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# Diversification and the banks' risk-return-characteristics – evidence from loan portfolios of German banks

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**Abstract**

Banks face a tradeoff between diversifying and focusing their loan portfolio. In this paper we carry out an empirical study for the German market to shed light on the question whether or not the benefits of risk sharing outweigh those of specialization. We use data from the Bundesbank's quarterly borrowers statistic to determine the degree of diversification in the banks' loan portfolios and combine this data with the banks' balance sheets and audit reports. The unique database comprises data from *all* German banks during the period from 1993 to 2003.

Our main results can be summarized in three statements: i) Specialized banks have a slightly higher return than diversified banks. ii) Specialized banks have lower relative loan loss provisions and lower shares of non-performing loans, iii) However, the standard deviations of the loan loss provision ratio and the non-performing loan ratio are lower for diversified banks.

**Keywords:** bank lending, loan portfolio, portfolio theory, diversification, risk-return analysis

**JEL classification:** G11, G21, C23, C43

# Non technical summary

Should a bank diversify its loan portfolio as much as possible or should it concentrate its lending to those industries in which it has special expertise? If the expected return and the risk of a loan were completely exogenous, the answer would clearly be in favour of the risk diversification as we know it from the stock markets. However, to some extent a bank can influence the risk-return-characteristics of its loans. For instance, the bank determines the effort for screening and monitoring of its debtors. By building up expertise in a certain industry, a bank can tell more easily good debtors from bad ones and can thereby reduce the risk of originated loans. The specialization, however, comes along with a loss of portfolio diversification across industries.

The question from above (diversification vs. specialization) has no unambiguous theoretical solution, because the effects work in opposite directions. Therefore, we examine this question in an empirical study. Our dataset consists of data for all the banks in Germany in the period from 1993 to 2003. In our dataset the lending is broken down to industries at the bank-level. We calculate different measures of diversification for each bank and each year. These measures of diversification are then related to return and risk figures of the banks.

The results of our empirical study can be summarized as follows: more specialized banks tend to have a slightly higher return, measured as profits over equity and total assets, respectively, than more diversified banks. However, the slightly higher return comes along with a slightly higher risk, which we measure as the serial volatility of the non-performing loans ratio. To sum up, focused banks enjoy a slightly better return performance, but their non-performing loans ratio is a bit more volatile.

# Nicht-technische Zusammenfassung

Soll eine Bank ihr Kreditportfolio möglichst breit streuen, oder soll sie sich bei der Kreditvergabe auf diejenigen Branchen konzentrieren, in denen sie über besondere Kompentenz verfügt? Wären der erwartete Ertrag und das Risiko ihrer Kredite nur durch äußere Umstände bestimmt, dann müsste die Antwort eindeutig zugunsten der Risikodiversifikation ausfallen, wie wir sie etwa von den Aktienmärkten her kennen. Jedoch kann die Bank zu einem gewissen Grad selbst die Ertrags- und Risikomerkmale eines Kredits beeinflussen, indem sie etwa festgelegt, wie genau sie ihre Kreditnehmer prüft und überwacht. Indem also eine Bank besondere Kompentenz in einer Branche aufbaut, kann sie bei den potenziellen Kreditnehmern aus dieser Branche leichter gute von schlechten Schuldnern unterscheiden und so das Risiko des einzelnen vergebenen Kredits senken; sie verliert dabei aber die Möglichkeit, das Risiko ihres Gesamtportfolios über die Branchen zu streuen.

Theoretisch lässt sich die oben gestellte Frage (Diversifikation vs. Spezialisierung) somit nicht eindeutig beantworten; in diesem Papier soll sie daher empirisch untersucht werden. Wir verwenden dazu einen Datensatz für die Banken in Deutschland, der auf der Ebene der einzelnen Bank eine Aufgliederung des Kreditvolumens in die einzelnen Branchen erlaubt. Wir berechnen für jede Bank und jedes Jahr des Untersuchungszeitraums (1993-2003) Maße für die Diversifikation des Kreditportfolios und setzen diese Maße in Beziehung zu Ertrags- und Risikokennziffern der einzelnen Banken.

Die empirischen Ergebnisse unserer Studie lassen sich folgendermaßen zusammenfassen: Banken mit einem höheren Grad an Spezialisierung erreichen einen leicht höheren Ertrag, gemessen als Jahresüberschuss bezogen auf das Eigenkapital bzw. die Bilanzsumme, als Banken mit einem stärker diversifizierten Portfolio. Allerdings zeigt sich, dass der höhere Ertrag mit einem leicht höheren Risiko einhergeht, wenn das Risiko als zeitliche Schwankung der Kreditvorsorgequote einer Bank gemessen wird. Demnach erkaufen die spezialisierten Banken ihren leicht höheren Ertrag mit einem etwas höheren Risiko im Vergleich zu den diversifizierten Banken.

# Contents

# Diversification and the Banks' Risk-Return-Characteristics – Evidence from Loan Portfolios of German Banks*

## 1 Introduction

Should a bank diversify its loan portfolio or should a bank hand out loans only to those firms whose business the bank is very familiar with? If a loan were a liquid asset with exogenous payoff, the question would clearly be answered in favor of risk diversification. However, loans cannot be traded in a liquid market and the bank can at least in part determine the payoff of the loan: Depending on its screening and monitoring abilities, a bank can prevent or at least mitigate the information asymmetry problems associated with the loan contract and can thereby reduce the riskiness of the payoff.

Obviously, there is a tradeoff between the strategy of risk diversification and the strategy of building up expertise in certain industries, and it is not clear which strategy is the better one. In the real world we observe both strategies: On the one hand, the banking act sets upper limits for the exposure to one single borrower which is an argument in favor of the (assumed) necessity of diversification. On the other hand, there are banks like the *Deutsche Apotheker- und Ärztebank* which built up expertise in certain industries (here the health care business) they have a superior knowledge about, hoping that their superior monitoring abilities will increase risk-adjusted returns. As there are various examples for banks with industry expertises, we can conclude that focussing is at least for some banks an alternative strategy.

The main contribution of this article is an empirical study for the German banking sector to find out which of the two strategies, diversification of the loan portfolio

* We are indebted to the discussants and participants at conferences including the 33rd Annual Meeting of the European Finance Association (Zürich, Switzerland, August 2006), the IFSAM VIIIth World Congress (Berlin, Germany, September 2006), the 13th Annual Meeting of the German Finance Association (Oestrich-Winkel, Germany, October 2006) and to Thomas Kick for helpful comments on the paper. All remaining errors are of course ours.

or its specialization, has generated better results in the past. We use data on the loan portfolio composition of German banks and relate this data to performance and risk measures of the corresponding banks. Our findings can be summarized as follows: Banks which focus their lending on few industries have higher returns and lower loan loss provision ratios respectively non-performing loan ratios, than banks with a diversified loan portfolio. Given these results, it seems as if the strategy of building up expertise is superior to the diversification of loan origination. However, the standard deviation of the loan loss provision ratio and the non-performing loan ratio respectively as proxies for the bank's unexpected losses are more prominent with specialized banks.

The paper is organized as follows. In Section 2 we put our paper in perspective to the existing literature in this area. The data is presented in Section 3. Section 4 is devoted to theoretical considerations concerning the benefits of diversification and those of being focussed. Our empirical results are presented in Section 5. Section 6 concludes.

# 2 Related Literature

The theoretical literature on the question whether or not to diversify does not offer an unanimous recommendation. Whereas Diamond (1984) comes to the conclusion that a bank maximizes the gains from delegated monitoring by perfect diversification, Hellwig (1998) extends the Diamond (1984) model and shows that banks may be well advised to concentrate at least on some large projects to reduce the monitoring costs. Stomper (2004) shows in an equilibrium model that both types of banks exist in equilibrium: those that are perfectly diversified and those that are specialized.

Winton (1999) explicitly models the tradeoff between diversification and specialization. In his model the gains from diversification and those from focusing depend on the riskiness of the bank. According to his model the gains from diversification are most dominant when the bank has a medium risk level; for low risk and for high risk banks it pays to run a specialization strategy.

There is a large body of empirical studies that analyzes benefits from strategic diversification of, mostly nonfinancial, firms. Whereas Lang and Stulz (1994) and Berger and Ofek (1995) find a discount for diversified firms, Campa and Kedia (2002) argue that this diversification-discount is rather due to the underlying characteristics of the diversified firms than to the decision for diversification. Stiroh (2004) and Laderman (2000) empirically analyze the benefits from strategic diversification in the case of banks. According to their studies the gains from diversification in terms of reduced risk are only weak.

Heitfield et al. (2005) analyze portfolios of Syndicated National Credits (SNC). They show that the portfolio risk goes up when the name and industry concentration is increased. However, their results are barely surprising because in their study the loan parameters are exogenous and therefore the banks' screening and monitoring abilities remain unconsidered. The empirical study of Acharya et al. (2004) is based on the theoretical results of Winton (1999). They analyze the portfolio diversification as well as risk and return figures of Italian banks and conclude that *"diversification, per se, is no guarantee of superior performance or greater bank safety and soundness"*. Elyasiani and Deng (2004) carry out a corresponding study for the banks in the United States. They find that diversified banks have lower returns, but at the same time these banks are less risky, hinting at a typical tradeoff of risk and return. Hayden et al. (2005) perform a study close to Acharya et al. (2004) with data for German banks. They find that diversified banks tend to show weaker results than specialized banks. Their study is the one most closely related to our own work. However, our study is different with respect to several aspects: i) We use different measures of diversification. Whereas Hayden et al. (2005) use only the Hirschman-Herfindahl-Index, we measure banks' diversification with distance measures as well. These distance measures describe the specialization relative to a benchmark, for instance the nationwide loan portfolio, and overcome thereby the limitations of the Hirschman-Herfindahl-Index which implicitly assumes an equally distributed benchmark.[1] ii) Our database differs from the database used by Hayden et al. (2005).

[1] See Pfingsten and Rudolph (2002) and Kamp et al. (2005).

The banks' portfolio composition in our study is calculated from the borrowers statistics, whereas Hayden et al. (2005) use individual loan data which is taken from the German credit register *(Millionenkredit-Evidenzzentrale)*. The problem with the credit register is that it only covers loans of more than 1.5 million euros, whereas the borrowers statistics comprises all national lending.

# 3 Data

In this section we give an overview of the data and the variables we use in our empirical study. At first we describe the German banking sector and the two principal databases of our study (Subsection 3.1). Then we introduce the bank specific variables (Subsection 3.2).

## 3.1 Databases

The German banking sector traditionally consists of three pillars: the commercial banks, the savings banks, and the credit cooperatives. Concerning the number of institutions, the cooperatives and the savings banks dominate the German market. This dominance of the savings banks and especially the cooperatives persists; in 2005 they still account for more than 82% of all institutions.[2] However, the last decade saw many mergers within the groups of credit cooperatives and savings banks, respectively.

Credit cooperatives and savings banks are allowed to offer all sort of banking services, but their business is locally restricted and, by and large, they do not compete with banks of their own pillar. The commercial banks comprise the five big banks; the majority of the commercial banks, however, are of medium size. All the banks in Germany have to regularly report to the German regulatory authorities and we use this data for our empirical analysis.

[2] In September 2005, Germany had 2098 banking institutions. Among these institutions, there were 1307 cooperative banks (62.3%), 475 savings banks and state banks (22.6%), 249 commercial banks (11.9%) and 67 other banks (3.2%). The other banks include real estate banks, building societies and special purpose banks.

The banking data of our study is taken from two principal databases: the *Kreditnehmerstatistik*, from which we calculate the degree of diversification in the banks' loan portfolios, and the *Bankaufsichtliches Informationssystem (BAKIS)*, from which we calculate bank specific financial indicators.

All banks in Germany have to report their loan exposure at the end of each quarter. The Deutsche Bundesbank collects this data in the borrowers statistics *(Kreditnehmerstatistik)*. The banks are required to report their loan exposure to corporate borrowers, which are broken down into 23 industries. We use the exposures to these industries to determine the degree of diversification (See Subsection 4.1). The borrowers statistics is limited to domestic borrowers. However, as most of the banks in Germany have no or little foreign business (especially the credit cooperatives and savings banks), this limitation seems not to be crucial.

The second principal database in our paper is the *Bankaufsichtliches Informationssystem (BAKIS)*. In this database, the German supervisory authorities (the Deutsche Bundesbank and the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin)) collect data used to supervise the German banks. This database contains balance sheet data and profits & losses accounts of all banks in Germany. In addition, it contains the yearly quantitative audit reports. There are yearly observations, starting in 1993 and ending 2003, i.e. our study covers 11 years. The database comprises the data of *all* German banks starting in 1993 with observations for 3,840 banks. Due to mergers the number of banks was reduced to 2,161 by the end of 2003.

## 3.2 Variables

In the empirical study, we explain financial indicators by the degree of loan portfolio diversification and certain control variables. In what follows these bank specific variables are defined. Measures of diversification (specialization) are described in more detail in the following section.

To measure the size of a bank we use the natural logarithm of the bank's total assets

($ta$). The capital ratio ($cap$) is defined as equity over total assets.[3] As the return of a bank we calculate the return on assets ($roa$) and the return on equity ($roe$), which is defined as the bank's profit over total assets and over equity, respectively. The loan loss provision ratio ($llp$) is defined as the ratio of a bank's loan loss reserve over its total lending. The loan loss reserves comprise specific allowances for bad debts, unidentified loss reserves and provisions for bad debts. As the non-performing loan ratio ($npl$) we calculate the nominal value of audited non-performing loans over all audited lending. Thus, the non-performing loan ratio only refers to the part of the loan portfolio which was audited while the loan loss provision ratio refers to the whole loan portfolio. The bank's efficiency is measured with the help of the personnel intensity ($pers$). This variable is expressed as the bank's average number of personnel divided by the bank's total assets in million euros.

Note that we relied on economically motivated rather than on regulatory variables. That is, we prefer the capital ratio over the regulatory capital ratio and total assets over risk weighted assets. As we estimate risk and return figures which are derived from balance sheet data, we feel that one should rather use balance sheet variables as the capital ratio in stead of regulatory variables as the BIS capital ratio for our estimations.

In Table 1, we give an overview of the relevant variables and display their summary statistics.

[3] In some empirical analyses the regulatory capital ratio is preferred over the capital ratio derived from balance sheet data. However, as we explicitly estimate return and risk variables that are based on balance sheet data, we do not follow this view.

Table 1: Summary statistics of variables

| | Mean | Median | Standard deviation | Min. | Max. |
|---|---|---|---|---|---|
| Total assets in million € | | | | | |
| 1993-2003 | 1,810 | 174 | 15,700 | 0 | 742,000 |
| 1993 | 884 | 104 | 6,350 | 0 | 191,000 |
| 2003 | 3,310 | 345 | 25,300 | 4 | 742,000 |
| Capital ratio | | | | | |
| 1993-2003 | 5.42% | 4.78% | 4.60% | -1.32% | 98.80% |
| 1993 | 4.96% | 4.33% | 4.64% | 0.00% | 96.16% |
| 2003 | 6.01% | 5.37% | 4.90% | 0.00% | 93.08% |
| Return on assets | | | | | |
| 1993-2003 | 0.28% | 0.26% | 0.97% | -87.07% | 32.87% |
| 1993 | 0.35% | 0.31% | 0.48% | -7.04% | 12.73% |
| 2003 | 0.17% | 0.22% | 1.76% | -54.01% | 16.33% |
| Return on equity | | | | | |
| 1993-2003 | 5.42% | 5.36% | 13.66% | -1.257.20% | 1.136.70% |
| 1993 | 7.25% | 7.11% | 4.10% | -54.74% | 68.34% |
| 2003 | 3.64% | 4.05% | 17.18% | -644.84% | 316.57% |
| Personnel intensity | | | | | |
| 1993-2003 | 0.33 | 0.31 | 2.00 | 0.00 | 347.60 |
| 1993 | 0.41 | 0.33 | 6.25 | 0.00 | 347.60 |
| 2003 | 0.28 | 0.27 | 0.22 | 0.00 | 6.92 |
| Loan loss provision ratio | | | | | |
| 1993-2003 | 2.13% | 1.74% | 2.23% | 0.00% | 95.78% |
| 1993 | 2.42% | 3.21% | 3.21% | 0.00% | 66.26% |
| 2003 | 2.26% | 1.98% | 1.71% | 0.00% | 30.16% |
| Non-performing loan ratio | | | | | |
| 1993-2003 | 22.14% | 18.94% | 15.61% | 0.00% | 100.00% |
| 1993 | 24.92% | 21.94% | 16.80% | 0.00% | 100.00% |
| 2003 | 19.69% | 16.75% | 14.03% | 0.00% | 100.00% |

# 4 Diversification and Risk-Return-Characteristics

In this section, we discuss the relation of the bank's diversification to the bank's performance and to its risk. Theoretically, it is not clear whether or not diversification in the banks' loan portfolios leads to higher expected returns and/or to lower risk.

In Subsection 4.1 we define our notion of diversification and we present the measures of diversification that we will employ in the empirical study. Then we discuss the theoretical arguments in favor and against diversification benefits and we show empirical approaches of how to test for possible effects of diversification on the bank's return (Subsection 4.2) and on the bank's risk (Subsection 4.3), respectively.

## 4.1 Heuristic Concepts of Diversification

Classical portfolio theory in the sense of Markowitz (1952) states that a portfolio is well diversified if there is no portfolio which has, at the same time, lower risk and at least as much expected return. However, this concept cannot be transferred easily to loan portfolios for the following reasons: i) The classical portfolio theory is based on mean-variance-efficiency. However, the return distribution of loan portfolios is highly skewed so that the variance is an inappropriate risk measure and the mean-variance-concept is no longer justified on the basis of the expected utility theory. ii) Even if the mean-variance framework were appropriate for loan portfolios, the problem to estimate the necessary input parameters would remain. In order to determine the composition of mean-variance efficient portfolios one needs, among others, the correlations of the portfolio's assets; but the correlations among loans cannot be estimated precisely, at least with the limited data which we usually have.

Accepting the inappropriateness of the Markowitz-concept in this context, we resort to more heuristic concepts and we use the loan portfolio concentration and the loan portfolio's distance to a benchmark as diversification measures.

In the context of classical portfolio theory an investor invests his money into different assets; in the context of our paper the bank originates loans to different industries,

i.e. in our case the loans granted to firms of one industry are seen as one asset. Thus, when referring to diversification we mean the diversification across industries.[4] The industry is often considered to be the most important factor when explaining stock or bond volatilities.[5] Talking about bank lending, the industry is considered to be a key factor when estimating the riskiness of a loan.

Let $X_i^{b,t}$ be the nominal exposure of bank $b$ at time $t$ to industry $i$ with $i = 1, \ldots, n$. $x_i^{b,t}$ denotes the corresponding relative exposure, i.e.

$$x_i^{b,t} = \frac{X_i^{b,t}}{\sum_{j=1}^{n} X_j^{b,t}} \ . \tag{1}$$

Sometimes we calculate the diversification relative to the naively diversified portfolio, sometimes the diversification is determined relative to a benchmark portfolio. In the latter case, $y_i^t$ with $i = 1, \ldots, n$ denotes the share of the industry $i$ in the benchmark portfolio.[6]

In our study, we will use four different measures of diversification (specialization): the Hirschman-Herfindahl-Index (HHI), the Shannon Entropy (SE), an absolut distance measure ($D_a$, the normalised sum of differences) and a relative distance measure ($D_r$, the average relative difference).

The HHI is a commonly accepted measure of market concentration. The HHI of bank $b$ at time $t$ is calculated as

$$HHI(x) = \sum_{i=1}^{n} x_i^2 \ . \tag{2}$$

Note that the lower limit for the HHI is $1/n$ and is attained when exposures to all industries are equal. The HHI is equal to 1 when all loans are granted to one industry.

Entropy measures are also powerful instruments to indicate variety in distributions at a given point in time. Their potential applications include measuring industrial

[4] Due to data restrictions we cannot control for name concentration within the industries.
[5] See for instance Roll (1992).
[6] When later defining the measures, we suppress the superscripts $b, t$ and $t$ for simplicity.

concentration or corporate diversification.[7] We apply the Shannon entropy[8] (SE) in order to measure loan portfolio concentration:[9]

$$SE(x) = -\sum_{i=1}^{n} x_i \cdot \ln\left(\frac{1}{x_i}\right) \tag{3}$$

If all loans are handed out to one industry, the measure SE is equal to 0, representing maximum focus. Perfect naive diversification is expressed by a value of $-\ln(n)$.

Describing a loan portfolio composition as the (normalized) vector of relative industry shares, the measures $D_a$ and $D_r$ can be used to quantify the distance between a bank's loan portfolio $x$ and the benchmark's loan portfolio $y$. In this setting, diversification is at its maximum when a bank's loan portfolio composition perfectly reflects the industry shares of the benchmark portfolio.[10] The normalized sum of differences $D_a$ and the average relative distance $D_r$ are calculated as

$$D_a(x, y) = \frac{1}{2}\sum_{i=1}^{n} |x_i - y_i| \tag{4}$$

and

$$D_r(x, y) = \frac{1}{n}\sum_{i=1}^{n} \frac{|x_i - y_i|}{x_i + y_i} \ . \tag{5}$$

Note that both distance measures are normalized to the interval $[0, 1]$. $D_a$ is a normalized version of the arithmetic mean of the *absolute differences* (therefore $D_a$) across all segments. It can be interpreted as the proportion of a bank's portfolio $x$ which would have to be rearranged in order to achieve the composition of the benchmark portfolio. The measure $D_r$ is based on *relative differences* $\frac{|x_i - y_i|}{x_i + y_i}$.[11] The relative measure $D_r$ has the property that the deviation in each segment is seen relative to the size of this segment. However, this measures comes along with a disadvantage when some of the segments are not relevant (that is $x_i = 0$). Each

[7] See Frenken (2005).
[8] See Shannon (1948).
[9] Please note that $\lim_{x_i \to 0} x_i \cdot \ln(\frac{1}{x_i}) = 0$. See Theil (1972).
[10] For some basic properties of distance measures see Pfingsten and Rudolph (2002).
[11] More precisely the relative differences should be called relative *absolute* differences as they are calculated from absolute values.

segment $i$ with $x_i = 0$ contributes $1/n$ towards the distance measure, irrespective of the related $y_i$.

As suggested by Pfingsten and Rudolph (2002) the industry composition of the economy's loan market portfolio can be used as a benchmark for statistical diversification. However, this benchmark neglects regional business structures. If the loan portfolio of a bank reflects the industry structure of its region, than a decline in distance of an individual bank to the national market loan portfolio might be due to a change in regional industry structures. Based on this argument Kamp et al. (2005) argue that one should also use regional benchmarks when measuring loan portfolio diversification. Therefore, our analysis also comprises the distance of an individual bank's loan portfolio to the state's loan portfolio. We apply these two benchmarks as reference points for diversification:[12]

1. composition by industry of the whole German loan market portfolio ($D_a^{Nation}$ and $D_r^{Nation}$) and
2. composition by industry of a state's loan market portfolio ($D_a^{State}$ and $D_r^{State}$)

As for all measures high values stand for specialization while low values stand for diversification, it is more intuitive to refer to the measures as *specialization measures* (sm) rather than diversification measures.

## 4.2 Diversification and Return

Standard capital market theory states that there is a tradeoff between risk and return:[13] the more risk one is willing to accept the more return can be expected. However, this tradeoff only holds true for the unsystematic risk, not for the risk

[12] Kamp et al. (2005) suggest two more benchmarks: composition by industry of a county's loan portfolio and composition by industries of the GNP. Although these benchmarks are not explicitly considered in this paper, all analysis were also performed with theses alternative benchmarks. However, the results are quite similar to the results presented in this paper. For more details on these analysis see Kamp (2006).

[13] See Markowitz (1952) and Sharpe (1964).

that can theoretically be avoided by diversification. Financial theory therefore predicts that well diversified banks yield higher expected returns than banks with little diversification.

However, financial theory based on the notion of perfect capital markets is not really applicable for banks. This argument leads to the theory of financial intermediation, taking into account the role of asymmetric information which incorporates the relevance of *monitoring*. Industry expertise goes along with superior monitoring abilities. Thus, a specialization in loan origination might be superior to diversification as specialized banks might be more efficient in monitoring loans than diversified banks. In the Diamond (1984) model monitoring costs and monitoring quality are considered to be constant across all banks. Therefore not surprisingly Diamond (1984) argues that diversification reduces the bank's monitoring costs and banks should be as diversified as possible. Explicitly taking into account that monitoring costs and quality depend on a bank's sector expertise, Winton (1999) shows, that specialization might be the superior strategy. According to this view we expect a negative relation between the return of the bank and the degree of diversification. There is another argument in favor of focussed banks: Banks that aim at expanding their business activities rapidly, for instance by lending to firms from industries unknown to the bank so far, run the risk that they attract those firms to whom banks with more experience would not lend *(winner's curse)*.
It is not clear which of the effects mentioned above dominates. In our empirical study, we will estimate the following fixed effects panel regressions to see whether the relation between the bank's return and its degree of specialization in the loan portfolio is positive or negative:[14]

$$roa^{b,t} = \alpha + \beta \ \cdot sm^{b,t-1} + \gamma' \cdot z^{b,t-1} + \mu^b + \lambda^t + \varepsilon^{b,t} \tag{6}$$

$$roe^{b,t} = \alpha + \beta \ \cdot sm^{b,t-1} + \gamma' \cdot z^{b,t-1} + \mu^b + \lambda^t + \varepsilon^{b,t} \tag{7}$$

[14] The Hausman test (Hausman (1978)) reveals a violation of the assumptions of the *random effects* model. Thus, we use *fixed effects* estimations.

In the equations above, $roa^{b,t}$ and $roe^{b,t}$ denote the return on assets and the return on equity of bank $b$ at time $t$, $sm^{b,t-1}$ is a specialization measure[15] of bank $b$ at time $t-1$ and the vector $z^{b,t-1}$ contains bank specific variables representing the bank's risk, its capitalization and its size.[16] $\mu_b$ and $\lambda_t$ capture bank individual and time individual fixed effects.

We control for the bank size, as, based on the better scale efficiency of big banks, theoretical and empirical works reveal a positive linkage of bank size and return.[17] As high capital puffers are more expensive than collecting deposits, we also control for the capital ratio. Moreover, the personnel intensity might influence the return as a high personnel intensity goes along with high costs. Finally, we control for the bank risk, as risk and return are assumed to be positively linked. Bank individual fixed effects are used in order to control for all effects which do not change over time for individual banks. The time dummies are used to control for time effects as macroeconomic or structural changes in the data.

If the benefits of specialization outweigh the benefits of diversification, we expect $\beta$ to be positive. Accordingly, the coefficient $\beta$ is negative, if it pays for the banks to diversify its loan origination across industries.

## 4.3 Diversification and Risk

In the sense of Markowitz diversification is a means to change the risk of a portfolio. Keeping monitoring abilities and monitoring costs constant, the default risk of a bank is likely to decrease when a bank's loan portfolio gets better diversified. This view seems to be predominant in the German banking act *(Kreditwesengesetz)* stipulating that a bank's sum of large loans is limited to eight times the bank's liable capital.[18]

[15] Note, that we refer to the measures HHI, SE, $D_a$ and $D_r$ as *specialization* measures as high values stand for specialization while low values represent diversification.

[16] Accordingly, $\gamma$ is a column vector of coefficients with the same size as the vector $z^{b,t}$.

[17] For empirical evidence of German banks see for instance Lang and Welzel (1997).

[18] See § 13 Kreditwesengesetz (KWG). A loan is defined as *large* if the total exposure to the borrower exceeds 10 percent of the bank's liable capital. Apparently, this is an issue of name rather than industry concentration.

Winton (1999) shows that diversification does not need to lower the banks' default risk. This model result is based on the idea that specialized banks can benefit from their screening and monitoring advantages. However, it must be taken into consideration that the results of the model rely to some degree on the assumption that there are only two sectors in the model economy. Thus, within the Winton model diversification is an "all or nothing" decision.

As for the relationship of diversification and return there seems to be a tradeoff between the benefits from risk diversification and specialization. Thus, we empirically investigate the relationship of risk and loan portfolio diversification.

While return figures can easily be derived from balance sheet data it is by far less clear how the risk of a bank's loan portfolio should be estimated.[19] A common approach to measure the bank's risk is to use the loan loss provision ratio (llp) or the non-performing loan ratio (npl). Acharya et al. (2004) refer to these ratios as a measure for the bank's risk in the loan portfolio. They admit that this interpretation is questionable: The risk of a loan portfolio is its unexpected loss, not the losses that are expected. However, the denominators of the loan loss provision ratio and of the non-performing loan ratio are also determined by losses that were expected when originating the loans. Theses expected losses should be reflected in a risk-adjusted pricing and therefore not be considered as risk. Consequently, in our study, we do not only measure the risk in the bank's loan portfolio by the loan loss provision ratio and the non-performing loan ratio but also by the fluctuation of these variables in the course of time, i.e. we define the variables $\sigma_{llp}$ and $\sigma_{npl}$ as the standard deviations of a bank's loan loss provision ratio and non-performing loan ratio, respectively, in the course of time.

Using the loan loss provision ratio and the non-performing loan ratio as measures for risk we run the following fixed effects panel regressions:[20]

$$llp^{b,t} = \alpha + \beta \cdot sm^{b,t-1} + \gamma' \cdot z^{b,t-1} + \mu^b + \lambda^t + \varepsilon^b \tag{8}$$

[19] These return data may, of course, be influenced by accounting practices.

[20] Again, the Hausman test (Hausman (1978)) reveals a violation of the assumptions of the *random effects* model. Thus, we use *fixed effects* estimations.

$$npl^{b,t} = \alpha + \beta \cdot sm^{b,t-1} + \gamma' \cdot z^{b,t-1} + \mu^b + \lambda^t + \varepsilon^b \tag{9}$$

In the regressions above, $llp^{b,t}$ and $npl^{b,t}$ denote the loan loss provision ratios and the non-performing loan ratios of bank $b$ at time $t$, $sm$ is one of our specialization measures, and $z$ is a vector of control variables. Again, $\mu^b$ and $\lambda^t$ represent bank individual and time individual fixed effects.

We control for the bank size, as due to the too-big-to-fail phenomenon, big banks tend to have a higher risk. As regulatory capital requirements aim to create a positive linkage between loan losses and capital requirements, we also control for the capital ratio. The personnel intensity is used as a measure of monitoring quality, because monitoring is rather personal intensive. Finally, the return on assets is used as a control variable, as one would expect a relationship between the bank risk (as measured by the loan loss provision ratio and non-performing loan ratio) and a bank's return. Bank individual fixed effects are used in order to control for all effects which do not change over time for individual banks. The time dummies are used to control for time effects as macroeconomic or structural changes in the data.

Whenever risk is defined as $\sigma_{llp}$ or $\sigma_{npl}$, we only have one observation for each bank as dependent variable of our regression. In this context we use the following between groups estimations:

$$\sigma^b_{llp} = \alpha + \beta \ \cdot \overline{sm^b} + \gamma' \cdot \overline{z^b} + \varepsilon^b \tag{10}$$

$$\sigma^b_{npl} = \alpha + \beta \ \cdot \overline{sm^b} + \gamma' \cdot \overline{z^b} + \varepsilon^b \tag{11}$$

In the regression above, $\sigma^b_{llp}$ and $\sigma^b_{npl}$ denote the standard deviation of a bank's loan loss provision ratio and the standard deviation of a bank's non-performing loan ratio over all observations. $\overline{sm^b}$ is the serial average of a specialization measure for bank $b$ and $\overline{z^b}$ is a vector of serial averages of control variables for bank $b$. Note that the regressions (10) and (11) are purely cross-sectional, whereas the regressions (6) to (9) have a time and a cross-sectional dimension. Equations (10) and (11) have no

time dimension because the variables $\sigma^b_{llp}$ and $\sigma^b_{npl}$ are estimated from the banks' time series.

As pointed out in Subsection 4.1, the specialization measures $sm$ are defined such that high degrees of specialization are associated with high values while low values stand for diversification. Therefore, we expect a positive sign for the coefficient $\beta$, if diversification tends to reduce the risk of a bank. On the other hand, if focussed banks tend to identify effectively the low-risk borrowers and thereby reduce their risk, we will find a negative relation between the banks' risk and their specialization measure.

# 5 Empirical Results

In this section we will present the results of regressions 6 through 11. We start with the estimations of the return on assets and the return on equity.

## 5.1 Diversification and Return

The results of the fixed effects estimations of the return on assets (Equation 6) are presented in Table 2. These estimations aim at analyzing the relationship between specialization and return, controlling for the bank size (log(ta)), the capital ratio (cap), the personnel intensity (pers) as well as the loan loss provision ratio (llp) as a proxy for a bank's risk.

Each column in Table 2 represents the results for the estimation depending on the specialization measure used. Thus, the first column shows the results for using the HHI as specialization measure (sm). The upper figure of each cell in the table depicts the coefficient of the respective variable while the lower figure represents the corresponding t-statistic. From the first line in Table 2 we can see that the coefficients for all specialization measures but $D_r^{Nation}$ are positive. The coefficients for the entropy measure as well as for $D_r^{State}$ are significantly positive. As far as the concentration measures (HHI and SE) are concerned, one can identify a positive link

Table 2: Fixed effects estimation of return on assets (Equation (6))

| | $HHI$ | $SE$ | $D_a^{Nation}$ | $D_r^{Nation}$ | $D_a^{State}$ | $D_r^{State}$ |
|---|---|---|---|---|---|---|
| sm | 0.00141 | 0.00161 | 0.00014 | -0.00015 | 0.00167 | 0.00206 |
| | 1.62 | 4.12*** | 0.15 | -0.17 | 1.34 | 1.64* |
| log(ta) | -0.00076 | -0.00060 | -0.00077 | -0.00078 | -0.00060 | -0.00053 |
| | -2.72*** | -2.14** | -2.76*** | -2.78*** | -1.97** | -1.70** |
| cap | -0.01917 | -0.01998 | -0.01899 | -0.01903 | -0.02782 | -0.02771 |
| | -6.41*** | -6.66*** | -6.35*** | -6.36*** | -7.82*** | -7.80*** |
| pers | -0.00001 | -0.00001 | -0.00001 | -0.00001 | -0.00001 | -0.00001 |
| | -0.42 | -0.37 | -0.44 | -0.44 | -0.49 | -0.49 |
| llp | -0.01046 | -0.01015 | -0.01045 | -0.01046 | -0.01208 | -0.01232 |
| | -2.50** | -2.43** | -2.49** | -2.50** | -2.85*** | -2.92*** |

***,**,* indicate statistical significance at 1, 5, 10 percent significance level, respectively. sm: specialization measure, log(ta): natural logarithm of total assets, cap: capital ratio, pers: personnel intensity, llp: loan loss provision ratio.

between an concentrated loan portfolio and a bank's return on assets. This positive linkage is not confirmed for the distance measures using the national loan portfolio as a benchmark. However, using the states' loan portfolios as a benchmark one can see a slightly positive relationship between the level of specialization and the return on assets.

The results for the control variables are rather homogenous. For the bank size, expressed by the natural logarithm of total assets, we find a negative relationship in all estimates. That is: big banks tend to have a lower return on assets than small banks. This result is somewhat surprising. In the theoretical literature we find two basic arguments why big banks should have higher returns than small banks. The first argument is that big banks benefit from economies of scale. Secondly, some theoretical papers claim that big banks benefit from a better diversification

as increasing size goes along with increasing diversification.[21] However, explicitly considering the level of diversification in modelling the bank return reveals that there are rather negative benefits from the bank size alone.[22] These negative economies of scale could for instance be a result of increasing complexity. This finding excites the idea of explicitly considering the level of loan portfolio diversification when estimating bank efficiency.[23]

The coefficients of the capital ratio are significantly negative in all estimations. Thus, banks with a high capital ratio reveal a rather low return on assets. This result is not surprising, as equity is more expensive than deposits.

The personnel intensity does not show a significant impact on the estimation while the coefficients of the loan loss provision ratio are significantly negative in all estimations. Thus, high loan loss provisions go along with a low return on assets. If one takes into consideration that building a loan loss provision directly decreases the profit, this result is not surprising. However, if one interprets the loan loss provision as a proxy for the bank risk, this result does not reflect the expectation that high risks should go along with a high expected return. This point underlines the criticism of using the loan loss provision ratio as a variable to measure risk.[24, 25]

So far, we have used the return on assets when estimating banks' returns. The results of the estimation of the return on equity corresponding to Equation (7)

[21] See for instance Krasa and Villamil (1992) or McFadden (2005).

[22] This result hints at an interaction between bank size and the level of diversification. However, adding a corresponding interaction term into Equations (6) and (7) does not reveal a significant impact. Following Friedrich (1982) non-significant interaction terms are not taken into further consideration.

[23] Such estimations of bank efficiency are out of the scope of this paper.

[24] We get very similar results when using the non-performing loan ratio as a proxy for risk in Equations 6 and 7.

[25] Given the criticism of using the loan loss provision ratio and the non-performing loan ratio as control variables for risk, one could also use $\sigma_{llp}$ or $\sigma_{npl}$ as variables in Equations 6 and 7 in order to control for risk. However, as we only have one observation for each bank the risk measures would be perfectly multicollinear with the bank-individual fixed effects. Thus, if one wanted to consider $\sigma_{llp}$ or $\sigma_{npl}$ as risk variables in order to estimate the return on assets or the return on equity, one would need to apply a random effects estimation. Such random effects estimations reveal a significantly positive relationship between the level of specialization and the banks' return for all six measures of specialization. However, one has to take into consideration that the assumptions of the random effects model are violated. Therefore, the results of these estimations are not depicted in detail.

are shown in Table 3. Again, we see a positive relationship between the level of loan portfolio concentration, as defined by HHI and SE, and the return figure. All distance measures show a positive but non-significant linkage of specialization and return. The results for the control variables are in line with the results from Table 2 and are therefore not discussed in detail.

Table 3: Fixed effects estimation of return on equity (Equation (7))

| | HHI | SE | $D_a^{Nation}$ | $D_r^{Nation}$ | $D_a^{State}$ | $D_r^{State}$ |
|---|---|---|---|---|---|---|
| sm | 0.03018 | 0.01238 | 0.02327 | 0.02399 | 0.01450 | 0.02414 |
| | 1.92* | 1.75* | 1.34 | 1.46 | 0.68 | 1.12 |
| log(ta) | -0.02018 | -0.01921 | -0.01999 | -0.01949 | -0.01608 | -0.01509 |
| | -4.02*** | -3.78*** | -3.97*** | -3.84*** | -3.10*** | -2.85*** |
| cap | -0.26384 | -0.26781 | -0.25817 | -0.25611 | -0.34379 | -0.34314 |
| | -4.88*** | -4.94*** | -4.77*** | -4.73*** | -5.63*** | -5.62*** |
| pers | -0.00011 | -0.00010 | -0.00011 | -0.00011 | -0.00011 | -0.00011 |
| | -0.26 | -0.25 | -0.25 | -0.26 | -0.28 | -0.28 |
| llp | -0.23477 | -0.23227 | -0.23345 | -0.23378 | -0.23560 | -0.23759 |
| | -3.10*** | -3.07*** | -3.08*** | -3.09*** | -3.24*** | -3.27*** |

***,**,* indicate statistical significance at 1, 5, 10 percent significance level, respectively. sm: specialization measure, log(ta): natural logarithm of total assets, cap: capital ratio, pers: personnel intensity, llp: loan loss provision ratio.

We can sum up, that there is a weak positive linkage between the level of specialization and the return of German banks. Thus, specialized banks tend to have higher returns than their diversified competitors. This finding especially holds when the level of specialization is measured with concentration measures whereas the positive linkage between the distance to the national loan market and states' loan markets is by and large non-significant.

## 5.2 Diversification and Risk

Now, we turn to the relationship between loan portfolio diversification and bank risk. We begin our analysis with the results of the estimations of the loan loss provision ratio as described by Equation (8). Table 4 shows the results.

Table 4: Fixed effects estimation of loan loss provision ratio (Equation (8))

| | HHI | SE | $D_a^{Nation}$ | $D_r^{Nation}$ | $D_a^{State}$ | $D_r^{State}$ |
|---|---|---|---|---|---|---|
| sm | 0.00034 | -0.00154 | -0.00312 | -0.00093 | -0.01306 | -0.00220 |
| | 0.26 | -2.64*** | -2.17** | -0.68 | -7.16*** | -1.20 |
| log(ta) | 0.00227 | 0.00210 | 0.00219 | 0.00223 | 0.00196 | 0.00226 |
| | 5.41*** | 4.94*** | 5.21*** | 5.25*** | 4.32*** | 4.87*** |
| cap | -0.00336 | -0.00243 | -0.00372 | -0.00352 | -0.01111 | -0.01227 |
| | -0.72 | -0.52 | -0.80 | -0.76 | -2.05** | -2.26** |
| pers | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00001 |
| | 0.30 | 0.26 | 0.26 | 0.29 | 0.22 | 0.33 |
| roa | -0.20527 | -0.20344 | -0.20335 | -0.20468 | -0.22955 | -0.23498 |
| | -11.80*** | -11.70*** | -11.69*** | -11.77*** | -11.81*** | -12.08*** |

***,**,* indicate statistical significance at 1, 5, 10 percent significance level, respectively. sm: specialization measure, log(ta): natural logarithm of total assets, cap: capital ratio, pers: personnel intensity, roa: return on assets.

For all specialization measures but the HHI we see negative coefficients. The coefficients of the two absolute distance measures and the entropy measure are statistically significant. When measuring specialization with these measures, specialized banks tend to have lower loan loss provision ratios than diversified banks.

Again, the results for the control variables are rather homogenous. For the bank size we observe highly significant positive coefficients. Thus, bigger banks tend to have a higher loan loss provision ratio than smaller banks. This finding is in line with theoretical and empirical papers dealing with the too-big-to-fail phenomenon.[26]

[26] See for instance Boyd and Runkle (1993) and De Nicoló (2001).

The coefficients of the capital ratio are negative. This relationship is significant in the estimations using $D_a^{State}$ and $D_r^{State}$. High loan loss provision ratios go along with low capital ratios. This finding is somewhat surprising as bank regulation aims at creating a positive linkage of the bank risk and the capital requirements. However, under Basel I the capital requirements are not really linked to the riskiness of lending.

As an alternative to the loan loss provision ratio we apply the non-performing loan ratio as a measure of bank risk, which is estimated by Equation 9. The results of this estimation are shown in Table 5.

Table 5: Fixed effects estimation of non-performing loan ratio (Equation (9))

| | HHI | SE | $D_a^{Nation}$ | $D_r^{Nation}$ | $D_a^{State}$ | $D_r^{State}$ |
|---|---|---|---|---|---|---|
| sm | -0.05093 | -0.02439 | -0.03554 | -0.02377 | -0.22800 | -0.06464 |
| | -4.12*** | -4.49*** | -2.65*** | -1.86* | -13.67*** | -3.84*** |
| log(ta) | 0.05042 | 0.04837 | 0.05018 | 0.04995 | 0.05140 | 0.05497 |
| | 12.99*** | 12.33*** | 12.89*** | 12.74*** | 12.41*** | 12.93*** |
| cap | 0.11907 | 0.12758 | 0.10795 | 0.10661 | 0.15592 | 0.12660 |
| | 2.71*** | 2.90*** | 2.46** | 2.42** | 3.06*** | 2.47** |
| pers | -0.00012 | -0.00013 | -0.00012 | -0.00011 | -0.00017 | -0.00011 |
| | -0.36 | -0.39 | -0.37 | -0.35 | -0.55 | -0.36 |
| roa | -1.39416 | -1.39259 | -1.40243 | -1.41313 | -1.49916 | -1.60027 |
| | -8.21*** | -8.20*** | -8.25*** | -8.32*** | -7.91*** | -8.41*** |

***,**,* indicate statistical significance at 1, 5, 10 percent significance level, respectively. sm: specialization measure, log(ta): natural logarithm of total assets, cap: capital ratio, pers: personnel intensity, roa: return on assets.

This time all coefficients of the applied specialization measures are significantly negative, but at different levels. Specialized banks have on average a lower ratio of non-performing loans than diversified banks. A possible explanation for this finding is that specialization helps to improve the monitoring abilities of banks.

The results for the control variables bank size, personal intensity and return on assets are not discussed in detail as they are very similar to the results from table 4. However, the results for the capital ratio should be given some attention. In contrast to Table 4, all coefficients of the capital ratio are now positive and even significant. A high ratio of non-performing loans goes along with a high capital ratio. This is what one would expect from the idea of regulatory capital requirements.

To sum up, we find that specialized banks are characterized by lower ratios of loan loss provisions and non performing loans as diversified banks. If one interprets these ratios as risk figures one would conclude that specialization in lending tends to go along with an improvement of the bank performance, expressed by higher returns and lower risks. This would mean that the benefits of specialization outweigh the benefits of risk diversification. However, this argumentation is based on the assumption that the loan loss provision ratio as well as the non-performing loan ratio reflect the bank risk. As discussed before, these figures depend to some degree on loan defaults that were already expected when originating loans. Expected defaults are taken into consideration when pricing loans and can therefore not be considered as risk. Next, we therefore use the standard deviation of the loan loss provision ratio and the non-performing loan ratio as proxies for unexpected losses.

The results for the estimation based on Equation (10), using $\sigma_{llp}$ as dependent variable, are shown in Table 6. Remember that we apply a between-groups estimation as we only have one observation of $\sigma_{llp}$ for each bank. Thus, the explanatory variables are condensed to the group means. The group mean of a variable is the mean of all observations of a bank $b$ over the given time horizon.

For all specialization measures we find highly significant positive coefficients. Thus, specialized banks tend to have a higher fluctuation of their loan loss provisions over time as diversified banks. This is an indicator, that diversified banks are less risky than specialized banks.

Again, we find that the bank size is positively linked to the risk measure as predicted by theoretical papers dealing with the too-big-to-fail phenomenon. For the capital ratio we observe negative coefficients as already seen in Table 4. All coefficients of

Table 6: Between groups estimation of $\sigma_{llp}$ (Equation (10))

| | HHI | SE | $D_a^{Nation}$ | $D_r^{Nation}$ | $D_a^{State}$ | $D_r^{State}$ |
|---|---|---|---|---|---|---|
| $\overline{sm}$ | 0.00752 | 0.00256 | 0.00977 | 0.00998 | 0.00916 | 0.01001 |
| | 6.41*** | 6.98*** | 7.26*** | 7.47*** | 6.90*** | 7.16*** |
| $\overline{log(ta)}$ | 0.00011 | 0.00024 | 0.00046 | 0.00056 | 0.00043 | 0.00060 |
| | 1.00 | 2.10** | 3.81*** | 4.42*** | 3.32*** | 4.33*** |
| $\overline{cap}$ | -0.00675 | -0.00671 | -0.00501 | -0.00486 | -0.00392 | -0.00353 |
| | -1.76* | -1.78* | -1.37 | -1.34 | -0.89 | -0.81 |
| $\overline{pers}$ | -0.00009 | -0.00010 | -0.00013 | -0.00010 | -0.00011 | -0.00008 |
| | -0.56 | -0.58 | -0.80 | -0.62 | -0.65 | -0.49 |
| $\overline{roa}$ | -0.26598 | -0.26600 | -0.26535 | -0.26442 | -0.31550 | -0.31568 |
| | -13.51*** | -13.52*** | -13.50*** | -13.46*** | -14.59*** | -14.60*** |
| $\overline{llp}$ | 0.33083 | 0.33162 | 0.33288 | 0.33332 | 0.33233 | 0.33182 |
| | 43.48*** | 43.60*** | 43.71*** | 43.76*** | 42.92*** | 42.94*** |

***,**,* indicate statistical significance at 1, 5, 10 percent significance level, respectively. sm: specialization measure, log(ta): natural logarithm of total assets, cap: capital ratio, pers: personnel intensity, roa: return on assets, llp: loan loss provision ratio.

the return on assets are highly significant and negative. This finding is in line with our results from Tables 4 and 5. As risk and return are expected to be positively linked, this finding is surprising. Our observations indicate that high risks in lending do not go along with high returns and therefore support Hayden et al. (2005) who state that "German banks are not risk-return efficient". Finally we control for the loan loss provision ratio when estimating $\sigma_{llp}$. The coefficients of the loan loss provision ratio are highly significant and positive, which means high ratios of loan loss provisions tend to go along with high fluctuations of the ratio.

The results for the estimation based on Equation (11), using $\sigma_{npl}$ as risk measure, are shown in Table 7. They are very similar to the results from Table 6. However, one striking exception applies. The coefficients of the personnel intensity are significantly

Table 7: Between groups estimation of $\sigma_{npl}$ (Equation (11))

| | HHI | SE | $D_a^{Nation}$ | $D_r^{Nation}$ | $D_a^{State}$ | $D_r^{State}$ |
|---|---|---|---|---|---|---|
| $\overline{sm}$ | 0.06510 | 0.01957 | 0.05785 | 0.05986 | 0.04505 | 0.04547 |
| | 10.19*** | 9.74*** | 7.79*** | 8.10*** | 6.27*** | 6.01*** |
| $\overline{log(ta)}$ | 0.00493 | 0.00588 | 0.00700 | 0.00760 | 0.00658 | 0.00725 |
| | 8.22*** | 9.67*** | 10.61*** | 11.05*** | 9.78*** | 9.92*** |
| $\overline{cap}$ | -0.02349 | -0.01272 | 0.01619 | 0.01628 | -0.00510 | -0.00024 |
| | -1.11 | -0.61 | 0.79 | 0.80 | -0.21 | -0.01 |
| $\overline{pers}$ | -0.00200 | -0.00206 | -0.00230 | -0.00214 | -0.00193 | -0.00179 |
| | -2.24** | -2.30** | -2.55** | -2.38** | -2.19** | -2.03** |
| $\overline{roa}$ | -0.38456 | -0.38533 | -0.38298 | -0.37745 | -0.46458 | -0.46701 |
| | -3.55*** | -3.55*** | -3.51*** | -3.47*** | -4.01*** | -4.03*** |
| $\overline{npl}$ | 0.23686 | 0.23894 | 0.23778 | 0.23883 | 0.23187 | 0.23074 |
| | 32.69*** | 32.74*** | 32.28*** | 32.38*** | 31.16*** | 31.10*** |

***,**,* indicate statistical significance at 1, 5, 10 percent significance level, respectively. sm: specialization measure, log(ta): natural logarithm of total assets, cap: capital ratio, pers: personnel intensity, roa: return on assets, npl: non-performing loan ratio.

negative in all estimations. Thus, banks with a high personnel intensity tend to have lower fluctuations of the non-performing loan ratio. A possible explanation for this observation is that a high personnel intensity could go along with high monitoring resources, helping to increase the quality of monitoring and smoothing the fluctuation of non-performing loans. However, based in this reasoning we should also see significantly negative coefficients of the personnel intensity in Table 6 which is not the case. The coefficients are negative but all non-significant.

To sum up the results from this subsection, we find that specialized banks tend to have lower ratios of loan loss provisions as well as lower ratios of non-performing loans as diversified banks. However, they also reveal significantly higher fluctuations of these ratios over time than their diversified competitors, indicating that special-

ized banks have a higher risk than diversified banks. In combination with our results from Subsection 5.1 this means, that the question of loan portfolio diversification versus loan portfolio specialization depicts the typical tradeoff of risk and return.

# 6 Conclusion

This paper analyzes the tradeoff between the benefits of loan portfolios diversification and the benefit from specialization of loan portfolios. To this end we calculate a broad set of heuristic measures of loan portfolio specialization. These measures are used to estimate risk and return figures, that were taken from the banks' balance sheets and audit reports. Our database comprises all German banks from 1993 to 2003.

We can show that specialized banks tend to have slightly higher returns than their diversified competitors. At the same time specialized banks reveal lower ratios of loan loss provisions and non-performing loans. These findings indicate that the benefits of specialization outweigh the benefits of diversification. However, using the fluctuation of the loan loss ratio and the fluctuation of the non-performing loan ratio as proxies for unexpected losses, we find that specialized banks are characterized by a higher volatility of these ratios, indicating a higher level of risk. This means that the question of diversification versus specialization portrays a picture of typical risk-return tradeoff, confirming a conclusion by Elyasiani and Deng (2004) for more coarse U.S. data.

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