table 36 present empirical evidence on the role of local banking competition for firm creation. The available data allows to differentiate firm creation by a completely new business, a change of the legal form, relocation, and takeover. The former and the latter groups are of the most interest for the analysis since they serve as new formation. For West German regions, OLS results provide statistically significant estimations (except for takeover) which suggest that banking competition is generally favorable for the emergence of new firms especially for start-ups. Taking into account the possible endogeneity issue the IV estimations at most cases support that regions where local banks exhibit less market power encourage more firm entries. The implied economic influence is also considerable: Regions where the banking concentration index is one standard deviation below the West-regions mean have, on average, around 10.82 (IV) or 3.2 (OLS) more start-ups per 10,000 inhabitants. This is along the lines of the findings by Black and Strahan (2002) and Cetorelli and Strahan (2006) supporting the traditional market power hypothesis. Turning to East Germany, the results revel no significant impact of banking market structure on firm registrations although the direction of relationship is opposite compared to West Germany.

The last five rows of Table 36 illustrate the results from analysing the effect of banking competition on firm deregistrations. Similarly, the data allows to classify firm closures as a complete closure, a change in the legal form, a change in location, and a result of takeover. Likewise firm entries, the former and the latter group present the most interest for the purpose of examination. The obtained estimations - both from OLS and IV - imply a significant negative effect of more concentrated banking markets on firm deregistrations for West

German regions and this effect is more pronounced for complete closures. More specifically, counties with the HHI one standard deviation above the West-regions mean are characterized by 7.88 (IV) or 2.29 (OLS) less closures per 10,000 inhabitants than the average region. However, no significant impact of banking rivalry on firm shutdowns is found for East Germany.

2.5.3 Local banking competition and firm dynamics

European Commission (2016) as well as the recent survey of European Central Bank (2018) document that there is high demand for external finance from enterprises and mostly bank-related products remain the major source of financing compared to market-based or other sources. This is in particular the case for small and medium-sized firms (SMEs) given their more severe information opaqueness. Furthermore, they are, in generally, limited in their finance opportunities. For example, SMEs are very often cut off from capital markets due to low volumes and high costs of issuing bonds or stocks. Thus, the credit supply that is affected by bank competition should play an important role for firms growth.

To examine this, I regress the indicators of firm dynamics on the concentration index at the local banking markets. As the indicators that represent firm development the number of firms and employment in the manufacturing sector are used. Both of them are disaggregated at the firm-size level.

The first seven rows of Table 37 demonstrate the examination of the effect of banking competition on the number of manufacturing firms. The OLS and IV estimations for West Germany indicate a negative significant (IV) impact of banking rivalry on the overall amount of operating companies in manufacturing: Regions with the HHI being one standard deviation below the West-regions mean have 2.22 (IV) or 0.19 (OLS) firms per 10,000 inhabitants less than the average region. Furthermore, lines 2-7 evidence that this applies to all groups of firms except large and very large ones when differentiated by firm size while the economic effect is the largest for those with less than 50 employees. For East German regions, the results do not allow to draw conclusion about any significant effect of local banking rivalry on the number of firms in manufacturing.

The next seven lines of Table 37 report the outcome for employment in manufacturing. The estimations from both OLS and IV for overall occupation

are statistically significant and show that banking concentration favors the growth of workforce in West Germany. More specifically, in regions with the concentration index being one standard deviation above the mean 312.33 (IV) or 50.53 (OLS) more employees per 10,000 inhabitants work in manufacturing than in the average region. Moreover, further analysis and the obtained significant estimations display that less rivalry among local banks promotes employment in firms with up to 500 employees and as the estimations display this effect is the greatest for businesses with 250-500 workers. Thus, regions with intense banking competition are characterized by a smaller firm size. This finding is consistent with Cetorelli (2004) who also reports that increased competition in OECD banking markets results in lower average firm size. Additionally, the obtained outcome reveal that the banking concentration plays a considerable role primarily for figures of SMEs. Combining this evidence with one for establishment and business deregistrations in Section 2.5.2 one can infer the following. Market power allows banks to extract rents from informationally captured firms with whom they have already built close lending relationship as they raise barrier to entry the manufacturing sector. This is reflected in a lower number of firm deregistrations that, in turn, leads to enhanced concentration in nonfinancial markets.

Turning to East Germany, the OLS estimations indicate a negative significant effect of banking concentration on employment in manufacturing however, controlling for endogeneity turns the coefficients to be insignificant although the first stage supports the validity of the instrument. So, no significant effect could be found in case of East German regions.

2.6 Summary and conclusions

Theory and empirical evidence provide contradictory suggestions on how competition in banking market ought to affect economic development giving an incentive for further investigations. In this paper, I examine the relationship between the intensity of competition in local banking markets and regional growth using unique banking and regional data sets for Germany, a country which is well-known as a bank-based system.

Addressing this research question I employ an IV approach based on historical and legal features of strongly regionally oriented German banking system. Whereas the obtained results do not find any significant effect for East Germany

the empirical evidence suggests that more vigorous banking competition in the West German banking markets that is associated with lower value of the HHI at NUTS 3 level increases labor productivity and unemployment rate as a result of more effective employers. Better banking competition also promotes firm creation while stronger concentration in regional banking markets is beneficial for firms population and their size. Significantly, this effect is more pronounced for small and medium enterprises which makes sense given their information opaqueness and, thus, limited options to rise external funds from other sources apart bank finance. Therefore, while more fierce rivalry in local banking markets benefits start-ups, it imposes financial barriers for already existing businesses forcing some of them to exit the market. This is consistent with the theoretical argument that banks with market power may tend to support more their established borrowers than new borrowers. The future profitability of bank's borrowers determines the value of its current lending relationships and depends on new entries and their growth. So, the evidence demonstrates that a bank's willingness to promote the profitability of its existing clients overweights its incentive to extend credit supply to new borrowers resulting in higher concentration in nonfinancial markets. Overall, banking market power leads to a fewer number of new businesses, a larger average firm size, and a prevalence of small and medium firms rather than large ones.

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2.7 Appendix

2.7.1 Tables

Table 31: Descriptive statistics

	All	West	East
Local banking markets structure			
Branches	80.695	87.499	51.600
	(54.037)	(56.285)	(28.793)
Commercial banks	11.311	12.193	7.540
	(20.998)	(22.994)	(7.051)
Cooperative banks	33.349	37.292	16.491
	(22.544)	(22.892)	(9.564)
Savings banks	35.359	37.220	27.399
	(22.985)	(23.633)	(18.047)
HHI	0.236	0.222	0.296
	(0.081)	(0.073)	(0.089)
Regional economic development			
GDP per capita, in thousands EUR	27.880	29.610	20.479
	(11.489)	(11.953)	(4.283)
GDP per person employed, in thousands EUR	56.582	58.830	47.027
	(10.154)	(9.762)	(4.873)
Income per capita, in thousands EUR	18.436	19.044	15.836
	(2.167)	(1.931)	(0.701)
Unemployment rate	8.363	6.994	14.219
	(3.818)	(2.549)	(2.604)
Business registrations per 10K inhab.	93.163	96.216	80.104
	(18.765)	(18.470)	(13.823)
Business deregistrations per 10K inhab.	81.045	82.513	74.767
	(15.498)	(15.929)	(11.642)
Manufacturing fims per 10K inhab.	6.252	6.249	6.265
	(2.534)	(2.556)	(2.452)
Employment in manufacturing per 10K inhab.	804.824	869.360	528.846
	(506.737)	(531.069)	(236.417)

Notes: Table 31 reports mean values and cross-sectional standard deviations (in brackets) of the measurement of local banking competition as well as regional economic development which are averaged over 2000-2006 and 2010-2015. "All" refers to the overall country, "West" ("East") reports numbers for West (East) Germany only. "HHI" refers to the Herfindahl-Hirschman index based on number of bank branches. There are 325 in West and 76 regions in East Germany (excluding Berlin).

Table 32: Relationship between savings bank branch density (1982), GDP (1982), and HHI (2010-2012)

	Savings banks branch density (1982)	Savings bank branch density (1982)	HHI (2010-2012)
GDP p. c. (1982)	-0.108***	-0.052	
	(0.026)	(0.035)	
City		-1.672***	
		(0.211)	
Savings bank branch density (1982)			0.008***
			(0.003)
Constant	4.005***	2.884***	0.202***
	(0.263)	(0.299)	(0.009)
R^2	0.070	0.182	0.023
F	17.16	51.33	7.69
Observations	324	324	324

Notes: Column 1 and 2 of Table 32 report results from regressing savings bank branch density in 1982 on GDP per capita in 1982 in this region. Coefficients in column 3 result from regressing the average HHI over 2010-2012 on the savings bank branch density in 1982.

Table 33: Relationship between branch density (1990), GDP (1992), and HHI (2010-2012)

	Branch density (1990)	Branch density (1990)	HHI (2010-2012)
GDP p. c. (1992)	-0.342***	-0.0615	
	(0.0536)	(0.0894)	
City		-1.917***	
		(0.510)	
Branch density (1990)			0.016*
			(0.009)
Constant	6.583***	4.425***	1.971***
	(0.511)	(0.742)	(0.235)
R^2	0.359	0.464	0.063
F	40.82	31.16	3.07
Observations	75	75	75

Notes: Column 1 and 2 of Table 19 report results from regressing bank branch density in 1990 on GDP per capita in 1992 in this region. Coefficients in column 3 result from regressing the average HHI over 2010-2012 on the branch density in 1990.

Table 34: Local banking competition and GDP per capita

	West			East		
	OLS	IV		OLS	IV	
Independent variable		1st stage	2nd stage		1st stage	2nd stage
HHI	-0.543***		-0.629	-0.279*		-0.209
	(0.118)		(0.470)	(0.155)		(0.638)
Ln GDP per capita (1982)	0.900***	-0.085***	0.894***			
	(0.053)	(0.018)	(0.059)			
Ln GDP per capita (1992)				0.366***	-0.067	0.370***
				(0.100)	(0.071)	(0.098)
City	-0.015	0.040**	-0.013	0.139**	-0.128***	0.147
	(0.042)	(0.016)	(0.042)	(0.061)	(0.047)	(0.095)
Size in square km.	-0.016	-0.046***	-0.019	-0.017*	-0.031***	-0.015
	(0.021)	(0.011)	(0.029)	(0.010)	(0.011)	(0.022)
Branch density (1982)		0.013***				
		(0.003)				
Branch density (1990)					-0.016*	
					(0.008)	
N	325	324	324	75	75	75
F-stat	240.099	14.831	199.628	54.615	12.095	53.560

Notes: Table 34 reports results from estimating Equation (2.4.1) employing a linear squares model (column 1) and a two-stage least squares model where the local banking market concentration index (HHI) is instrumented by the number of savings bank branches per 10,000 inhabitants in 1982 for West Germany (columns 2 and 3) and by the number of bank branches per 10,000 inhabitants in 1990 for East Germany (columns 5 and 6). Dependent variable: average log gross domestic product measured in 1,000 Euros per inhabitant in years 2000-2006 and 2010-2015. HHI is the Herfindahl-Hirschman Index based on branch network and is a measure of local banking concentration with the value between 0 and 1. Other independent variables are the size of the region measured in 1,000 square kilometers, an indicator for independent city, and regional log gross domestic product in 1982 (1990) measured in 1,000 Euros per inhabitant for West (East) Germany. Robust standard errors are in brackets. Significance level *** 1%, ** 5%, and * 10%.

Table 35: Local banking competition and macroeconomic dynamics

	West		East	
Dependent variable	OLS	IV	OLS	IV
Ln GDP per employed	-0.473***	-1.674***	0.049	-0.141
	(0.085)	(0.440)	(0.122)	(0.674))
Ln income per capita	-0.224***	-0.340	0.017	-0.257
	(0.063)	(0.271)	(0.062)	(0.283)
Unemployment rate	2.288	-16.350**	2.349	26.243
	(1.692)	(7.262)	(3.602)	(21.798)

Notes: Table 35 reports results from estimating Equation (2.4.1) employing a linear squares model (columns 1 and 3) and a two-stage least squares model where the local banking market concentration index (HHI) is instrumented by the number of savings bank branches per 10,000 inhabitants in 1982 for West Germany (column 2) and by the number of bank branches per 10,000 inhabitants in 1990 for East Germany (column 4). All dependent variables are averages of the years 2000-2006 and 2010-2015. Only estimates of the coefficient on the HHI multiplied by 10,000 are reported. Other independent variables are the size of the region measured in 1,000 square kilometers, an indicator for independent city, and regional log gross domestic product in 1982 (1990) measured in 1,000 Euros per inhabitant for West (East) Germany. Robust standard errors are in brackets. Significance level *** 1%, ** 5%, and * 10%.

Table 36: Local banking competition and firm registrations/deregistrations

	West		East	
Dependent variable	OLS	IV	OLS	IV
Business registrations per 10K inhabitants				
total	-56.085***	-199.732***	30.404*	65.329
	(13.676)	(68.054)	(16.817)	(61.280)
by foundation	-43.838***	-148.187***	18.598	53.867
	(11.239)	(53.007)	(13.434)	(48.485)
as corporate body	-9.994***	-19.769	6.246**	7.474
	(2.587)	(13.468)	(3.110)	(13.512)
by relocation	-11.423***	-52.535***	9.783**	18.306
	(3.052)	(18.083)	(4.051)	(14.795)
by takeover	-1.663	-0.349	2.805	-5.909
	(1.901)	(7.591)	(1.864)	(11.452)
Business deregistrations per 10K inhabitants				
total	-44.679***	-157.543***	10.534	65.699
	(11.365)	(50.969)	(12.725)	(44.464)
closures	-31.353***	-107.981***	2.047	50.466
	(9.323)	(36.740)	(10.153)	(34.495)
as corporate body	-4.550**	-18.440*	0.579	6.480
	(2.019)	(10.439)	(2.330)	(10.811)
by relocation	-11.351***	-45.574***	6.079*	18.947
	(2.931)	(16.267)	(3.304)	(12.071)
by takeover	-2.429	-5.357	3.641**	-5.903
	(2.039)	(7.336)	(1.580)	(11.550)

Notes: Table 36 reports results from estimating Equation (2.4.1) employing a linear squares model (columns 1 and 3) and a two-stage least squares model where the local banking market concentration index (HHI) is instrumented by the number of savings bank branches per 10,000 inhabitants in 1982 for West Germany (column 2) and by the number of bank branches per 10,000 inhabitants in 1990 for East Germany (columns 4). All dependent variables are averages of the years 2000-2006 and 2010-2015. Only estimates of the coefficient on the HHI multiplied by 10,000 are reported. Other independent variables are the size of the region measured in 1,000 square kilometers, an indicator for independent city, and regional log gross domestic product in 1982 (1990) measured in 1,000 Euros per inhabitant for West (East) Germany. Robust standard errors are in brackets. Significance level *** 1%, ** 5%, and * 10%.

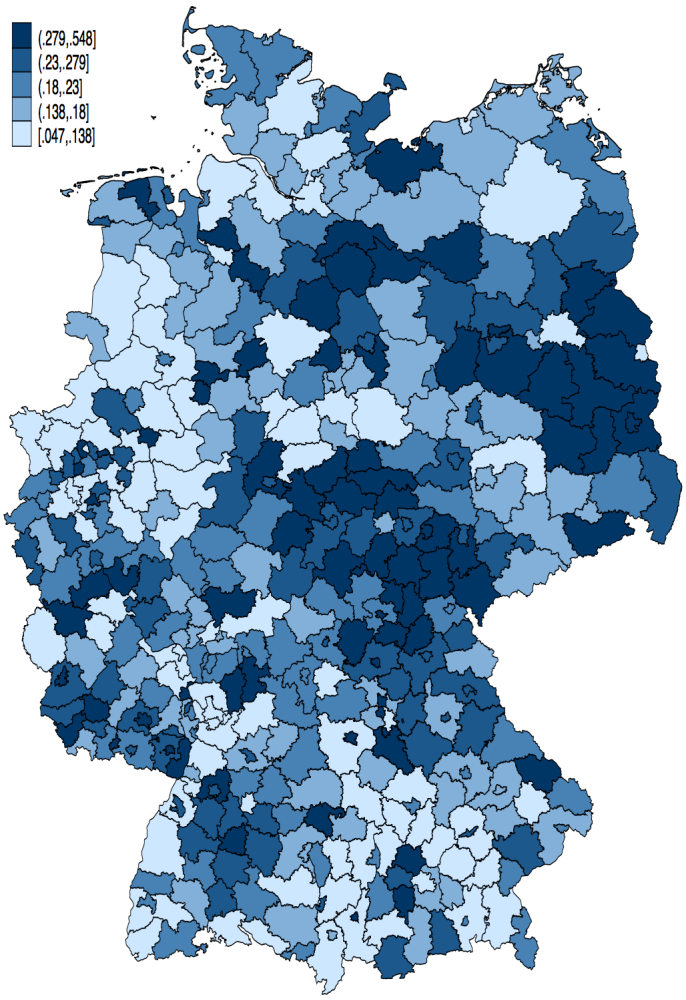
Table 37: Local banking competition and firm dynamics

	West		East	
Dependent variable	OLS	IV	OLS	IV
Manufacturing firms per 10K inhabitants				
total	2.584	30.459***	-7.045**	-5.636
	(2.087)	(10.324)	(2.890)	(11.509)
with <50 employees	0.931	17.105***	-3.279**	-2.221
	(1.063)	(6.537)	(1.545)	(6.071)
with 50-100 employees	0.821	8.399**	-1.572**	0.325
	(0.638)	(3.408)	(0.740)	(2.744)
with 100-250 employees	0.471	5.811**	-1.479**	-3.673
	(0.487)	(2.432)	(0.616)	(4.056)
with 250-500 employees	3.728**	13.904**	-0.393*	0.576
	(1.489)	(6.347)	(0.224)	(1.073)
with 500-1000 employees	-0.085	0.073	-0.104	0.374
	(0.110)	(0.540)	(0.067)	(0.437)
with >1000 employees	0.120	1.533**	-0.000	-0.129
	(0.102)	(0.624)	(0.043)	(0.271)
Employment in manufacturing per 10K inhabitants				
total	692.199*	4278.462***	-648.765**	-189.708
	(387.445)	(1526.940)	(287.611)	(1082.891)
with <50 employees	27.823	492.559**	-111.489**	-98.595
	(33.430)	(198.527)	(48.540)	(208.375)
with 50-100 employees	61.988	613.525**	-106.602**	57.152
	(45.517)	(246.338)	(51.051)	(204.320)
with 100-250 employees	94.031	890.895**	-260.343***	-626.802
	(76.435)	(373.844)	(91.500)	(672.941)
with 250-500 employees	187.662*	1441.687***	-114.554	511.292
	(97.459)	(522.873)	(74.341)	(485.730)
with 500-1000 employees	-56.678	129.958	-74.991	197.119
	(81.686)	(446.823)	(74.639)	(318.817)
with >1000 employees	151.548	1711.269	-61.483	-705.866
	(370.801)	(1054.479)	(45.364)	(751.298)

Notes: Table 37 reports results from estimating Equation (2.4.1) employing a linear squares model (columns 1 and 3) and a two-stage least squares model where the local banking market concentration index (HHI) is instrumented by the number of savings bank branches per 10,000 inhabitants in 1982 for West Germany (column 2) and by the number of bank branches per 10,000 inhabitants in 1990 for East Germany (columns 4). All dependent variables are averages of the years 2000-2006 and 2010-2015. Only estimates of the coefficient on the HHI multiplied by 10,000 are reported. Other independent variables are the size of the region measured in 1,000 square kilometers, an indicator for independent city, and regional log gross domestic product in 1982 (1990) measured in 1,000 Euros per inhabitant for West (East) Germany. Robust standard errors are in brackets. Significance level *** 1%, ** 5%, and * 10%.

2.7.2 Figures

Figure 5: Local banking market competition

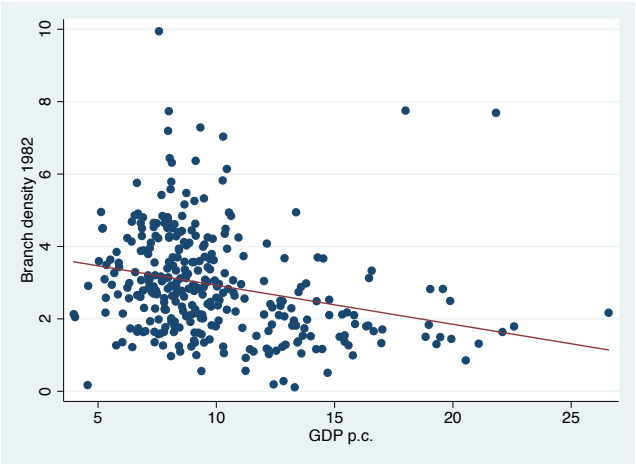


Notes: Figure 5 illustrates the mean values of the HHI based on number of bank branches over 2000-2006 and 2010-2015. There are 325 in West and 77 regions in East Germany.

Figure 6: East Germany: Number of bank branches in 1990 vs. HHI in years 2010-2012

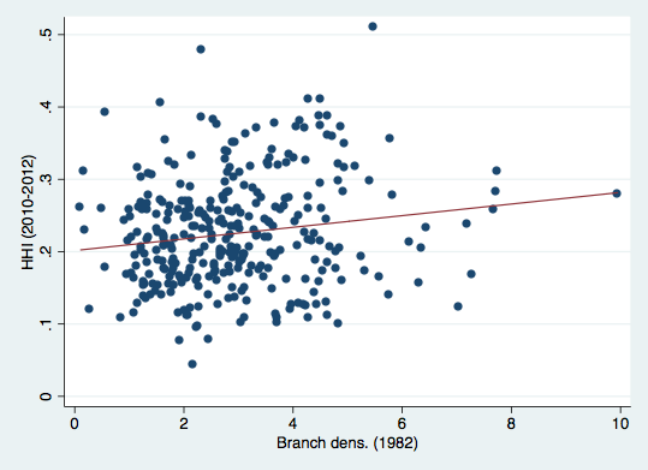
Notes: Figure 6 plots the branch density in 1990 versus the average HHI over 2010-2012 for East German regions.

Figure 7: West Germany: Number of savings bank branches in 1982 vs. GDP per capita



Notes: Figure 7 plots the savings bank branch density in 1982 versus GDP per capita in 1982 for West Germany.

Figure 8: West Germany: Number of savings bank branches in 1982 vs. HHI in years 2010-2012



Notes: Figure 8 plots the savings bank branch density in 1982 versus the average HHI over 2010-2012 for West German regions.

Chapter 3

Public debt and local financial development in Germany

3.1 Introduction

Starting from the work by Schumpeter (1911) numerous studies have been devoted to analyze the link between financial development and growth. On the microeconomic level, Demingüç-Kunt and Maksimovic (1996) demonstrate that high-quality financial institutions and better access to finance are essential for firms' sustainable operation and their future progress. On the macroeconomic level, as Levine and Zervos (1998) show the development of financial markets, in general, and of a banking sector, in particular, is beneficial for real economic growth. Many other theoretical as well as empirical studies document the same finance-growth relation (Gurley and Shaw (1955), Goldsmith (1969), King and Levine (1993a), King and Levine (1993b), Beck, Levine, and Loayza (2000), Guiso, Sapienza, and Zingales (2004), Levine (2005), Loayza and Rancière (2006), and Hasan, Koetter, and Wedow (2009), among others). The importance of financial development on economic growth, in turn, triggers an interest with respect to the factors that determine financial development itself. For example, there are papers that investigate this research question from the perspective of financial liberalization (McKinnon (1973)), the government ownership of banks (LaPorta, Lopez-de-Silanes, and Shleifer (2002) and Andrianova, Demetriades, and Shortland (2008)), legal system (Porta et al. (1998)), political stability (Girma and Shortland (2008)), trade openness (Baltagi, Demetriades, and Law (2009) and Zhang, Zhu, and Lu (2015)), and inflation (Boyd, Levine,

and Smith (2001)). Other researchers analyze the effect of the combination of the aforementioned factors: for instance, Chinn and Ito (2006) show that financial openness can promote financial development only if the level of legal development reaches the particular threshold.

Another important determinant of financial development is domestic bank credits to government which has been underappreciated in the literature. Traditionally, theoretical arguments suggest that public debt is considered to play a positive role for financial depth that is associated with the safe government assets on the banks' balance sheets serving a collateral like function (a "safe asset" view) (see Kumhof and Tanner (2005)). However, an alternative - a "lazy banks" - view implies that banking sectors holding large public debt may grow more sluggishly since lending too much to government makes them too complacent to further development (Hauner (2009); Section 3.2 gives a detailed representation of theoretical arguments). The relevant literature has focused mainly on indirect mechanisms through which the latter can influence financial depth, e.g. crowding out (Caballero and Krishnamurthy (2004)) and inflation (Catão and Terrones (2005)). Exceptions are Hauner (2008) and Hauner (2009) who use bank-level and country-level data to examine the impact of credits to government on three aspects of banking sector performance: its development, profitability, and productive efficiency. Hauner (2008) finds that there is a considerable negative impact of government borrowing on banking depth in developing countries but no effect in developed economies. Furthermore, there is a critical threshold above which public debt has a smaller marginal effect than below it. For bank regressions, the results demonstrate that credit to government enhances profitability but adversely affects efficiency. The study by Hauner (2009) additionally incorporates the interaction term with financial repression. Besides to the conclusions similar to the above mentioned he documents that public debt holding by banks has a negative effect only on high levels of financial repression. Nevertheless, there is a lack of evidence for the direct implications of public debt on financial sector deepening and this aspect continues to be a less explored question.

The aim of this study is to investigate the relationship between public debt and banking development using an alternative approach to Hauner (2008) and Hauner (2009). More specifically, I focus on a country analysis employing local banking markets and regional data rather than a cross-country approach. The data represents a combination of information on bank branches and on

government debt at the county level in Germany. To the best of my knowledge, this is the first study done for Germany analyzing factors that influence the degree of banking sector development.

The obtained results suggest that government debt has an adverse effect on banking sector development providing some support for the "lazy banks" view. However as robustness check shows this outcome is driven by outliers. Moreover, the results do not provide evidence on the threshold effect that implies a smaller marginal effect for higher levels of public debt.

The rest of the paper is organized as follows: Theoretical considerations are presented in Section 3.2 with the discussion of two alternative views on the role of public debt in banking sector development - the "safe asset" and "lazy banks" views. Section 3.3 illustrates a description of the data sets and provides some descriptive statistics. The employed econometric approach is described in Section 3.4 followed by Section 3.5 with the obtained results. Section 3.6 summarizes and concludes.

3.2 Theoretical considerations

The theoretical literature mostly evidences benevolent influence of government debt on financial development which is called the "safe asset" view. Kumhof and Tanner (2005) argue that in this case fiscal policy and particularly conduct of adequate policy with respect to public debt facilitates financial intermediation and promotes communication between lenders and borrowers by providing a safe asset. The intuition behind is the following. It is well known that financial markets are associated with asymmetric information. Therefore, safe government debt plays a collateral role on bank balance sheets encouraging depositors to place their funds in intermediaries. Public debt also performs such a function in repurchase agreements which require it to be safe. Moreover, this collateral can assist to deal with other features of financial markets as legal and institutional imperfections that make it difficult and costly to take security interests in real estate and movable property which in turn could help to overcome an asymmetric information problem (De Soto (2000)). Hauner (2009) emphasizes that the deepening of derivative markets and payment and settlement systems need the existence of liquid collateral as well. And finally, as is highlighted in a number of studies, government bonds contribute to the development of the private sector bond markets serving as a benchmark yield

curve (Reinhart and Sack (2000), World Bank (2001), and Kumhof and Tanner (2005)).

However, Hauner (2009) introduces alternatively a "lazy banks" view on the role of public debt for financial markets expansion. Although well-known in policy circles, the term so far has been missing in academic literature. The adverse effect of large borrowing from government lies in the structural nature of the banks. Those banks that heavily rely on lending to government could be more profitable but less efficient. The author argues that this can be explained by the following drawbacks of private sector lending. First, its refinancing rate will be greater if private sector credits are more risky and, as a consequence, depositors demand risk premium. Second, the associated administrative costs are probably higher given the economies of scale that support public sector lending. Next, taxes on such loans are higher in comparison to government sector credits. Last but not least, the expected loss and the cost of capital that are associated with credit line to private clients will be mostly higher. Higher bank profitability would reduce stimulus to enhance the banking market development that is strongly influenced by, for example, the bank branch network (Demetriades and Luintel (1996)), while as Fry (1995) debates low financial efficiency forms the deadweight loss on the side of financial intermediation damaging its growth. Additionally, holding the safe government assets might discourage banks from financing more risky private projects and restrain from searching for new lending opportunities. (Emran and Farazi (2009)). This would provoke less development in the banking sector and the crowding out effect of private credit (Caballero and Krishnamurthy (2004)).

3.3 Data and descriptive statistics

To address the research question a unique data set of German regional bank branch and public sector finance information is compiled and covers the time period over 2000-2015. The local market is defined at NUTS 3 (county) level (for more details see Chapter 1).

3.3.1 Measure of local financial development

As discussed in Chapter 1 the financial development is measured by the number of bank branches per person in a given region. This measure is widely used

in the literature and has, as Benfratello, Schiantarelli, and Sembenelli (2008) point out, the advantage of providing for a statistics which is robust across time and regions.

To construct the variable for financial development the same dataset as in Chapter 1 and Chapter 2 was employed[1].

To have more precise understanding about the data and its dynamics over the given years, let us have a more precise look at the statistics. As Table 38 shows an average (median) district has about 98 (84) bank branches operating there in 2000 while this number in 2015 decreases to 70 (59). Figure 9 displays that the branch network is being cut down in almost all German districts. Branch closures can be observed in 94% of regions. Seven regions demonstrate unchanged figures of bank branches while 17 regions have been characterized by a positive trend in the local banking market. In general, cities are slightly less affected compared to rural areas. Considering closures across all types of credit institutions, Figure 10 illustrates that cooperative, credit, and savings banks have experienced shutdowns of their branches in an equal manner.[2] Moreover, the figures in the table as well as Figure 11 reveal that there exists considerable cross regional heterogeneity in bank branch density with a region at the 90th percentile exhibiting a branch density almost three times as large as that of a region at the 10th percentile. The distribution has slightly shifted to the left and the overall distribution of branch density has declined during the observed 15 years. Breaking down by region illustrates the gap in branch propagation between West and East Germany which remains significant over time.

3.3.2 Regional public debt

Most previous studies that investigate the determinants of financial development have not included a variable for public sector financing and those that have reported insignificant results while the measures employed are not so directly defined to capture public sector's borrowing. More precisely, some studies have used overall public deficit that apart from banking financing includes central bank financing, domestic non-bank financing, and external financing; others have used government expenditures which in addition to the aforementioned items cover government revenues and grants (e.g., Boyd, Levine, and Smith

[1]For more details about the data, its structure, and collecting process, see Chapter 2
[2]For more details on branch closures in Germany see Schwartz et al. (2017).

(2001) and Detragiache, Gupta, and Tressel (2005)).

I follow Hauner (2008) and Hauner (2009) and use information on government borrowing. In case of Germany, the German Statistical Office provides figures on aggregate public debt at the end of each year and also at county level reporting separate numbers for its level on the credit market with. This measure directly captures relationship between public sector and banking markets and, therefore, employing this statistics should result in more accurate findings. Thus, its level as a percentage of GDP serves as a major independent variable which coefficient is at the most interest of this study.

The descriptive statistics reported in Table 39 show that there is an upgoing trend of public sector debt overall and its level on the credit market in particular with the overall distribution shifted to the right over time. Public debt on the credit market comprises almost 95% (99%) of total debt in 2000 (2015). While at the beginning of the analyzed period the average East German region has possessed higher level of debt, both in terms of absolute values and as a percent of GDP, in comparison to the West German average the opposite is observed in 2015.

3.4 Econometric approach

To explore what influences the development of local banking markets I follow Hauner (2008) and employ two specifications. First, I explore the time-series dimension of the data estimating a fixed effects panel specification where the dependent variable is a growth rate over five-year non-overlapping windows of branch density in a region (to smooth short-run fluctuations):

$$\frac{BANKDEV_{i,t}}{BANKDEV_{i,t-5}} - 1 = \alpha_0 + \alpha_1 BANKDEV_{t-5} + \alpha_2 DEBT_{i,t-5} + \alpha_3 GDP_{i,t-5} + \alpha_4 YEAR_{t-5} + \varepsilon_{i,t} \tag{3.4.1}$$

where subindex i stands for a region, t indicates time (year), $BANKDEV$ is a measure of local banking development, i.e. branch density per 10,000 inhabitants, $DEBT$ is the initial level of debt-to-GDP (in 2000), GDP is GDP per capita. Also, time dummies are included.

Second, a cross-section specification of the following form is estimated:

$$BANKDEV_{i,t} - BANKDEV_{i,0} = \beta_0 + \beta_1 BANKDEV_{i,0} + \beta_2 \overline{DEBT_i} + \beta_3 GDP_{i,0} + u_i \tag{3.4.2}$$

where on the left-hand side is the change in the branch density over 2000-2015, or more precisely the change between 2000-2002 and 2013-2015 averages in order to diminish short-term variations. The right-hand side variables $BANKDEV$ and GDP are levels of explanatory variables in the initial period (in 2000) in region i, $\overline{DEBT}$ is the average government debt on the credit market of region i over 2000-2015.

The two specifications complement each other. While the panel is better in dealing with possible endogeneity by employing the growth rates over non-overlapping five-year windows and controls omitted variable bias by using fixed effects, the cross-section focuses on the long-run relationship between variables.

3.5 Results

Following the above estimation approach I move to the results on the role of public sector debt for local banking markets development. I start with the panel specification and then discuss evidence from the cross-sectional estimation.

3.5.1 Panel specification

Table 40 presents results from the panel specification described by Equation (3.4.1). Column 1 shows that public sector debt has a statistically significant negative impact on local banking development, providing evidence on the "lazy banks" view: A 1 percentage point increase in the debt-to-GDP rate leads to around 0.3 percentage point decrease in branch propagation. Furthermore, a higher level of income per capita seems to not support greater banking deepening, however the correspondent coefficient is statistically insignificant. Turning to the estimate of the regional banking variable, it is negative and at 1% statistically significant. The coefficient reveals that more advanced banking markets do not guarantee greater growth rates of financial development. The specification explains 43% of the variation in branch density.

In Section 3.3 we have seen that German regions considerably differ in their banking sector development as well as in holding public sector credit. In column 2, I explore whether there are any heterogeneity in effect of government

debt and allow the corresponding slopes to vary for West and East regions. The results seem to provide evidence of a negative influence of government debt on banking sector depth which applies both for West and East regions although the coefficient for the former is not statistically significant. In terms of implied economic impact, the interaction with the East dummy is much larger than with the West dummy: The estimation implies that an increase in the debt-to-GDP rate by 1% point reduces the 5-year growth rate by about 1.5% points for branch density in East while for West regions a drop of 0.2% points would be observed. Indeed, the Wald test indicates that at 10% level one can reject the hypothesis that the coefficients are not significantly different.

Following Hauner (2008) I check for possible non-linearity in the effect of government debt by including dummies for its extreme values (one standard deviation away from the mean in both directions). If including a dummy for low levels of debt will decrease the coefficient for debt and vice versa for a dummy for high levels then one could conclude on the threshold effect. In other words, as the damage is done the marginal effect of an additional increase in government debt above the threshold on the growth pattern of the banking sector is smaller than below the threshold. The results are presented in columns 3-4. The high debt dummy increases the size of coefficients for debt in West and East regions. The low debt dummy leaves the interaction for East the same while the intercept for West negligibly increases. Both dummies are statistically insignificant and their effect on the coefficients seem to not provide evidence on the presence of the threshold effect.

3.5.2 Cross-sectional specification

The estimations for the cross-section in Equation (3.4.2) are reported in Table 41. Column 1 reveals that well-developed banking markets are associated with lower speed of banking deepening. Furthermore, higher levels of government debt adversely affect local banking growth: An increase in government debt by 1% point leads to a decline in the 16-year bank expansion by 0.03% points. The variation of the independent variables explains a substantial part of the variation in banking development with an R^2 of almost 0.6. The results in column 2 where I differentiate the effect by region suggest similar negative slope for the West and East regions. However, in comparison with the panel regressions here the coefficient for East regions becomes no longer significant

while the opposite applies for the interaction with the West regions. Meanwhile, the size of the impact turns to be very similar. More specifically, an increase in government debt by 1% point leads to a decline in the 16-year bank expansion by 0.03% points both for West and East Germany. Indeed, the Wald test suggests that one cannot reject the null hypothesis and therefore, both estimations are not significantly different from each other. Similarly, examining for possible non-linearity in the effect (columns 3 and 4) does not provide evidence on existence of some threshold above which one would observe heterogeneity in the impact of the government debt. Including the dummy for low level of government debt only negligibly increases both coefficients of interaction for West and East Germany. Likewise, once controlling for high level also increases both interactions. Thus, the evidence does not support the threshold effect in the impact of government debt on bank deepening.

Overall, the cross-section results complement the panel estimations and likewise tend to contribute to the "lazy banks" view with the adverse effect of public sector borrowing on banking sector development. The evidence for different debt effect for West and East regions is mixed while there is no support for the diminishing marginal effect with growing public debt.

3.5.3 Robustness check

According to Chinn and Ito (2006) data for financial development measurements such as amount of credit given, stock market capitalization, etc. are subject to even greater measurement error than macroeconomic data. Additionally, such measurements may absorb unusual dynamics as, for instance, financial bubbles. Given that in this study the branch data is employed I could exclude the former issue while the second may still be the case: During the financial crisis many banks followed strategy of cutting costs and, as a result, they reduced number of branches. Thus, I examine here whether the results are sensitive to outliers. More specifically, the values of branch density that are two standard deviations away from the mean in both directions are excluded.

Since the panel regression is assumed to deal better with the endogeneity issue literature gives preference to this estimation (e.g., Hauner (2008)). Therefore, I concentrate here on robustness check based on the panel specification. Table 42 reveals that the coefficients of our interest do not change in terms of sign: The debt coefficients are still negative. However, quantitatively they are

half less and none of them is economically significant compared to Table 40. Columns 2 provides evidence on absence of heterogeneity in the effect of government debt in West and East regions (the Wald test reports no significant differences) although none of the coefficients is statistically significant.

Overall, the key finding - a negative effect of government debt on local banking markets independently of regions location and the level of debt - seems to be driven by outliers although such an outcome could be influenced by the short time series of the data.

Reverse causality

One may reasonably argue that financial development is what drives the level of government debt or per capita income. Whereas the growth rates over 5-year non-overlapping windows are applied to diminish the simultaneity problem it may still be useful to examine the direction of causality. On the contrary, if it is shown that the reverse causality is irrelevant, that will indicate that regions can develop their local banking markets by exogenously determining the level of public debt and economic growth. To this end, Equation (3.4.1) is estimated with government debt and GDP per capita as dependent variables and branch density as an independent variable, or more specifically:

$$\frac{DEBT_{i,t}}{DEBT_{i,t-5}} - 1 = \gamma_0 + \gamma_1 BANKDEV_{t-5} + \gamma_2 DEBT_{i,t-5} + \gamma_3 GDP_{i,t-5} + \gamma_4 YEAR_{t-5} + v_{i,t} \tag{3.5.1}$$

$$\frac{GDP_{i,t}}{GDP_{i,t-5}} - 1 = \phi_0 + \phi_1 BANKDEV_{t-5} + \phi_2 DEBT_{i,t-5} + \phi_3 GDP_{i,t-5} + \phi_4 YEAR_{t-5} + \epsilon_{i,t} \tag{3.5.2}$$

The coefficients of interest are γ_1 and ϕ_1. A statistically significant and positive coefficient on branch density would indicate the reverse causality. Or in other words higher banking expansion leads to greater government debt and greater income.

Table 43 reports the results. The estimates for branch density are statistically insignificant and even negative for debt-to-GDP regression. Thus, the obtained results are not affected by the simultaneity issues.

Another way to check reverse causality is to use a procedure proposed by Dumitrescu and Hurlin (2012) for detecting Granger causality in panel datasets. The results are presented in Table 44. First, it is necessary to select the optimal

number of lags using the information criterion. The Schwartz information criterion (BIC) (column 1) suggests lag length of one. Running the test shows that the p-value allows to reject the null hypothesis that the level of government debt does not Granger-cause the branch density. In column 2, I also check Granger causality using the Akaike and Hannan-Quinn information criterion which both recommends the number of lags equal to three. The obtained result also implies that the government debt level Granger-causes the branch density in the region.

3.6 Summary and conclusions

The theoretical and empirical literature on determinants of financial development has examined the importance of different factors that can influence financial deepening as financial and trade openness, inflation, institutions quality, etc. however neglected the role of government debt. This paper investigates the impact of public debt on banking development measured by the number of branches in Germany. A distinctive feature of the analysis is that, first, in comparison to most literature it is conducted in the frame of one particular country rather than a cross-country analysis; second, to the best of my knowledge, this is the first examination done for Germany that studies the potential determinants of banking sector development.

Addressing the research question I employ two econometric approaches: the panel and cross-section models. While the former allows to have more observations and exploit the time-series dimension and deals better with potential endogeneity and omitted variable bias, the latter provides evidence on the long-run relationship and mitigates the noise of short-run fluctuations. The obtained results seem to support neither the “lazy banks” view nor the “safe asset" view as the robustness check indicates that negative effect of the public debt on banking development is driven by outliers. Moreover, there is no evidence on the threshold effect that implies a decrease in the marginal effect of public sector borrowing on banking development for higher levels of the former. The evidence on heterogeneous effects of the public debt in West and East parts of Germany is also not found.

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3.7 Appendix

3.7.1 Tables

Table 38: Descriptive statistics: Local banking markets

	Mean	St. dev.	10%	25%	50%	75%	90%
				2000			
Branches	98.368	71.305	34	52	84	127	169
West	104.794	65,835	39	61	94	131	177
East	71.247	86.185	25	34	50	88	117
Branch dens.	5.427	2.215	2.914	3.749	5.047	6.834	8.445
West	5.916	2.125	3.412	4.293	5.690	7.313	8.741
East	3.363	1.143	2.157	2.633	3.224	3.939	4.658
				2015			
Branches	69.634	50.768	25	37	59	86	121
West	74.425	49.143	27	43	64	91	129
East	49.416	52.833	20	28	37	59	85
Branch dens.	3.869	1.468	2.233	2.723	3.592	4.765	6.019
West	4.126	1.473	2.447	3.014	3.944	5.009	6.296
East	2.785	0.802	1.783	2.249	2.668	3.228	3.745

Notes: Table 38 reports descriptive statistics for the distribution of bank branches across regions. "Branches" refers to the total number of branches in a given region, "branch density" refers to the total number of branches per 10,000 inhabitants. "West" ("East") reports numbers for West (East) Germany only. Reported statistics of the cross-regional distribution are the mean, the standard deviation and the 10th, 25th, 50th (median), 75th and 90th% percentiles. Numbers are reported for the first (2000) and last (2015) year of our data sample. There are 325 regions in West and 77 regions in East Germany (according to NUTS 2013 classification).

Table 39: Descriptive statistics: Public sector debt

	Mean	St. dev.	10%	25%	50%	75%	90%
			2000				
Debt, in millions EUR	216.398	261.720	63.714	93.714	135.613	246.037	384.071
West	211.302	153.963	79.855	114.117	157.647	301.254	364.651
East	217.585	281.121	62.947	90.825	130.742	238.212	386.417
Debt (credit), in millions EUR	205.276	251.394	59.879	86.663	130.514	233.676	374.429
West	204.844	269.731	58.647	82.453	122.307	222.219	374.429
East	207.130	150.323	79.855	113.291	156.593	298.516	354.606
Debt (credit), % of GDP	4.754	2.346	2.141	2.884	4.329	6.138	7.865
West	4.211	1.865	2.098	2.633	4.106	5.439	7.019
East	7.088	2.751	3.734	4.919	7.165	9.248	10.288
			2015				
Debt, in millions EUR	330.606	445.145	61.801	95.234	169.844	378.047	750.213
West	370.738	482.998	65.233	105.986	187.695	439.596	824.747
East	161.103	122.009	45.725	80.583	132.597	212.943	324.274
Debt (credit), in millions EUR	326.278	431.286	62.255	96.728	169.844	378.047	750.213
West	363.8756	467.266	64.307	103.853	187.332	439.596	832.159
East	164.202	122.135	54.072	83.517	137.648	213.8	324.273
Debt (credit), % of GDP	5.555	5.009	1.251	2.174	4.043	7.225	11.121
West	5.861	5.407	1.142	2.121	4.175	8.343	13.155
East	4.235	2.284	1.680	2.462	3.733	5.479	7.295

Notes: Table 39 reports descriptive statistics for the distribution of public debt across regions. "Debt" refers to the total public sector debt in a given region, "Debt (credit)" refers to the public sector debt on the credit market, "Debt (credit), % of GDP" refers to the public sector debt on the credit market as a percent of GDP. "West" ("East") reports numbers for West (East) Germany only. Reported statistics of the cross-regional distribution are the mean, the standard deviation and the 10th, 25th, 50th (median), 75th and 90th% percentiles. Numbers are reported for the first (2000) and last (2015) year of our data sample. There are 325 regions in West and 77 regions in East Germany (according to NUTS 2013 classification).

Table 40: Panel regressions

	Branch dens.	Branch dens.	Branch dens.	Branch dens.
Branch dens.	-11.216***	-11.250***	-11.253***	-11.223***
	(1.287)	(1.279)	(1.280)	(1.270)
Debt	-0.323*			
	(0.195)			
Debt*West		-0.208	-0.228	-0.424
		(0.199)	(0.201)	(0.324)
Debt*East		-1.463**	-1.463**	-1.841**
		(0.697)	(0.703)	(0.718)
Low Debt			-1.422	
			(2.456)	
High Debt				3.027
				(2.415)
Ln GDP p.c.	-7.092	-9.569	-9.067	-9.247
	(7.628)	(7.779)	(7.850)	(7.752)
Constant	64.265**	73.176***	71.741***	72.801***
	(25.891)	(26.565)	(26.797)	(26.465)
N	1186	1186	1186	1186
R2 within	0.433	0.437	0.437	0.439
R2 between	0.053	0.040	0.040	0.037
R2 overall	0.087	0.082	0.082	0.081
F-stat	91.422	75.253	64.704	64.545
Wald test		0.085		

Notes: Table 40 reports results from OLS fixed effects panel regressions (Equation (3.4.1)). In each specification, the dependent variable is the five-year growth rate of branch density. Robust standard errors in parenthesis. Significance level *** 1%, ** 5%, and * 10%.

Table 41: Cross-section regressions

	Branch dens.	Branch dens.	Branch dens.	Branch dens.
Branch dens.	-0.336***	-0.334***	-0.333***	-0.334***
	(0.020)	(0.023)	(0.023)	(0.023)
Debt	-0.033***			
	(0.012)			
Debt*West		-0.033***	-0.036***	-0.037**
		(0.012)	(0.013)	(0.016)
Debt*East		-0.028	-0.030	-0.032
		(0.018)	(0.018)	(0.022)
Low Debt			-0.170	
			(0.127)	
High Debt				0.050
				(0.121)
Ln GDP p.c.	-0.101	-0.087	-0.054	-0.091
	(0.082)	(0.099)	(0.102)	(0.099)
Constant	1.131***	1.071***	0.987**	1.101***
	(0.313)	(0.392)	(0.401)	(0.401)
N	398	398	398	398
R2	0.598	0.597	0.598	0.596
F-stat	91.555	75.188	62.464	60.192
Wald test		0.742		

Notes: Table 41 reports results from OLS cross-section regressions (Equation (3.4.2)). In each specification, the dependent variable is the change of branch density from its 2000-2002 average level to its 2013-2015 average level. Robust standard errors in parenthesis. Significance level *** 1%, ** 5%, and * 10%.

Table 42: Panel regressions: Robustness check

	Branch dens.	Branch dens.	Branch dens.	Branch dens.
Branch dens.	-6.716***	-6.757***	-6.760***	-6.757***
	(0.851)	(0.851)	(0.851)	(0.852)
Debt	-0.165			
	(0.144)			
Debt*West		-0.110	-0.152	-0.104
		(0.150)	(0.152)	(0.224)
Debt*East		-0.733*	-0.724*	-0.722
		(0.405)	(0.407)	(0.456)
Low Debt			-2.818	
			(1.932)	
High Debt				-0.087
				(1.807)
Ln GDP p.c.	-4.274	-5.451	-4.506	-5.456
	(6.256)	(6.309)	(6.334)	(6.310)
N	1147	1147	1147	1147
R2 within	0.447	0.449	0.451	0.449
R2 between	0.036	0.026	0.027	0.027
R2 overall	0.103	0.100	0.101	0.100
F-stat	112.776	94.737	81.549	81.106
Wald test		0.149		

Notes: Table 42 reports results from OLS fixed effects panel regressions (Equation (3.4.1)). The model excludes extreme values of banking growth - two standard deviations away from the mean in both directions. In each specification, the dependent variable is the five-year growth rate of branch density. Standard errors are in brackets clustered at the regional level. Significance level *** 1%, ** 5%, and * 10%.

Table 43: Reverse causality: Panel specification

	GDP p.c.	Debt
Debt	-0.431***	-2.138
	(0.099)	(1.554)
Ln GDP p.c.	-69.647***	35.832*
	(5.469)	(20.171)
Branch dens.	0.339	-1.189
	(0.373)	(1.484)
Constant	248.389***	-111.689
	(18.198)	(68.263)
N	1186	1180
R2 within		
R2 between	0.013	0.000
R2 overall	0.041	0.005
F-stat	167.309	12.629

Notes: Table 43 reports results from OLS fixed effects panel regressions (Equation (3.4.1)). In column 1, the dependent variable is the five-year growth rate of GDP per capita, in column 2 - of debt-to-GDP rate. Robust standard errors in parenthesis. Significance level *** 1%, ** 5%, and * 10%.

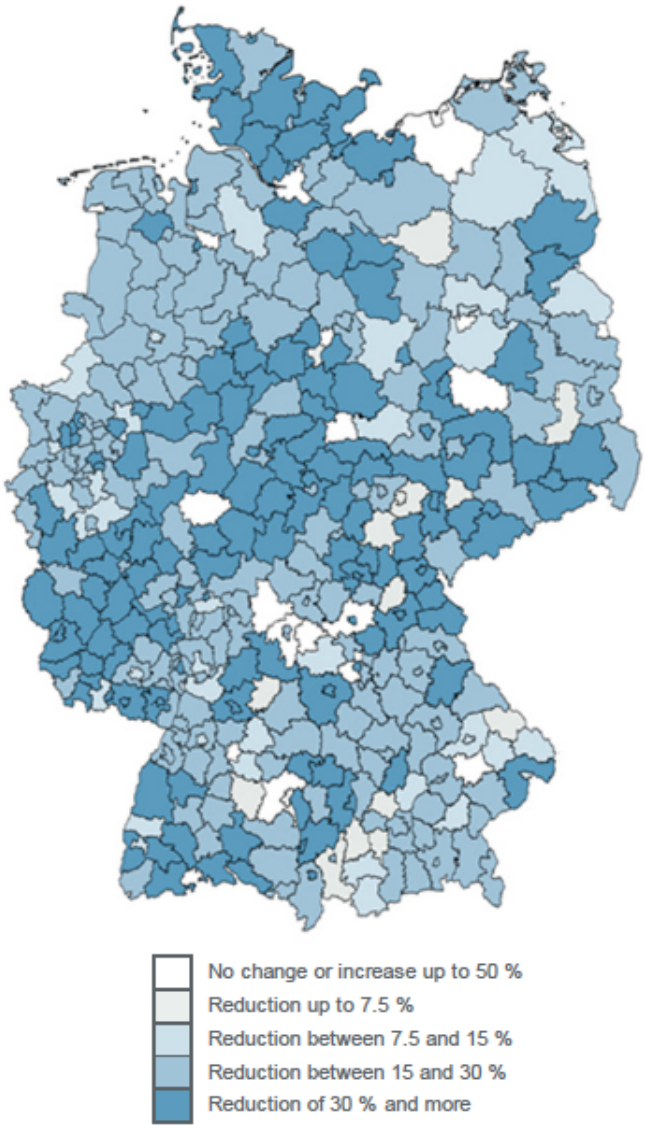
Table 44: Reverse causality: Granger causality

	BIC	AIC, HQIC
Optimal number of lags	1	3
$\bar{W}$	2.064	9.323
$\bar{Z}$	14.777	50.718
	(0.000)	(0.000)
$\tilde{Z}$	8.523	13.786
	(0.000)	(0.000)

Notes: Table 44 reports results from Dumitrescu and Hurlin (2012) for detecting Grenger causality in panel datasets. In column 1, the Schwartz information criterion (BIC) is applied to define optimal lag length. In column 2, the test is done for lag length determined by the Akaike and Hannan-Quinn information criterion.

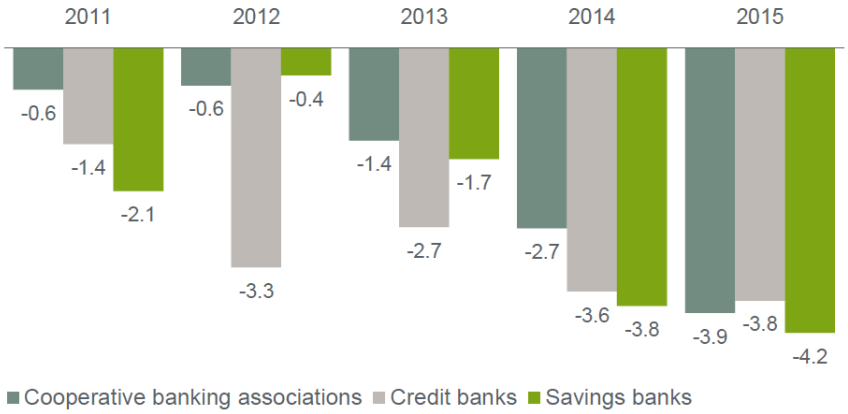
3.7.2 Figures

Figure 9: Relative change in the number of branches



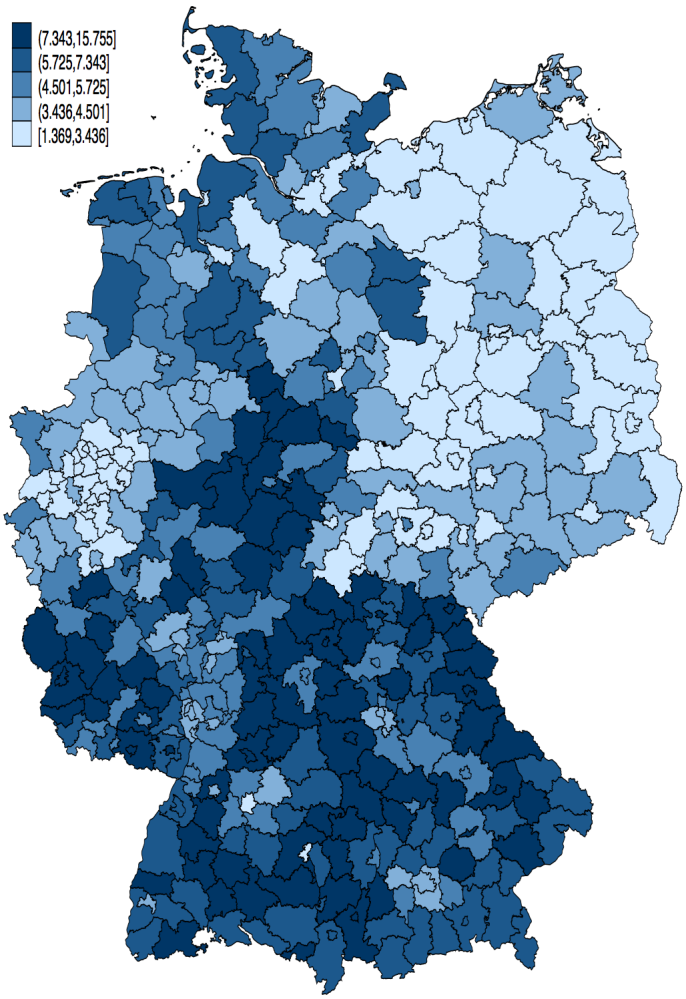
Notes: Figure 9 plots the relative change in the number of bank branches from 2000 to 2015 in percent. Regional units correspond to German NUTS 3 regions.

Figure 10: Annual change in branch numbers across all types of credit institutions



Notes: Figure 10 plots the the annual change (in per cent) in branch numbers across all types of credit institutions.

Figure 11: Bank branch density



Notes: Figure 11 plots the branch density in 2000. Regional units correspond to German NUTS 3 regions. Bank branch density is measured by the number of bank branches per 10,000 inhabitants in a given region.