Testing for Competition Among German Banks

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Discussion paper 04/02

Economic Research Centre

of the Deutsche Bundesbank

January 2002

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ISBN 3–935821–01–8

Abstract

Given the marked reduction in the number of banks in Germany during recent years, the study estimates competitive behavior in the German banking system by applying an empirical method developed by Panzar and Rosse (1987). By estimating the banks' reduced form revenue functions, the sums of their estimated factor price elasticities which constitute the so called *H-statistics* provide information about banks' competitive behavior. Based on the micro data of banks' balance sheets and profit and loss accounts for the years 1993-1998, the hypotheses of perfect collusion as well as of perfect competition can be rejected by means of panel-econometric estimations. For individual categories of banks significant differences were found with respect to savings banks and cooperative banks, on the one hand, and credit banks, on the other, as well as for several size categories. However, despite the decrease in the number of banks in Germany during the investigated period and a slight increase in concentration during that time, there are no clear indications of a different competitive behavior in the second half of the time period under investigation.

Zusammenfassung

Angesichts des starken Rückgangs der Anzahl von Banken in Deutschland während der letzten Jahre, untersucht die Studie das Wettbewerbsverhalten im deutschen Bankensystem mit Hilfe einer von Panzar und Rosse (1987) entwickelten empirischen Methode. Bei der Schätzung der reduzierten Form der Ertragsfunktion von Banken bildet die Summe der geschätzten Faktorpreiselastizitäten die sogenannte *H-Statistik*, die Hinweise auf das Wettbewerbsverhalten der Banken gibt. Für die Jahre 1993-1998 können auf der Basis der Einzeldaten zur Bilanzstatistik und den Gewinn- und Verlustrechungen aller in Deutschland tätigen Banken die Hypothesen vollständiger Kollusion sowie vollständigen Wettbewerbs mit Hilfe panel-ökonometrischer Verfahren abgelehnt werden. Für die einzelnen Bankengruppen wurden signifikante Unterschiede zwischen Sparkassen und Genossenschaftsbanken einerseits und den Kreditbanken andererseits ebenso festgestellt wie für verschiedene Größenklassen. Trotz des starken Rückgangs der Anzahl von Banken in Deutschland während des Untersuchungszeitraums und einer leichten Zunahme der Marktkonzentration gibt es keine klaren Hinweise auf ein verändertes wettbewerbliches Verhalten der Banken in der zweiten Hälfte dieses untersuchten Zeitraums.

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Testing for Competition Among German Banks

I. Introduction

The German banking system has undergone a number of major changes in recent years caused by the increasing integration and liberalization of financial markets as well as technological progress. At the same time, an ongoing process of consolidation has been observed in the German banking market. In view of these structural changes, the question arises as to what impact these developments have had on competition on the German banking market and their conceivably important repercussions for market conditions.

Generally, the characteristic features of the German banking market are the still very large number of credit institutions (just over 2,700 as of December 2000) and the relatively high market shares of the public and cooperative banking sectors. Although a number of mergers, or intended mergers, between major private banks sometimes shape the public perception of the consolidation process, in terms of numbers that process is concentrated primarily in the cooperative banking and savings bank sectors. Furthermore, when considering size categories (see Tab. 5 on p. 13), small institutions continue to dominate, especially among cooperative banks, which means the consolidation process in that sector must especially be viewed from the point of view of enhancing efficiency.

In order to assess the market structure in more detail and quantify the degree of concentration, different types of measurement are used in the literature. The most simple measurement often referred to is the plain number of banks in the market. However, it does not contain information about the distribution of business volume among the counted banks. For Germany, the number of banks (see Tab. 1) has been clearly decreasing during the entire time period covered by this study (1993 to 1998) after having gone up in the early nineties due to German unification in 1990.

Tab. 1 Number of banks reporting to the central bank

	1993	1994	1995	1996	1997	1998
Reporting banks*	3,880	3,727	3,622	3,517	3,414	3,246

* Up to the end of the respective year. Source: Deutsche Bundesbank

I would like to thank Fred Ramb, Andreas Worms, Karl-Hermann Fischer, Hans Bauer, Heinz Herrmann and Ralf Körner for their valuable suggestions and support. All errors and short-comings are, of course, my own.

A more detailed look at the market structure with respect to the distribution of market shares give the measures of concentration commonly applied in the context of competition in banking: the *concentration* or *m-firm ratio (CR)* and the *Herfindahl-Hirschman Index (HHI)*.[1] The *CR* as the sum of the market shares *(MS)* of the *m* largest banks in the respective market is calculated by the ratio of the individual bank's total assets to the sum of all banks' total assets; total assets thereby proxy overall bank activity, defining the "product market" in a rather broad sense.[2] The *HHI* [3] is calculated as the sum of the squared market shares (MS_i) of all individual banks ($i= 1,...,n$) participating in the respective market.[4] Generally, however, delineating the "market" for such concentration measures geographically on the grounds of national borders makes such figures extremely crude indicators of market structure, as e.g. a small bank in the very north of the country is unlikely to directly compete with another small bank in the south.[5]

For the *m-firm* or *concentration ratio (CR)* all three ratios in Tab. 2 exhibit a slight increase in concentration which is especially pronounced in 1998. The market share held by the largest banks has therefore expanded somewhat during the respective period (these findings are mirrored by the *HHI* figures for Germany calculated on a national basis see appendix on p. 34).

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1 Less popular measures of market structure concerning the firm-composition of markets are the *entropy index*, *Hannah-Kay Index,* as well as the *Gini coefficient* and the *Lorenz curve* as inequality measures. However, there is an important distinction to be made between measuring concentration vs. inequality, e.g. while there is no inequality in a market with shares being equally distributed over only a few banks, it goes along with a high degree of concentration, or as Hall and Tideman (1967) put it: „The Gini coefficient of the Lorenz curve would not distinguish between a single firm industry and one with thousand equal sized firms". (For details on the distinction see, inter alia, Hannah and Kay (1977), Encaoua and Jaquemin (1980), Hall and Tideman (1967).)

2 Alternatively, more narrow definitions could be chosen such as deposits or loans omitting the remaining parts of bank business such as trade for banks' own account and off-balance-sheet business in general. However, given the increasing importance of the latter and the aim of finding an overall concentration index covering total bank activity, total assets seem to be a plausible measure for assessing the volume of banks' business. Concentration ratios for Germany based on deposits and loans are listed in the appendix on p. 34.

3 The *Herfindahl-Hirschman Index (HHI)* was independently developed by A.O. Hirschman (1945) and O.C. Herfindahl (1950) as a statistical measure of concentration. For details see Hirschman (1964).

4 $HHI = \sum_{i=1}^{n} MS_i^2$. For further details on the *HHI*, see p. 34 in the appendix.

5 With technology (e.g. telecommunications, the Internet) induced changes in access to and delivery of financial services more local delineations of markets will nevertheless become increasingly meaningless (see Claessens et al. (2000), p. 15).

Tab. 2 CR3, CR5, and CR10 for all of Germany based on banks' total assets

	1993	1994	1995	1996	1997	1998
CR3	10.3 %	11.0 %	10.9 %	10.4 %	10.7 %	12,8 %
CR5	16.0 %	16.6 %	16.7 %	16.1 %	16.7 %	19.1 %
CR10	27.1 %	27.8 %	27.9 %	27.7 %	28.3 %	31.2 %

Source: Deutsche Bundesbank internal banking statistics, own calculations.

Compared to other European countries these figures are rather low: [6] apart from German figures, European concentration ratios for the *CR5* lie within the range of 20 to 90 percent with the (unweighted) average a little above 50 percent for the period from 1995 to 1997. Even big countries like France (around 40 percent), UK (close to 30 percent), and Spain (above 40 percent) have significantly higher concentration ratios than Germany; at around 25 percent, Italy is at the lower end. The same qualitative conclusion, despite significant quantitative differences in their concentration measures for 1998, draws a recent IMF study stating: "Notably, Germany has the lowest level of concentration in the euro area almost regardless of how it is measured."[7] Therefore, despite the fact that we can observe a recent increase in the German concentration ratios one has to keep in mind that they are still comparatively low.

Summing up the above reported measures, we find indications that concentration in the overall German banking market has increased slightly during recent years. Whether these developments in the market structure correspond with less competitive behavior on the part of market participants remains to be analyzed. Conventional views on the relation between competition and market structure such as the structure-conduct-performance paradigm (Bain (1951)) would suggest that more concentrated markets tend to be more collusive. However, this view was questioned by the contestabilty theory (Baumol (1982)) and the efficiency hypothesis by Demsetz (1974). While the contestability theory argues that the threat of entry alone can lead to competitive conduct independent of the number of firms actually acting in the market given free market entry and exit, in the efficiency hypothesis concentration may result from the strategic decision of the more efficient firms to increase market share rather than to exploit their efficiency advantages at the original market share and price level. Neither line of reasoning would support a jump to conclusions about less

6 See ECB (1999), Annex 2, 3.1.

7 See Belaisch, et al. (2001), p. 14, and Table 9.

competitive conduct in a market merely because of a higher degree of observed concentration.

As theory does not give a clear prediction, it is instead necessary to test empirically for the actually prevailing type of competition given a certain market structure. In this context, the New Empirical Industrial Organization (NEIO) developed testable hypotheses about competitive conduct in markets. One approach suggested by Panzar and Rosse (1987) and explained in detail in section II.2 is the basis for this study about the competitive behavior of German banks in the period from 1993 to 1998.

To study the market behavior chapter II features the empirical assessment of competitive market conditions in the New Empirical Industrial Organization (NEIO) describing in more detail the method suggested by Panzar and Rosse (1987). This method is then applied to the extensive micro data set of German banks covering the period form 1993 to 1998 in chapter III estimating the competitive conduct for the overall bank sample as well as for individual banking groups, size classes and time subperiods. Chapter IV summarizes the results of previous studies for Germany employing the Panzar-Rosse approach and, furthermore, compares the estimation results obtained in the previous chapter III with the specifications stemming from previous studies as a test for robustness of the qualitative results from chapter III. Chapter V concludes.

II. Methodology

II.1 General Approach

To assess competitive conditions in a market, the New Empirical Industrial Organization (NEIO) literature provides empirically applicable tests based on either aggregate industry data or individual firm data. These approaches are estimation techniques to identify static models of industry equilibrium which are compatible with the actual data and thereby indicate the type of competitive conduct on the part of the firms.

For aggregate industry data an approach by Bresnahan (1982) has been applied in several industry studies including studies analyzing banking markets.[8] By estimating

[8] Shaffer (1989, 1993) for Canadian and US banks, Suominen (1994) extended the Bresnahan model to a two product model analyzing the Finnish banking market, and Swank (1995) for Dutch banks.

simultaneously supply and demand functions as well as a price equation, an index of market power is developed. Most studies using individual firm data apply an alternative test for competitive market conditions based on the reduced form revenue equation of the firms in the investigated market elaborated by Panzar and Rosse (1982, 1987)[9]. The sum of the factor price elasticities estimated from this equation constitute the so called *H*-statistic reflecting the firms' competitive conduct. As far as data requirements are concerned, this latter test is especially suitable for the available Bundesbank data set which consists of individual firm data on banks' profit and loss (PaL) accounts and on their balance sheets yet does not include price data.

However, to transfer the NEIO approaches from classical industry to banking markets, assumptions about banks' production activity have to be made since they are only to a limited extent comparable to a "normal" firm. In principle there are two ways how the production process in banking is described in the literature: the "production approach" and the "intermediation approach".[10] The production approach regards the banking firm as an entity producing services which are related to loans and deposit accounts. Therefore, interest payments are not included in the cost function and output is instead measured by the number of deposit accounts serviced and loans originated.[11] The intermediation approach[12] (Sealey and Lindley (1977)) views the bank as a firm collecting deposits and other funds in order to transform them into loans and other assets. For this transformation, labor and physical capital are employed; their costs as well as interest payments on deposits and other funds enter the bank's cost function; the main input here being funds. The output is typically measured by the loans and investments recorded in the balance sheet.

For empirical applications, the decisive difference between these two approaches lies in their treatment of deposits. Whereas in the production approach banks are viewed as an entity producing deposits and loans labor and physical capital (fixed assets) as inputs, the intermediation approach focuses on loans as outputs and interprets deposits as the main input factor. To assess this question empirically, Hancock (1991) developed a "user cost

9 See also Rosse and Panzar (1977).

10 Freixas and Rochet (1998), p. 77-79, on the production and intermediation approach.

11 For reasons of data availability banks' output is often proxied by their money value and supplemented by firm specific data taking account of size, business mix, etc. (see Freixas and Rochet (1998), p.78).

methodology" to determine the classification into inputs and outputs estimating the user costs of financial services and classifying services with positive user costs as inputs and those with negative user costs as outputs.[13] In her data sample, all aggregate loan types have negative user costs and are therefore classified as outputs, among the deposits the picture is less clear. While time deposits have positive user costs and are categorized as inputs, demand deposits yield negative user costs and are thus graded as outputs.[14] Using an alternative methodology, however, Hughes and Mester (1993a,b) classify demand deposits empirically as inputs. In a more recent study additionally accounting for risk, Hughes, Mester and Moon (2001)[15] find that uninsured and insured deposits alike are to be categorized as inputs.

Despite the aforementioned uncertainty concerning the treatment of funds as inputs, in the application in chapter III we follow previous studies in this literature as well as recent results mentioned above assuming (as in the intermediation approach) that all funds are an input in the bank's production function. This choice is additionally supported by the rising importance of interbank deposits which certainly do not meet the criteria of outputs put forward in the context of customer demand deposits.

II.2 The Rosse-Panzar Methodology[16]

II.2.1 Description

As mentioned above, a frequently applied approach[17] to empirically assess the competitive conditions in banking markets is a method developed by Rosse and Panzar estimating the reduced form revenue equations (R^*) of the market participants derived from marginal revenue and cost functions and the zero profit constraint in equilibrium[18]:

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12 Also referred to as the "asset approach" (see e.g. Stiroh (2000), p. 1714).

13 See Hancock (1991), pp. 27-32.

14 See Hancock (1991), pp. 67-80.

15 See Hughes, Mester, and Moon (2001), pp. 2175.

16 Rosse and Panzar (1977); Panzar and Rosse (1982, 1987).

17 See Shaffer (1982, 1985) for US banks; Nathan and Neave (1989) for Canadian banks, Molyneux et.al. (1994), Bikker and Groneveld (2000) and De Bandt and Davis (2000) for European banks; Lang (1997) for German banks; Mooslechner and Schnitzer (1995) for Austrian banks; Vesala (1995) for Finnish banks; Coccorese (1998) for Italian banks; Hondroyiannis et. al. (1999) for Greek banks; Rime (1999) for Swiss banks.

18 With marginal costs equaling marginal revenues as a result of banks' individual profit maximization,

$R^*(z,t,w)$ with: z exogenous variables shifting the firm's revenue function

t exogenous variables shifting the firm's cost function

w factor prices

Thereby the elasticities of total revenues of the individual firms are estimated with respect to the firm's input prices (w_j). The sum of these elasticities constitutes the so called "*H*-statistic" allowing inference about the firm's competitive conduct given the underlying assumptions.

(3.2.1) $$H = \sum_{j=1}^{m} \left(\frac{\partial R^*}{\partial w_j} \frac{w_j}{R^*} \right),$$

Assuming that firms' cost functions are linearly homogeneous in the factor prices or that the production functions are homothetic[19], that factor prices are exogenous to the individual firm, that the elasticity of the perceived demand of the individual firm is nondecreasing in the number of (symmetric) rivals as well as free entry and exit,[20] Rosse and Panzar show that in market equilibrium perfect competition is indicated by *H* equal to 1. In perfectly competitive equilibrium, discrimination between more or less efficient firms should have resulted in entry and/or continuation of the former as well as exit of the latter. In long-run equilibrium, firms operate in the minimum of average costs which then is also equal to the price. An increase in input prices and thus in average costs should lead to a proportionate price increase and - at the firm level - to a proportionate rise in revenues (*H*=1). It reflects an upward shift of the average cost function without changing the optimal level of output at the minimum of average costs. However, at the industry level, the resulting higher price will lead to lower demand and therefore a less than proportionate increase in industry revenues and the market exit of some firms.[21]

$MC_i(y_i, w_{i,j}, t_i) = MR_i(y_i, n, z_i)$, y_i = bank's output, n = number of banks in the market, and zero profits earned in market equilibrium, $R_i^*(y^*, n^*, z) - C_i^*(y^*, w, t) = 0$.

[19] I.e. their technical rate of substitution does not depend on the scale of costs or production (see. Varian (1992), p. 482.)

[20] Furthermore they assume as usual that $\partial w/\partial y < 0$ and $\partial w/\partial n < 0$ (n denoting the number of (symmetric) rival firms).

[21] Panzar and Rosse (1987), p. 452.

Monopolistic competition or the (symmetric) *Chamberlin model* of monopolistic competition is consistent with values for *H* below 1. Assuming some sort of product differentiation between the output of the different banks,[22] the profit maximizing firms are confronted with a falling aggregate demand curve and behave like monopolists, which results in equalizing marginal costs and marginal revenues in the equilibrium state. By market exit and entry of imperfect substitutes, the demand curve always shifts in a way that the "monopolist" just earns zero profits.[23]

Negative values for *H* correspond to monopoly or perfectly collusive oligopoly: a rise in input prices increases marginal costs and - by setting them equal to marginal revenues - reduces equilibrium output and the firm's revenues. However, negative values of *H* need not necessarily be caused by a monopoly or perfectly collusive conduct. While it does apply to "monopolists" in the strict sense of a firm operating in isolation, they need not enjoy the monopoly power usually attributed to the term "monopolist".[24] The decisive feature of "operating in isolation" might as well be caused by monopolistic competition where only weak substitutes to the product of the analyzed firm exist. To rule out these special cases, a more detailed look at the market situation is necessary to deduce either monopolistic or perfectly collusive behavior from negative values for *H*.

Tab. 3 Interpretation of the Panzar-Rosse "*H-Statistic*"

$H \leq 0$	Monopoly or perfectly collusive oligopoly
$H < 1$	Monopolistic competition
$H = 1$	Perfect competition, natural monopoly in a perfectly contestable market, or sales maximizing firm subject to a break-even constraint

[22] E.g. the location model of Salop (1979) with differentiation by transportation costs.

[23] Panzar and Rosse (1987), pp. 448-451

[24] Panzar and Rosse (1987), p. 446.

II.2.2 Limitations of the Rosse-Panzar Methodology

When applying the above described technique to assess banks' market conduct and interpreting the results, several limitations of the Panzar-Rosse approach if applied to banking need to be taken into account: general limitations regarding the scope of models captured by this static approach, the assumptions made, as well as resulting biases when applying this technique to "real world" (bank) data. However, its special advantages pertaining to its applicability to limited data-bases nevertheless make this approach a valuable tool in assessing market conditions.

Generally, the Panzar-Rosse statistic was developed on the basis of static (oligopoly) models whereas for dynamic models there are no predictions on the value of the *H*-statistics.[25] As the interpretation of the *H-statistics* is derived for the market equilibrium, the fact that we do observe market entry and exit might question the existence of an overall equilibrium in the market over the investigated time span and, therefore, imposes further limits on the interpretation of such analyses. Nevertheless, Panzar and Rosse (1987)[26] stress that to only test the 'monopoly' hypothesis the long-run equilibrium is not a prerequisite. However, to test for the alternative models, i.e. monopolistic or perfect competition, it is necessary for the observations to be generated in long-run equilibrium.

Furthermore, problematic within this approach is the assumption of perfect competition in input markets (banks as price takers on input markets) on the one hand and the use of individual, bank specific input prices on the other. Generally, one would find perfect competition in input markets to be an especially demanding assumption in the case of deposits, since there are still good reasons to question the existence of complete competition in the market for deposits;[27] however, there are undoubtedly clear signs that competition has increased since the beginning of the nineties.[28] Furthermore, the use of – differing – bank specific input prices for deposits would at first sight seem to contradict

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[25] See e.g. Corts (1999) for details on the problems of measuring market power for dynamic oligopoly models.

[26] See pp. 446.

[27] See Berger, Bonime, Covitz, and Hancock (2000) for market power in banks' input markets as source for performance persistence in the US banking industry.

[28] In Germany, indicators are among others the strong growth of special savings accounts with a higher remuneration than the classic savings accounts, the increasing importance of money market funds and papers, and a rise in remunerated sight deposit accounts.

this assumption by indicating imperfect factor markets. However, they may also be interpreted as the result of local (competitive) factor markets. The indirect measurement of factor prices through expenses divided by respective volume might additionally overstate the actual variation in prices[29].

Moreover, some downward bias in the estimated elasticities results from the maturity structure of banks' asset portfolios. As longer maturities in fixed rate contracts[30] prevent banks from direct price adjustments, even in perfectly competitive markets delayed changes in pricing imply lower elasticities estimated. This also calls for caution when comparing the empirical results for different countries as is done in some European studies, since for countries with predominantly variable rate contracts such maturity biases do not exist or at least not to the same extent as they do for Germany.

Despite the above mentioned drawbacks, an important advantage of Panzar and Rosse's method is that, because revenues are estimated and not output prices, data availability becomes much less of a constraint, since revenues are more likely to be observable than output prices and quantities or actual cost data. The estimation of reduced-form revenue equations is often possible even though the structural equations cannot be estimated. This is of special importance in the case of the structural supply equation due to the often encountered lack of data for the supply side. Additionally there is no need for quality corrections as in the case of prices.[31]

Another important advantage is that there is no need to specify a geographic market, since the behavior of the individual banks themselves gives an indication of their market power.[32] This is especially advantageous in the case of Germany where - as opposed to the US - banking data are not compiled on such a disaggregated geographical basis. The gaining importance of direct banking (via phone or PC) further complicates such market delineations.

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29 Mountain and Thomas (1999).

30 For Germany see footnote 41, p. 14.

31 Bresnahan (1989), p. 1035.

32 Shaffer (1994), p. 9.

III. Application to the German Banking System

III.1 Data

The data used in this paper stem from two statistical sources: the bank balance sheet statistic (BISTA) and the bank profit and loss account statistic (PaL) at the Deutsche Bundesbank. These statistics comprise data from all credit institutions reporting to the Deutsche Bundesbank.

Although data are available back until 1989 for the PaL accounts and until 1992 for the BISTA, the merged yearly[33] data begin with 1993 as the earliest observation date. This is mainly because East German banks were not included in the PaL statistics prior to 1993 and additionally because of the changes in the reporting scheme of the PaL in 1993. Therefore, the overall data set prior to any outlier reduction comprises all banks reporting from 1993 to 1998 at least for three consecutive years and is unbalanced since not all banks submitted reports throughout the entire time-span. The choice of an unbalanced[34] data set entails the advantage of permitting a greater number of observations to enter the estimations, however, at the price of including banks which presumably do not behave as banks typically do in market equilibrium since they are either new entrants, exiting or merged banks. [35]

In this study, the data set is not adjusted for bank mergers, i.e. two merging banks are treated as separate banks up to the year they are merged from where on only the 'take over' bank is accounted for. Thereby it is implicitly assumed that the behavior of that bank does not change due to the merger with respect to business mix and competitive stance. [36]

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[33] While the BISTA contains monthly data, the PaL data are reported on a yearly basis. To match the differing frequencies, the monthly data from the BISTA were transformed into yearly data by taking the end of year i.e. the December values for the given year.

[34] As mentioned in chapter IV.1, preceding studies for Germany also used unbalanced data sets.

[35] For details on the data filtering see appendix pp. 36.

[36] Greater deviations in the results for an adjusted data set are not expected since the majority of the mergers took place among small cooperative banks which supposedly operate under similar competitive conditions and with a similar business mix. The results of other authors for merger adjusted and unadjusted data sets (e.g. Kishan, Opiela (2000), p. 127) support this practice, yet their analysis referred to different banking markets (US). Nevertheless, adjustments such as treating the merging banks as only one bank throughout the entire sample period (e.g. Peek, Rosengren (1995), p. 631, Kishan, Opiela (2000), p. 127), also make implicit assumptions about the banks' behavior.

Despite the above adjustments, the absence of a selection bias resulting from the (partial) omission of small banks as in commercial data sets is a big advantage of this comprehensive data set. As small banks may have market power in local markets, their exclusion from the study would possibly bias results somewhat towards more competitive conditions than actually prevail in the investigated banking system. As can be seen in Tab. 4, the analyzed sample is dominated by (small) cooperative and savings banks. Given the regional demarcation within the cooperative banks group and the savings banks group theoretically preventing them from competing against each other within their group, they – potentially – do exercise some local market power.

Tab. 4 Descriptive statistics of the banks included in the sample:
(*averages in percentage of total assets; standard deviations in brackets below):

	No. of banks	Total revenues*	Interest revenues*	Loans*	Interbank loans*	Total deposits*	Funding costs***	Total assets (avg. in DM billion)
Overall sample	3 473	7.3 (1.1)	6.7 (0.96)	71.4 (11.4)	13.7 (10.7)	87.5 (7.4)	4.1 (0.87)	1.9 (12.5)
Cooperative banks**	2 573	7.3 (0.84)	6.7 (0.80)	71.8 (10.4)	13.3 (7.8)	89.1 (4.4)	4.0 (0.70)	0.3 (0.68)
Savings banks**	624	7.2 (0.72)	6.5 (0.75)	66.3 (10.9)	8.1 (5.5)	86.2 (4.4)	4.1 (0.70)	2.2 (3.2)
Credit banks**	185	8.1 (2.8)	6.7 (2.3)	77.0 (16.0)	26.0 (18.6)	79.3 (11.6)	4.9 (1.7)	4.2 (14.5)
Foreign banks	34	7.1 (2.4)	6.1 (2.0)	84.5 (11.5)	58.9 (22.9)	87.5 (7.0)	5.3 (2.1)	1.1 (1.2)

** Excluding cooperative central banks, giro central banks, and large credit banks, respectively, due to their deviations in size and structure from the respective group average.

*** Interest expenses to total funds.

To make a further distinction among size effects, the overall sample is classified into three size classes: "small" for banks with total assets below DM 1 billion, "medium-sized" for banks with total assets in the range of DM 1 billion to DM 5 billion, and large with more than DM 5 billion in total assets.[37] Tab. 5 reports some features on the different size classes the most striking one definitely being the very high percentage of cooperative banks among the "small" banks.

[37] Banks changing size over time to an extent that would call for reclassification are categorized as belonging to the size class they have the most observations in.

Tab. 5 Data sample in different size classes:
(*averages in percentage of total assets; standard deviations in brackets below):

	No. of banks	Cooperative banks	Savings banks	Private banks	Foreign banks	Total assets (average in DM billion)	Total revenues*	Funding costs*
"Small" banks	2 786	2 449	209	103	22	0.25 (0.22)	7.3 (0.8)	4.0 (0.8)
"Medium-sized" banks	554	119	366	53	12	2.0 (1.0)	7.2 (1.1)	4.3 (1.0)
"Large" banks	133	9	62	33	0	34.8 (53.3)	7.0 (1.5)	5.2 (1.4)

III.2 Estimation equation

To apply the method developed by Panzar and Rosse to the described data set of German banks and estimate the sum of the factor price elasticities (denoted below with the coefficients b_1, b_2, and b_3) with respect to banks' revenues, the following estimation equation is set up:[38]

$$\ln TIN1tTA_{i,t} = a_1 + b_1 \ln IETF2_{i,t} + b_2 \ln wage\ 1_{i,t} + b_3 \ln aCEtFA_{i,t} + c_1 LtTL_{i,t} + c_2 IDtTD_{i,t} + c_3 lmab1t_{i,t} + c_4 cashi_{i,t} + d_1 t + \lambda_t + \mu_i + u_{i,t}$$

where:

Dependent variable:

TIN1tTA = total income to total assets

Factor prices:

IEtF2 = interest expenses to total funds

wage1 = personnel expenses to total assets

CEtFA = capital expenses to fixed assets

Other bank specific variables:

LtTL = customer loans to total loans

IDtTD = interbank deposits to total deposits

lmab11 = maturity structure of customer loan portfolio

cashi = cash flow to business volume by sector of the borrower, weighted with the portfolio of loans to enterprises

(More precise definitions of the variables can be found in the appendix on pp. 39.)

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[38] Moreover, time dummy variables are added to account for yearly macro effects. "*ln"* for natural logarithm.

In order to estimate the *H-statistic,* total revenues rather than interest revenues are chosen as the dependent variable (*TIN1tTA*) to take account of fee income and the growing off-balance sheet business. The dependent variable is expressed as a ratio to total assets to abstract from size effects. [39] As actual factor price data are not available, they are proxied by ratios of expenses to respective volume following the literature: funding costs are expressed as interest expenses divided by total funds (*IEtF2*), wages are proxied by personnel expenses to total assets (*wage1*)[40], and for costs of fixed capital, the depreciation and the write-down on intangible and tangible assets are divided by fixed assets (*CEtFA*).

To cover bank specifics affecting banks' revenues and cost functions, the individual bank business mix regarding the importance of interbank business is comprised in two variables: the ratio of customer loans to total loans (*LtTL*) and interbank deposits to total deposits (*IDtTD*). The maturity structure of the loan portfolio is expressed as the ratio of customer loans with a maturity of up to one year to total customer loans (*lmab1t*) [41]. To account for bank specific demand[42], a loan portfolio weighted proxy for sectoral cash flow relative to business volume (*cashi*)[43] is included in the estimation equation signaling credit demand with low cash flow figures.

The above equation is estimated with a fixed effect ("within") panel regression. Thus, λ_t represents the time specific constant or "time effect" accounted for by including time dummies and μ_i the bank specific constant or "individual effect"; $u_{i,t}$ are the error terms corresponding to the endogenous variable, $TIN1tTA_{i,t}$.[44]

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39 For details on the implications see short discussion on p. 24.

40 Figures on the number of employees were not available.

41 The results of an internal paper based on survey data from 1997 among banks show that only a minority of long-term loans to enterprises is endowed with lock-in periods of less than one year or floating rates.

42 Bresnahan (1989), p. 1035, stresses that to include only cost variables on the right hand side of the reduced form revenue equation omitting demand shifters is only appropriate when testing the hypothesis of perfect competition. To test for monopoly also requires the inclusion of the demand shifters as exogenous variables.

43 Ratio of sectoral cash flow to business volume weighted with sectoral weights in each banks' loan portfolio (sectoral cash flow ratios approximated by the financial statements stemming from "Jahresabschlüsse westdeutscher Unternehmen 1971-1996" (special publication of the Deutsche Bundesbank) and some internal data updates)

44 Whether the "individual effects" are fixed or random effects is tested for by applying the Hausmann test. Only for foreign banks do the results indicate the use of random effects estimation (see. Tab. 6); however, for better comparability of the results, fixed effects are used throughout for all banking groups.

The equation is estimated for the overall sample as well as for single banking groups and size classes. To test for the significance of the differences obtained in the *H-statistics* of different banking groups and size classes, we then include group specific interaction terms. The significance of changes over time is finally analyzed by multiplying all variables with interaction terms for the two subperiods 1993-1995 and 1996–1998 and estimating them within one regression. Furthermore, for the overall sample as well as for individual banking groups, the *H-statistic* is estimated cross-sectionally for each year to get a second indication of changes over time.

III.3 Estimation Results and Interpretation

With respect to the *H-statistic*, the empirical results listed in Tab. 6 are generally consistent with monopolistic competition as a characteristic of the analyzed banks' behavior since the reported *H*-values are in the range of above zero and below 1.[45] While the *H*-statistic for the overall sample reaches a value of 0.68, cooperative banks which make up the largest part of the overall sample attain the lowest H-statistic of 0.53, savings banks 0.64, credit banks 0.80, and foreign banks 0.83. These results are very much in line with previous results from panel econometric estimations for the German banking system (for a more detailed comparison see Tab. 11, p. 24). In a further estimation it is tested for the significance of the differences in the *H*-statistics of the different banking groups by using interaction terms and estimating two groups within one regression. Thereby the significance of the differences in the *H*-values was verified for credit vs. savings banks and credit vs. cooperative banks (see Tab. 14, p. 30), as well as between savings and cooperative banks (see Tab. 15, p.30).[46]

As in previous studies the main factor price driving the *H*-statistic is the price for funds with coefficients between 0.39 for cooperative banks and 0.66 for foreign banks. The elasticity with respect to labor prices is clearly lower, however, significant and of positive sign throughout. The price of fixed capital contributed only marginally to overall factor price elasticity. As already mentioned in chapter II.2.2, some downward bias in the estimated elasticities may result from the structure of banks' loan portfolios. As longer maturities in fixed rate contracts prevent banks from direct price adjustments, even in

[45] For all values of the *H-statistic* the hypothesis of $H = 1$ was rejected.

[46] Due to the small sample of foreign banks and the amount of variables needed in the regression when including interaction terms, these estimations were not undertaken for foreign banks.

perfectly competitive markets delayed changes in pricing imply lower estimated elasticities.[47]

Tab. 6 Estimation results from robust fixed effects "within" panel regressions:[#]

(t-values calculated from robust standard errors below the coefficient estimates)

		Overall sample	Cooperative banks*	Savings banks*	Credit banks*	Foreign banks
Factor prices	**Funds**	0.501^{+} 32.1	0.387^{+} 28.2	0.457^{+} 18.0	0.541^{+} 14.5	0.661^{+} 17.5
	Labor	0.173^{+} 11.9	0.138^{+} 14.3	0.183^{+} 8.0	0.260^{+} 5.0	0.202^{+} 7.8
	Fixed Capital	0.004^{+} 2.7	0.006^{+} 4.8	0.004 1.5	-0.003 -0.4	-0.037^{+} -2.5
H-statistic **p(F-Test)**		0.68^{+} 0.00	0.53^{+} 0.00	0.64^{+} 0.00	0.80^{+} 0.00	0.83^{+} 0.00
	LtTL	0.108^{+} 10.4	0.131^{+} 15.0	0.118^{+} 7.1	0.110$^{\sim}$ 1.8	-0.072 -0.7
	IDtTD	-0.075 -2.5	-0.071^{+} -4.1	-0.003 -0.1	-0.099 -1.3	0.138^{+} 2.3
	lmab1t	0.065^{+} 2.9	0.118^{+} 7.1	0.075$^{\sim}$ 1.8	0.029 0.5	-0.010 -0.2
	cashi	-0.003 -1.6	0.002 1.3	-0.006^{+} -3.5	-0.005 -1.1	0.001 0.4
	trend	-0.009^{+} -7.8	-0.017^{+} -15.6	-0.014^{+} -7.9	0.001 0.2	0.003 0.4
	constant	-0.335^{+} -4.8	-0.851^{+} -12.0	-0.428^{+} -2.8	0.204 1.0	0.183 1.5
	p(Br/Pa), re	0.00	0.00	0.00	0.00	0.00
	p(F-Test), fe	0.00	0.00	0.00	0.00	0.00
	p(Hausmann)	0.00	0.00	0.00	0.00	0.98
	No. of banks°	3 473	2 573	624	185	34
	No. of observ.°	20 025	14 829	3 671	1 023	177

[#] Time dummies included, but not explicitly reported.
* Excluding cooperative central banks, giro central banks, and large banks, respectively.
$^{+}$ Significance at 5% level (robust standard errors).
$^{\sim}$ Significance at 10% level (robust standard errors).
° The number of banks and observations for the different banking groups are equivalent to the subsample included in the overall sample and were therefore subject to the outlier selection performed on the overall sample.

[47] With respect to the maturity structure, we indeed see strong differences in the loan portfolios of foreign and credit banks vs. cooperative and savings banks: while for savings (24 %) and cooperative banks (30 %) short-term loans (i.e. loans with maturities of up to one year) make up a rather small part of their overall loan portfolio, for credit (57 %) and foreign banks (87 %) it is notably higher.

Among the variables reflecting banks' business mix, the ratio of customer loans to total loans (*LtTL*) has the highest explanatory power with positive coefficients a little above 0.1 reflecting the positive impact of a higher share of customer loans within the loan portfolio on overall bank revenues. With respect to the maturity structure the variable capturing the ratio of short-term to overall customer loans (*lmab1t*) proved to be significant for cooperative and savings banks as well as for the overall sample. On the deposit side the picture is less clear. For cooperative banks and for the overall sample there is a significant negative relationship between the ratio of interbank deposits to total deposits (*IDtTD*) and revenues, while for credit and savings banks it was not significant and for foreign banks it was positively significant.

The chosen bank specific demand variable was only partially significant. The portfolio weighted sectoral cash flow ratio (*cashi*) - giving an indication for the need of short-term liquidity among commercial customers - proved indeed to be of significant negative sign for savings banks, whereas for the other banking groups no significant estimates were obtained.

Tab. 7 *H-statistics* from robust fixed effects "within" panel regressions including interaction terms for the respective time periods – Testing the hypothesis of no difference between the two periods:

		Overall sample	Cooperative banks*	Savings banks*	Credit banks*
1993-1995	***H-statistic* (H_1)**	0.68^{+}	0.54^{+}	0.68^{+}	0.76^{+}
	p(F-test)	0.00	0.00	0.00	0.00
1996-1998	***H-statistic* (H_2)**	0.68^{+}	0.51^{+}	0.59^{+}	0.82^{+}
	p(F-test)	0.00	0.00	0.00	0.00
H_0: $H_1 = H_2$	**p(F-test)**	0.97	0.02	0.00	0.08

To detect possible changes in competitive behavior over time the above regressions are run with interaction terms for the first and second half of the overall time period (1993-1995 and 1996-1998). By estimating all "interacted" variables within one regression, it is possible to test for the significance of the differences in the *H*-value*s* between the two periods. As shown in Tab. 7, for cooperative and especially for savings banks a slight, significant reduction in the *H*-values is reported. But for credit banks (at the ten percent

level) and for the overall sample it cannot be rejected that the *H-statistics* were the same during the two sub periods.[48]

When looking at the cross-sectional estimations[49], however, for the overall sample as well as for the savings banks there is a slight downward tendency in the yearly *H*-values while for cooperative and credit banks no clear time direction can be identified.

Tab. 8 Cross-sectional estimations of the yearly *H-statistics*:

	Overall sample	Cooperative banks**	Savings banks**	Credit banks**
1993	0.60^{+} 0.00	0.42^{+} 0.00	0.55^{+} 0.00	0.73^{+} 0.00
1994	0.57^{+} 0.00	0.44^{+} 0.00	0.50^{+} 0.00	0.65^{+} 0.00
1995	0.51^{+} 0.00	0.38^{+} 0.00	0.49^{+} 0.00	0.59^{+} 0.00
1996	0.54^{+} 0.00	0.38^{+} 0.00	0.38^{+} 0.00	0.70^{+} 0.00
1997	0.50^{+} 0.00	0.38^{+} 0.00	0.36^{+} 0.00	0.72^{+} 0.00
1998	0.51^{+} 0.00	0.41^{+} 0.00	0.31^{+} 0.00	0.71^{+} 0.00

* Heteroscedasticity robust p-values of F-test for joint significance of the three coefficients for the factor prices below each *H-statistic* value.

** Excluding cooperative central banks, giro central banks, and large banks, respectively.

+ Significance at 5% level.

In order to detect differences depending on bank size, the above regressions which have been conducted for different banking groups were rerun for different subsamples of the overall sample reflecting small, medium-sized, and large banks as defined in chapter III.1 on p. 11. Following these estimation results listed in Tab. 9, differences in the *H*-statistics also depend on bank size. While for small banks the estimated *H*-statistic lies at 0.64, it is 0.76 for medium-sized banks, and 0.86 for large banks. Again differences stem from the elasticity with respect to the price of funding.

[48] Due to the small number of observations for foreign banks, these estimations were not conducted for that subsample.

[49] See Molyneux et al. (1994) for the first yearly cross-sectional estimations for several European countries.

Tab. 9 Estimation results from robust fixed effects "within" panel regressions:[#]

(t-values calculated from robust standard errors below the coefficient estimates)

		Overall sample	Small banks*	Medium-sized banks*	Large banks*
Factor prices	**Funds**	0.501[+]	0.460[+]	0.584[+]	0.750[+]
		32.1	25.7	20.3	21.0
	Labor	0.173[+]	0.174[+]	0.184[+]	0.119[+]
		11.9	9.7	9.3	4.1
	Fixed capital	0.004[+]	0.005[+]	-0.004	-0.008
		2.7	4.1	-1.0	-1.2
H-statistic		0.68[+]	0.64[+]	0.76[+]	0.86[+]
p(F-Test)		0.00	0.00	0.00	0.00
	LtTL	0.108[+]	0.120[+]	0.071[+]	0.059
		10.4	10.5	3.0	1.0
	IDtTD	-0.075	-0.100[+]	-0.034	0.069
		-2.5	-2.7	-1.0	1.0
	lmab1t	0.065[+]	0.085[+]	0.032	0.029
		2.9	3.1	0.6	0.5
	cashi	-0.003	-0.002	-0.010[+]	0.006
		-1.6	1.2	-3.4	1.0
	trend	-0.009[+]	-0.012[+]	-0.007[+]	0.002
		-7.8	-7.9	-3.2	0.7
	constant	-0.335[+]	-0.460[+]	0.001	0.071
		-4.8	-5.7	0.01	0.4
	p(Br/Pa), re	0.00	0.00	0.00	0.00
	p(F-Test), fe	0.00	0.00	0.00	0.00
	p(Hausmann)	0.00	0.00	0.00	0.00
	No. of banks°	3 473	2 786	556	133
	No. of observ.°	20 025	15 984	3 274	781

[#] Time dummies included, but not explicitly reported.

* Sizes ("small", "medium-sized", and "large") as defined in the text.

[+] Significance at 5% level (robust standard errors).

~ Significance at 10% level (robust standard errors).

° The number of banks and observations for the different size classes are equivalent to the subsamples included in the overall sample and were therefore subject to the outlier selection performed on the overall sample.

However, looking at the size subsamples, no clear differences in the *H-statistics* for the two time subperiods can be identified indicating that changes over time seem to be more banking group-specific rather than size-specific. For large banks an increase of the *H-statistic* only significant at the 10 percent level is no clear indication of increased competition, either.

Tab. 10 *H-statistics* from robust fixed effects "within" panel regressions including interaction terms for the respective time periods – Testing the hypothesis of no difference between the two periods:

		Overall sample	Small banks*	Medium-sized banks*	Large banks*
1993-1995	***H-statistic* (H_1)**	0.68^{+}	0.64^{+}	0.76^{+}	0.81^{+}
	p(F-test)	0.00	0.00	0.00	0.00
1996-1998	***H-statistic* (H_2)**	0.68^{+}	0.64^{+}	0.78^{+}	0.87^{+}
	p(F-test)	0.00	0.00	0.00	0.00
H_0: $H_1 = H_2$	**p(F-test)**	0.97	0.97	0.65	0.08

* Sizes ("small", "medium-sized", and "large") as defined in the text.
$^{+}$ Significance at 5% level.

IV. Previous Empirical Results for Germany and Empirical Comparison

Previous studies employing the Rosse-Panzar approach to assess the competitive stance of the German banking market are mainly multi country studies[50] comparing competitive stance in the banking markets of major European countries. For Germany, they come in general to the conclusion that their results are consistent with monopolistic competition, i.e. values for the *H-statistic* of above 0 and below 1 (see Tab. 11). These different studies analyzing the German banking market, however, vary in the data set underlying their estimations, the functional form of the estimation equations, the specification of right and left hand variables, the inclusion of time dependencies of the *H-statistic*, the weighting of the individual banks in the sample and the estimation method.

In order to check the general results obtained in chapter III for robustness and to make these different studies somewhat comparable, different specifications of the previous studies mentioned above are reestimated for the Bundesbank data set covering the time period from 1993 to 1998. As in chapter III, the estimations are conducted for the overall sample as well as for individual banking groups: cooperative banks, savings banks, credit banks, and foreign banks. In a last step, within each specification it is tested for the significance of the differences between the estimated *H-statistics* of credit banks, savings banks and cooperative banks using interaction terms.

[50] Lang (1997) is the only one in that context exclusively analyzing German banks.

IV.1 Data and Empirical Application in Previous Studies

Multi country studies comparing the competitive situation of different banking markets usually rely on the Fitch IBCA data base which is commercially available and to a high degree standardized over the different national accounting schemes and thereby especially useful for comparative international studies. Lang (1997), specializing in the German market, had access to data (at least partially) not available to the general public which include a higher number of German banks and especially small banks (cooperative banks).[51] For their estimations the authors used unbalanced data sets and De Bandt and Davis (2000) contrasted their results obtained from a balanced data set with the ones stemming from an unbalanced data set (like the one used in this study).

To estimate the reduced form revenue equations, panel econometric methods are applied in general; only Molyneux et al. (1994) regress their estimation equations cross-sectionally. Among the different panel regression techniques, *fixed effects* estimations are the most widely used ones. Apart from fixed effects some studies used pooled regressions[52] and "between" estimators;[53] Lang (1997) also applies random effects wherever the Hausmann test indicates their use rather than fixed effects.

To test whether there is a time trend within the *H-statistic*, Bikker and Groeneveld (2000) include a logistic time curve model in the estimation equation and De Bandt and Davis (2000) estimate in one version of their estimates an *H-statistic* following a quadratic time-trend. By using a translog equation, Lang (1997) can calculate yearly *H-statistics* from the panel estimations since, for translog equations, the *H-statistic* (the sum of the factor price elasticities) is more complex, additionally involving the derivatives of cross products. However, the outcomes do not give strong indications for such time dependencies: Bikker and Groeneveld (2000) find that the inclusion of a logistic time curve hardly changed their results in their pooled regressions over all banks from the 15 EU countries.[54] Also when constraining the *H-statistic* by a quadratic time trend, De Bandt and Davis (2000) do not

[51] Lang (1997) used data from Hoppenstedt and Bavarian mutual cooperative union.

[52] Bikker and Groeneveld (2000) and De Bandt and Davis (2000).

[53] De Bandt and Davis (2000).

[54] In their single-country regressions there is no comparison of the results with and without the inclusion of a logistic time curve for Germany (see. p. 90). As in the multi-country regression, in Germany the time coefficient is significant and similar to the size of the coefficient in the multi-country regression and, therefore, supposedly hardly changed the results for Germany, as well.

obtain significant coefficients for that time trend in most countries (except for France). (see p. 1062). Lang (1997) does present *H-statistics* differing over time but does not give any indication to have tested for the significance of the displayed differences.

The functional form usually employed is a log linear reduced form revenue equation, with the exception being – as mentioned above – a translog function used by Lang (1997). The latter is far more demanding with respect to the amount of observations needed in the data set due to the large amount of explanatory variables necessary for this type of function. The use of this functional form stems from efficiency studies where the need to take proper account of economies of scale and scope is crucial.

The variable specifications differ for the endogenous as well as for the exogenous variables. Generally the definitions are given either in absolute values or ratios with e.g. total assets as the denominator. While for factor prices ratios of expenses to the respective volume create the relevant proxies for these price variables, for other exogenous variables, e.g. for outputs, the ratios serve to scale these variables in order to avoid unduly measuring bank size effects which should be separately accounted for. Furthermore by measuring variables as ratios of two nominal values these variables are quoted in real terms and there is no need to additionally account for inflation (Bikker and Groeneveld (2000), De Bandt and Davis (2000), Molyneux et al. (1994)).[55] A more detailed look at some differences and similarities in the variable definitions of the various studies can be found in chapter IV.3 on page 24.

IV.2 Previous Results

In general, all studies - except for Molyneux et al. (1994) - come to results of values for the *H-statistic* clearly above zero and below one indicating monopolistic competition for the German banking market for the time period between the late eighties and the mid-nineties (see Tab. 11). Furthermore, most studies find higher values for large banks than for small banks, which can be interpreted as an indication that small banks have greater market power.

[55] To account for inflation, Lang (1997) deflated the different variables with the GNP deflator.

In Bikker and Groeneveld (2000), the *H-statistic* for Germany for the time period from 1989 to 1996 was 0.88 with their standard model;[56] weighting individual banks according to their size of total assets yielded a higher value (0.94), which they interpret as an indication that larger banks face higher competition and small banks hold a higher amount of market power in local markets. Fitting into this picture, De Bandt and Davis (2000) find in their estimations for Germany (as well as for the other countries investigated) great differences in the *H-statistics* for large and small banks in their balanced sample estimates (large banks had an *H-statistic* of 0.63, while small banks only reached 0.15). However, in the unbalanced sample the discrepancy is less pronounced (large banks: 0.37; small bank 0.28). The estimations Lang (1997) reports result in *H-statistics* of 0.69 for credit banks and 0.44 and 0.45 for savings and cooperative banks, respectively. Also Lang gives as possible explanations for these differences the fact that some small savings or cooperative banks might enjoy greater market power in rural areas than larger credit banks which tend to have more international customers. Another reasoning put forward by Lang is the institutional background as competition within the savings banks group and the cooperative banks group is hindered by regional demarcation. Finally, Molyneux et al. (1994) obtain rather unstable results with the *H-statistics* switching signs and reaching values of –0.04 in 1986 and +0.47 in 1989 which would indicate rather unlikely strong changes in competitive conditions within only three years.

Among the factor price elasticities which together make up the *H-statistic*, in all studies[57] funding costs play the most important part. Labor costs give a rather mixed picture whereas costs of physical capital are mostly negligible in their contribution to the *H*-statistic.[58]

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56 The inclusion of so called bank specific factors in their "standard" regression equation did not change the H-statistic (0.88) very much compared to the exclusion of these variables (0.81).

57 De Bandt and Davis (2000) do not quote their results for single factor price elasticities.

58 For unit price elasticities in Germany, Bikker and Groeneveld (2000), p. 80, find high coefficients for funding costs (0.72 and 0.83) and also significant contributions of personnel expenses (0.16 and 0.10) whereas capital expenses were negligible. Lang (1997) also reports results in which funding costs have a great impact (0.4 to 0.6), labor costs a very low impact, and the cost of physical capital none whatsoever. On average, Molyneux et al. (1994) obtain the highest figures in their study for funding costs, as well, ranging from 0.04 to 0.16 for the four cross-sectional regressions. For labor costs they only get a significant coefficient for 1989 (0.24) whereas in previous years the coefficients turn out to be negative and insignificant. The coefficients for costs of physical capital are insignificant apart form 1989, where they reach a value of 0.07.

Tab. 11 Previous studies for Germany applying the Panzar-Rosse approach

	H-statistic	Result	Period	Estimation method	Number of observations	Type of study
Bikker, Groeneveld (2000)	0.84-0.86 (0.92-0.91 with weighted model)*	Monopolistic competition	1989-1996	Pooled regression (log linear equation)	88 banks, 624 observations for Germany	Multi-country study for 15 European countries
De Bandt, Davis (2000)	large banks: 0.63 (0.37) ** small banks: 0.15 (0.28) **	Monopolistic competition	1992-1996	Pooled regression, fixed effect, "between" estimator (log linear equation)	large banks: 360 observations; small banks: 1265 observations for Germany	Multi-country study for France, Germany, Italy, US
Lang (1997)	credit banks: 0.69 savings banks: 0.44 cooperative banks: 0.45	Monopolistic competition	1988-1992	fixed and random effects (translog equation)	credit banks: 586 savings banks: 1552 cooperative banks: 4006	Germany
Molyneux, Lloyd-Williams, Thornton (1994)	For Germany: 1986: -0.04 1987: 0.05 1988: 0.05 1989: 0.47	Monopolistic competition	1986-1989	Cross-sectional estimations (log linear equation)	For Germany: 1986: 115 1987:149 1988:162 1989:149	France, Germany, Italy, Spain, and United Kingdom

* Results from 1989 to 1996.

** Results for fixed effects estimations including time dummies for balanced panel data with "total income" as endogenous variable. Underlined in brackets are the values for the respective unbalanced panel regressions, which can be found on p. 30, table 10, in the eponymous working paper (1998) underlying their article. These are probably more comparable with the results from the study in this paper as we use unbalanced panel data, as well.

IV.3 Empirical Comparison: Generalization and Simplification

In order to compare the different estimation specifications applied in previous studies estimating the Rosse-Panzar statistic for German banks, for some representative specification types – the ones employed by Molyneux et al. (1994),[59] De Bandt and Davis (2000) and Lang (1997) - approximations of their specifications are constructed. That way all estimation equations are formulated in the functional form of a log linear equation, which constitutes to a certain degree a simplification of the original estimation equations since some authors amended their log linear estimation equations by a quadratic trend in the *H-statistic* (Bikker and Groeneveld (2000)) or included a logistic time curve model (De Bandt and Davis (2000)). Furthermore, Lang (1997) used a translog functional form which is likewise translated and thereby simplified into a log linear form. The variable definitions for these estimations are an attempt to match the original definitions as closely as possible.[60]

[59] The specification employed by Bikker and Groeneveld (2000) is very similar to one used by Molyneux et. al. (1994).

[60] In the appendix all variables included are listed with their precise definitions (see p. 39).

The endogenous variables differ in that they either cover the banks' total income (Lang (1997)) or just the interest income (Molyneux et. al. (1994), Bikker and Groneveld (2000)). De Bandt and Davis (2000) estimated two versions of their reduced revenue equations using alternatively total income and interest income alone. In the following estimations, the different definitions of the endogenous variables are covered by total income (*TINC*), interest income (*IINC*) and interest income to total assets (*IINCtTA*). Furthermore, Molyneux et. al. (1994) – as well as Bikker and Groneveld (2000) – use ratios to total assets for the endogenous variable whereas Lang (1997) and De Bandt and Davis (2000) employ the income data in levels. In this context, Vesala (1995) points out that by using revenues scaled with total assets the estimated equation no longer reflects a revenue equation but rather a price equation. However, Bikker and Groneveld (2000) state that the results obtained by using level data instead did not alter their overall conclusions.[61]

Generally, for the exogenous variables there are great similarities concerning the choice of factor price variables. They all include similar definitions of funding[62] and labor prices only instead of (fixed) capital prices De Bandt and Davis (2000) include a variable covering "other operational expenses" (in the following *OEtTA*). As in the original papers wages are approximated by the ratio of labor expenses to either total assets (*wage1*) or the sum of deposits and loans (*wage2*). For Lang (1997), due to the lack of data on the number of employees in our data-base, this is just a proxy for the variable he used (personnel expenses to number of employees). The price of fixed capital is covered by the ratio of capital expenses to fixed assets (*CEtFA*).

Furthermore, apart from Lang (1997) who followed in his specification pretty much the cost equations of the efficiency literature including as further exogenous variables primarily different forms of bank output measured as the money value of several asset positions of the balance sheet as well as commission income from the PaL account[63], the

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61 For details on the endogeneity problems encountered by the use of level data in this case see p. 27.

62 In this reestimation the main difference in the specification of the factor prices is for funding costs the denominator in the ratio of interest income to total sum of deposits and other liabilities where they differ in the inclusion of participating debt and hybrid capital as part of the funds (*IEtF1* and, including the latter *IEtF2*). Only for Lang's estimation the first definition is chosen due to the description in his paper; for all others the latter is included.

63 Lang (1997) includes commission income also in the endogenous income variable creating a problem of endogeneity for the exogenous variable.

additional exogenous variables in the other studies are bank specific variables covering mainly banks' business mix and capacities.[64]

These above described approximations and simplifications result in the following approximated estimation equations (the quotation marks indicate the approximative and simplified character of the following equations):

"Molyneux" specification* [65]:

(Eq. 1) $$\ln IINCtTA_{k,t} = a_1 + b_1 \ln IETF2_{k,t} + b_2 \ln wage\ 1_{k,t} + b_3 \ln aCEtFA_{k,t} + c_1 \ln TA_{k,t} + c_2 \ln EtTA_{k,t} + c_3 \ln LtTA_{k,t} + c_4 \ln IDtTD_{k,t} + d_1 t + \mu_k + u_{kt}$$

"De Bandt and Davis" specifications*:

(Eq. 2) $$\ln IINC_{k,t} = a_1 + b_1 \ln IEtF2_{k,t} + b_2 \ln wage\ 2_{k,t} + b_3 \ln OEtTA_{k,t} + c_1 \ln E_{k,t} + c_2 \ln FACBNEA_{k,t} + c_3 LtTA_{k,t} + c_4 TDtTDMM_{k,t} + d_1 t + \mu_k + u_{kt}$$

"Lang" specification*:

(Eq. 3) $$\ln TINC2_{k,t} = a_1 + b_1 \ln IEtF1_{k,t} + b_2 \ln wage\ 1_{k,t} + b_3 \ln aCEtFA_{k,t} + c_1 \ln s1loans_{k,t} + c_2 \ln l1loans_{k,t} + c_3 \ln ibloans_{k,t} + c_4 \ln finc\sec_{k,t} + c_5 \ln co\min c + d_1 t + e_1 \ln rGDP_t + \mu_k + u_{kt}$$

* Moreover, time dummy variables are added to account for yearly macro effects.

(More precise definitions of the variables can be found in the appendix on pp. 39.)

64 For the business mix the loan structure is covered by variables such as the ratio of loans to total assets (*LtTA*), which all of the other studies have in common, the deposit structure by the ratio of interbank deposits to total deposits (*IDtTD*) or the ratio of total deposits to the sum of total deposits and money market liabilities (*TDtTDMM*). To comprise banks' capacities in the estimations Molyneux et. al. (1994) include total assets (*TA*), De Bandt and Davis (2000) the sum of fixed assets, cash and due from banks and other earning assets (*FACNEA*) and the level value of equity (E). To account for bank specific risk the ratio of equity to total assets (*EtTA*) is chosen as a proxy by Molyneux et. al.. To account for demand effects, only Lang (1997) includes a - however not bank specific - demand parameter (real GDP) in his equation.

65 Bikker and Groeneveld (2000) basically followed in their study the specification employed by Molyneux et. al. (1994).

IV.4 Empirical Comparison: Estimation Results

As in chapter III, the above equations are estimated with panel-econometric techniques using the described Bundesbank data set covering the period from 1993 to 1998. To decide whether to apply fixed effects, random effects or pooled estimations, again the significance of the individual effects is tested by an F-test for fixed effects and a Breusch-Pagan test for random effects. Finally the Hausmann specification test indicates in the case of significant individual effects the use of fixed or random effects. However, for better comparability of the results, all equations are compared on the basis of fixed effects estimations. In the following, we concentrate on the results regarding the estimated *H-statistics* and factor price elasticities for the different banking groups from estimating the alternative specifications previously denoted as "Eq. 1-3" as well as the new specification from chapter III.2 denoted as "New".[66]

Starting with the results of the overall sample, the estimated *H-statistics* vary from 0.21 to 0.68 . However, when decomposing these sum values, the most important component, the factor price elasticity for funds lies between 0.5 and 0.6. The main differences in the *H-statistic* result from the elasticities estimated for labor costs. These are mainly due to severe endogeneity problems of the specifications from Eq. 2 and 3 encountered by indirect effects of the balance sheet restriction: As these specifications use level data as endogenous variables,[67] exogenous variables as ratios with little variation in the numerator and the sum of deposits and loans or total assets in the denominator - such as the wage variables - are by definition highly (negatively) correlated to these left-hand variables (here resulting in negative coefficients for labor costs). For this reason the respective *H-statistics* are only slightly shaded in the reported results and only interpreted to a limited extent.[68] The contribution of fixed capital costs (or in case of DeBandt and Davis (2000) - approximated by Eq. 2 - of "other expenses") are extremely limited. Taking this into account, the partially differing results for the *H-statistics* are put somewhat into perspective.

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66 The entire estimation results for the overall sample are provided in the appendix on p. 41.

67 For the implications on the interpretation of the results when using ratios, see comment on p. 24.

68 This endogeneity problem stemming from the balance sheet restriction is, of course, also highly relevant for other right-hand variables including loans or total assets or – as in the case of Lang's specification – income from securities in levels.

Tab. 12 Main estimation results for the overall sample:[#]
(robust t-values below)

		Eq. 1	Eq. 2	Eq. 3	New
Factor prices	**Funds**	0.58[+] 36.2	0.51[+] 20.5	0.49[+] 17.9	0.50[+] 32.1
	Labor	0.10[+] 9.4	-0.19[+] -7.2	-0.25[+] -9.9	0.17[+] 11.9
	Capital (Other)**	0.005[+] 3.6	-0.105[+] -9.8	-0.003 -0.9	0.004[+] 2.7
	H-statistic **p(F-Test)**	0.68[+] 0.00	0.21[+] 0.00	0.24[+] 0.00	0.68[+] 0.00
	p(F-Test), fe	0.00	0.00	0.00	0.00

[#] Time dummies included, but not explicitly reported.
[+] Significance at 5% level.
[~] Significance at 10% level.
** in Eq.2: other expenses to total assets.

With respect to the estimation results for different banking groups (see Tab. 13), here again cooperative banks reach the lowest *H-statistic* with 0.53, for savings banks values between 0.24 and 0.66 are obtained, whereas for credit banks the *H-statistic* lies between 0.76 and 0.80.[69] When only referring to funding costs, the results of the different estimation equations within each banking group - including the problematic specifications of Eq. 2 and 3 - are far more homogenous and mirror pretty much the picture obtained in chapter III.3 with the higher elasticities for foreign and credit banks and lower ones for cooperative and savings banks.

Looking at these results in the light of current public debate about the competitive stance of savings banks, we again have to first analyze whether the observed differences between savings and cooperative banks on the one hand, and credit banks, on the other, are indeed significant. To do so, they are estimated in pairs and included in one sample with interaction terms. Then it is tested for the significance of the differences in the values of the *H-statistic* with an F-test. The results are listed in Tab. 14 below. Likewise it is tested for significant differences in the *H-statistics* between savings and cooperative banks (Tab. 15).

[69] The H-statistics for Eq. 2 and 3 turned out not to be significantly different from zero. However, this is due to the above described problems of endogeneity encountered in these approximated specifications. For foreign banks see results in the appendix on p. 42. Here again, the great variability of the H-statistic is mainly caused by the factor price "other expenses" in Eq. 2 and labor costs in Eq. 3. Looking only at the elasticity of funding costs gives a more homogenous picture with elasticities ranging from 0.63 to 0.77.

Tab. 13 Main estimation results for the different banking groups:[#]
(robust t-values below)

	Cooperative banks*	Eq. 1	Eq. 2	Eq. 3	New
Factor prices	**Funds**	0.44[+]	0.43[+]	0.39[+]	0.39[+]
		32.4	17.8	22.9	28.2
	Labor	0.09[+]	-0.14[+]	-0.06[+]	0.14[+]
		10.2	-8.4	-3.8	14.3
	Capital (Other)**	0.007[+]	-0.040[+]	0.009[+]	0.006[+]
		5.3	-7.3	3.8	4.8
	H-statistic	0.53[+]	0.25[+]	0.34[+]	0.53[+]
	p(F-Test)	0.00	0.00	0.00	0.00
	p(F-Test), fe	0.00	0.00	0.00	0.00

	Savings banks*	Eq. 1	Eq. 2	Eq. 3	New
Factor prices	**Funds**	0.50[+]	0.40[+]	0.42[+]	0.46[+]
		18.5	8.8	14.3	18.0
	Labor	0.16[+]	-0.08	-0.11[+]	0.18[+]
		6.5	-1.6	-3.9	8.0
	Capital (Other)**	0.006[+]	-0.059[+]	0.014	0.004[+]
		2.1	-4.4	3.7	1.5
	H-statistic	0.66[+]	0.26[+]	0.32[+]	0.64[+]
	p(F-Test)	0.00	0.01	0.00	0.00
	p(F-Test), fe	0.00	0.00	0.00	0.00

	Credit banks*	Eq. 1	Eq. 2	Eq. 3	New
Factor prices	**Funds**	0.67[+]	0.62[+]	0.59[+]	0.54[+]
		19.6	12.3	11.1	14.5
	Labor	0.10[+]	-0.33[+]	-0.54[+]	0.26[+]
		2.1	-6.9	-8.5	5.0
	Capital (Other)**	-0.002	-0.24[+]	-0.04[+]	-0.003
		-0.2	-6.7	-1.9	-0.4
	H-statistic	0.76[+]	0.05	0.01	0.80[+]
	p(F-Test)	0.00	0.40	0.87	0.00
	p(F-Test), fe	0.00	0.00	0.00	0.00

[#] Time dummies included, but not explicitly reported.
[+] Significance at 5% level.
[~] Significance at 10% level.
* Excluding cooperative central banks, giro central banks, and large banks respectively.
** In Eq.2: other expenses to total assets.

Tab. 14 *H-statistics*: credit banks vs. savings and cooperative banks[#]

			Eq. 1	Eq. 2	Eq. 3	New Eq.
Credit vs. savings banks	**Credit banks**	***H-statistic* (H_p)**	0.76[+]	0.05	0.01	0.80[+]
		p(F-test)	0.00	0.40	0.87	0.00
	Savings banks	***H-statistic* (H_s)**	0.66[+]	0.26[+]	0.32[+]	0.64[+]
		p(F-test)	0.00	0.00	0.00	0.00
	H_0: $H_p = H_s$	**p(F-test)**	0.13	0.02	0.00	0.01
Credit vs. cooperative banks	**Credit banks**	***H-statistic* (H_p)**	0.76[+]	0.05	0.01	0.80[+]
		p(F-test)	0.00	0.40	0.87	0.00
	Cooperative banks	***H-statistic* (H_c)**	0.53[+]	0.25[+]	0.34[+]	0.53[+]
		p(F-test)	0.00	0.00	0.00	0.00
	H_0: $H_p = H_c$	**p(F-test)**	0.00	0.00	0.00	0.00

[#] Time dummies included.
[+] Significance at 5% level.

As can be seen in Tab. 14, the *H-statistics* of credit banks differ significantly from the ones of cooperative banks and attain significantly higher values for the *H-statistic*. However, the picture for savings and credit banks is not equally clear cut, as in Eq. 1 the equality of the two *H-statistics* cannot be rejected, while for the new equation the value is significantly higher for credit banks. If we compare savings and cooperative banks (see results in Tab. 15), the latter achieve significantly lower values.[70] Hence, with respect to the public debate on the competitive stance of savings banks, there are no indications of an especially low degree of competitiveness of savings banks derived from this approach. Instead, these results rather stress some parallels in the business structure of cooperative and savings banks in general, especially when comparing the factor price elasticities for funding costs.

Tab. 15

		Eq. 1	Eq. 2	Eq. 3	New Eq.
Savings banks	***H-statistic* (H_s)**	0.66[+]	0.26[+]	0.32[+]	0.64[+]
	p(F-test)	0.00	0.01	0.00	0.00
Cooperative banks	***H-statistic* (H_c)**	0.53[+]	0.25[+]	0.34[+]	0.53[+]
	p(F-test)	0.00	0.00	0.00	0.00
H_0: $H_s = H_c$	**p(F-test)**	0.01	0.90	0.70	0.02

[#] Time dummies included.
[+] Significance at 5% level.

[70] Due to the endogeneity problems for Eq. 2 and 3 already mentioned, we do not interpret their resulting *H-statistics*.

To test for significant changes over time, the sample period is again (as in Tab. 7 on p.17) split into two sub-periods. By estimating the different regression equations with interaction terms for the two periods, no significant changes over time are found for the two subperiods in the overall sample (see Tab. 16). The picture is mixed for regressions over the subsamples of cooperative, savings and credit banks (for detailed results see tables on p. 42 in the appendix). While for savings banks a statistically significant decrease can be reported, changes over time for credit banks are not significant and for cooperative banks the direction is not clear.[71]

Tab. 16 Estimation results with time interaction terms for the overall sample:[#]

		Eq. 1	Eq. 2	Eq. 3	New Eq.
1993-1995	***H-statistic* (H_1)**	0.68[+]	0.24[+]	0.28[+]	0.68[+]
	p(F-test)	0.00	0.00	0.00	0.00
1996-1998	***H-statistic* (H_2)**	0.69[+]	0.17[+]	0.19[+]	0.68[+]
	p(F-test)	0.00	0.00	0.00	0.00
H_0: $H_1 = H_2$	**p(F-test)**	0.53	0.01	0.00	0.97

[#] Time dummies included.
[+] Significance at 5% level.

IV.5 Interpretation

When checking the results from chapter III for their robustness using alternative estimation specifications, the *H-statistics* did vary to some extent in absolute terms depending on the estimation specifications. Due to the endogeneity problems encountered with the equations approximating the specifications from De Bandt and Davis (2000) and Lang (1997), the check of robustness for the overall *H-statistics* was limited to the specification by Molyneux et. al. (1994) which is also very similar to the one used by Bikker and Groeneveld (2000). However, when looking at the most important factor price elasticity of funding costs the qualitative results over all alternative specification remain basically unchanged compared to results obtained in chapter III.3.

The results for the overall sample as well as for the analyzed subsamples, generally indicate neither perfect collusion nor perfect competition. Furthermore, cooperative banks

[71] Due to the endogeneity problems for Eq. 2 and 3 already mentioned, we again do not interpret their resulting *H-statistics*.

and savings banks reached significantly lower values of the *H-statistic* than credit banks, hinting that the latter behave more competitively. However, the robustness check with an alternative specification could not support the findings of a significantly lower *H-statistic* for savings than for credit banks. At the same time the estimation results indicate significantly higher values of the *H-statistic* for savings than for cooperative banks. Changes in competitive behavior over time were not found for the overall sample of banks. For the different subsamples, though, there are indications for a small decrease in the values of the *H-statistic* for savings banks, while for cooperative and credit banks the picture is less clear.

V. Conclusions

Following the empirical results, for the period of 1993-1998 we can reject the hypotheses of perfect collusion as well as perfect competition for German banks, with values of the *H-statistic* lying, as in previous studies, clearly between zero and one. However, we also find significant differences when comparing the competitive behavior of different banking groups. While credit banks (excluding large banks) seem to operate more competitively than cooperative and savings banks (excluding their head institutions), savings banks appear to behave more competitively than cooperative banks. Regional demarcation for cooperative and savings banks might be responsible for these findings in comparison with private banks as it - at least theoretically - prevents cooperative and savings banks from competing with other banks pertaining to the same group in regional markets. Differences between savings and cooperative banks might in part be caused by the substantial size differences, since cooperative banks are on average much smaller than savings banks and serve on average highly “local” markets.

When comparing bank behavior by size, the estimations result in a decrease of the *H-statistic*s by bank size. We find the highest value for large banks, the group of small banks reaches the lowest *H-statistic* and medium-sized banks obtain a value in between. These findings support the results of earlier studies which also found higher *H-statistics* for large than for small banks, which to a certain degree contradicts the conventional wisdom that larger market shares correspond with the wielding of greater market power.

Furthermore, despite the decrease in the number of banks in Germany during the investigated period and a slight increase in concentration measures during that time, there are only very limited indications for a slightly less competitive behavior of savings banks in the second half of this time period, while for private banks no significant change is observable and for cooperative banks the direction of the small changes found were not robust over the different specifications. When looking at the sub-samples of different sized banks, no clear differences in the *H-statistics* for the two time subperiods can be identified indicating that changes over time seem to be rather banking group than size specific. Thereby, the estimation results give empirical backing to the theoretical reasons put forward in the introduction cautioning against a jump to conclusions about the development of competitive behavior from changes in crude measures of market structure.

Appendix

The *Herfindahl-Hirschman Index (HHI)* for Germany

In the context of competition, the *HHI* gained importance, when it became the basis of the formal numerical guidelines for horizontal mergers of the US Department of Justice[72] in 1982. These numerical guidelines, which were modified and revised in 1985 and 1992, also apply to the deposit market shares of banks in the affected market[73] and are supposed to simplify the application of the antitrust laws with respect to mergers. Accordingly, it is used as a screening device by regulators and constitutes one first element in the analysis of competitive effects of bank mergers.[74]

To determine the *HHI* for Germany, the individual market share per bank is calculated by the ratio of the individual bank's total assets to the sum of all German banks' total assets. As in the case of the concentration ratios, total assets are again supposed to proxy the overall bank activity.

Tab. 17 *HHI* for all of Germany based on banks' total assets

1993	1994	1995	1996	1997	1998
111	113	115	115	119	140

Source: Deutsche Bundesbank internal banking statistics, own calculations.

The figures for Germany do show an increase during the period form 1993 to 1998 which is especially strong for 1998. The absolute size of the index value, though, seems surprisingly low compared to the figures in the literature analyzing US markets. This is, however, due to the very different market definitions chosen. Whereas in US studies markets are usually defined as rather small geographic areas, we look for Germany – due to a lack of the respective regional data - at the entire national market. This implies of

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72 In the United States, the Department of Justice, the Federal Reserve System, the Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC) are in charge of the enforcement of antitrust laws in banking (s. e.g. Cetorelli (1999)).

73 The market shares of thrift institutions are only included with a weight of 50%; in the Justice Departments evaluation only with a weight of 20% (see Cetorelli (1999), p. 3, footnote 5).

74 The highest value of the *HHI* to be reached in the case of monopoly is 10,000, when the market share of a single firm is 100 percent. In the case of perfect competition the *HHI* takes on a theoretical value of zero In practice, the guidelines applied to the US banking industry presume a merger to have no anti-competitive effects, if (1) the post-merger *HHI* in a market takes on a value of less than 1,800 and (2) the resulting change in the *HHI* remains below 200. The merger application is approved if the merger does not result in a violation of these values, also referred to as the 1,800/200 rule. The rule thus serves as threshold for further investigation (see Cetorelli (1999), pp.2-3).

course that individual banks – even large banks – have a much smaller share of the overall national market than even average sized banks might have in regional markets, causing the index value to reach considerably lower levels. To complete the picture, *HHIs* are calculated on the basis of deposits and of loans; the results mirror the above figures:

Tab. 18 *HHI* for all of Germany based on banks' customer deposits, deposits incl. securitized deposits, and loans

HHI for all of Germany based on banks' customer deposits:

1993	1994	1995	1996	1997	1998
91	80	83	89	90	99

HHI for all of Germany based on banks' deposits incl. securitized deposits:

1993	1994	1995	1996	1997	1998
104	105	105	105	105	125

HHI for all of Germany based on banks' loans:

1993	1994	1995	1996	1997	1998
109	106	109	109	112	134

Source: Deutsche Bundesbank internal banking statistics, own calculations.

Concentration ratios for Germany

based on banks' customer deposits with and without securitized deposits and banks' loans to customers

Tab. 19 CR3, CR5, and CR10 for all of Germany based on banks' customer deposits:

	1993	1994	1995	1996	1997	1998
CR3	11.8 %	10.5 %	10.9 %	11.5 %	11.7 %	12.3 %
CR5	17.5 %	15.9 %	16.2 %	16.7 %	16.7 %	18.5 %
CR10	25.6 %	24.4 %	24.8 %	25.6 %	25.6 %	26.8 %

Source: Deutsche Bundesbank internal banking statistics, own calculations.

Tab. 20 CR3, CR5, and CR10 for all of Germany based on banks' deposits incl. securitized deposits:

	1993	1994	1995	1996	1997	1998
CR3	10.1 %	10.2 %	9.9 %	9,3 %	9.1 %	11.7 %
CR5	15.8 %	15.8 %	15.5 %	15.0 %	14.6 %	17.0 %
CR10	26.6 %	26.3 %	26.0 %	24.1 %	25.6 %	27.9 %

Source: Deutsche Bundesbank internal banking statistics, own calculations.

Tab. 21 CR3, CR5, and CR10 for all of Germany based on banks' loans to customers:

	1993	1994	1995	1996	1997	1998
CR3	10.7 %	10.5 %	10.5 %	10.5 %	10.6 %	13.2 %
CR5	16.7 %	16.1 %	16.1 %	16.3 %	16.6 %	18.7 %
CR10	27.0 %	26.6 %	27.3 %	25.2 %	27.3 %	29.4 %

Source: Deutsche Bundesbank internal banking statistics, own calculations.

Details of the data processing

Although the PaL data are available back until 1989 and for the BISTA back until 1992, the merged data set only includes 1993 as the earliest observation date. This is mainly because East German banks were not included in the PaL statistics prior to 1993 and also beause the reporting scheme of the PaL was changed in 1993. Therefore the merged data set comprises all reporting banks from 1993 to 1998. In a next step the data frequency was adjusted to yearly data by taking end-of-year data, i.e. December values of the monthly figures. This was done for the BISTA reporting sheets HV11 and HV21 containing the asset and liability side of the bank balance sheet (as already mentioned, the PaL data are already reported as yearly data). On the liability side observations with zero equity value were excluded (74 observations dropped). General discrepancies between institutions included in the BISTA reporting sheets and not in the PaL statistics are mainly due to the fact that banks with a truncated reporting year are excluded from the PaL accounts. Moreover, domestic branches of EC credit institutions, banks in liquidation, and building and loan associations are only included in the BISTA but not in the PaL statistics. 255 observations were thereby dropped. The remaining banks are listed in the second line of Tab. 22.

First adjustments to these data were undertaken in a general consistency check, excluding all observations where banks reported no revenues, no costs generated, no loans handed out to non-banks, no fixed assets, no deposits in general or no customer deposits. 217 observations were thereby dropped. In a next step, the data were adjusted for outliers, defined as observations lying in the lower or upper 0.1 percentiles of the revenue variables (only the ratio definitions) and the factor price variables. A total of 180 observations were excluded. An additional 68 observations were dropped due to missing values in some regression variables for business mix or demand proxies.

The further step regards the observation pattern. For the panel econometric estimations the sample should only consist of banks with at least three consecutive observations in order to take due account not only of cross section but also of time effects in the panel analysis. Therefore, first all banks with less than three remaining observations are dropped from the sample, reducing the sample by 315 banks the majority of which fall in the year 1993. Second, the remaining banks are checked for observation patterns with gaps. There are 32 banks with discontinuous observation patterns. Taken together these further adjustments

concern 347 banks and 764 observations. Including the reductions from the first step, this amounts to a reduction of the original raw data by 1,049 out of 21,074 observations which is equivalent to a reduction by around 4 percent; the reduction amounts to 414 banks out of 3,887 equivalent to a reduction by around 11 percent. The resulting data set included number of banks per year reported in the third line of Tab. 22.

Tab. 22 Number of banks reporting to the central bank and included in the estimations

	1993	1994	1995	1996	1997	1998
BISTA-reporting banks *	3,880	3,727	3,622	3,517	3,414	3,246
Banks reporting to BISTA and PaL	3,845	3,675	3,570	3,457	3,360	3,167
Banks included in the data set	3,443	3,455	3,466	3,359	3,254	3,048

* Up to the respective end of year.

List of variables

Endogenous variables:

- IINC = interest income from loans and money market transactions and from fixed interest securities debentures (GuV pos2010)
- TINC1 = interest income (GuV pos2010), current income from shares and other variable yield securities (GuV pos2022), commission income (GuV pos2040), [Net income from financial transactions (GuV pos2050)] (TINC2 for comparison to Lang (1997) without the latter)
- IINCtTA, TIN1tTA, TIN2tTA the above as ratios to total assets

Exogenous variables:

Factor prices:

- funding costs:

  IetF1 = ratio of interest expenses to sum of deposits and other liabilities
  (deposits by banks, customer accounts, and certified liabilities)

  IetF2 = ratio of interest expenses to sum of deposits and other liabilities
  ("other liabilities": interbank time and demand deposits, long term borrowing subordinated debt, participating debt, hybrid capital)

- labor costs:

  wage1 = ratio of annual personnel expenses to total assets

  wage2 = ratio of personnel expenses to sum of (customer) deposits and (customer) loans

- capital costs:

  CEtFA = ratio of capital expenses (depreciation, write-down on intangible and tangible assets) and fixed assets

- other costs:

  OEtTA = ratio of other non-interest expenses to total assets

Bank-specific variables (business mix):

- OItTA = ratio of other income to the total balance sheet (for interest revenues as endogenous variable)
- EtTA = ratio of equity to total assets
- TLtTA = ratio of total loans to total assets
- LtTL = ratio of customer loans to total loans
- LtTA = ratio of customer loans to total assets

- CLtTL = ratio of commercial loans to total loans
- IDtTD = ratio of interbank deposits to total deposits
- TDtTDMM = ratio of deposits to deposits plus money market liabilities
- TA = total assets
- lmab1t = ratio of short term loans to total loans
- cashi = ratio of sectoral cashflow to business volume weighted with sectoral weights in each banks' loan portfolio (sectoral cashflow ratios approximated by the financial statements stemming from "Jahresabschlüsse westdeutscher Unternehmen 1971-1996" (special publication of the Deutsche Bundesbank) and some internal data updates)

output: (for endogenous variable in absolute value)

- s1loans = short-term loans with a maturity of up to one year
- l1loans = long-term loans with a maturity of more than one year
- ibloans = loans and advances to banks
- fincsec = other assets similar to loans (sum of debt securities and other fixed interest securities)
- cominc =commission income

- r GDP = real GDP (as a demand shifter)
- GDPd = GDP deflator in the case of figures in nominal terms

capacity indicators:

- E = equity
- FA = fixed assets
- FACBNEA = fixed assets, cash and due from banks and other non-earning assets

Estimation Results from Chapter IV

Tab. 23 Fixed-effects estimation for <u>overall sample</u>
(robust t-values in parentheses; time-dummies included)

			Eq. 1	Eq. 2	New		Eq. 3
Endogenous variable		***ln IINCtTA***	**X**				
		ln IINC		**X**			
		ln TIN1tTA			**X**		
		ln TINC2					**X**
Exogenous variables	**factor prices**	***ln IEtF1***					0.49^{+} (17.9)
		ln IEtF2	0.58^{+} (36.2)	0.51^{+} (20.5)	0.50^{+} (32.1)		
		ln wage1	0.10^{+} (9.4)		0.17^{+} (11.9)		-0.25^{+} (-9.9)
		ln wage2		-0.19^{+} (-7.2)			
		ln CEtFA	0.005^{+} (3.6)		0.004^{+} (2.7)		0.003 (0.9)
		ln OEtTA		-0.10^{+} (-9.8)			
		H-statistic p(F-Test)	0.68^{+} (0.00)	0.21^{+} (0.00)	0.68^{+} (0.00)		0.24^{+} (0.00)
		ln TA	-0.009 (-1.4)			***ln s1loans***	0.125^{+} (8.0)
		ln E		0.559^{+} (19.4)		***ln l1loans***	0.109^{+} (4.8)
		ln FACBNEA		0.120^{+} (13.3)		***ln ibloans***	0.029^{+} (9.2)
		ln EtTA	0.044^{+} (4.6)			***ln fincsec***	0.032^{+} (10.1)
		(ln) IDtTD	0.001 (0.6)		-0.075^{+} (-2.5)	***ln cominc***	0.187^{+} (4.6)
		LtTL			0.108^{+} (10.4)	***ln rGDP***	(dropped)
		(ln) LtTA	0.058^{+} (3.6)	0.001^{+} (4.2)	0.065^{+} (2.9)	***lmab1t***	
		ln TDtTDMM		-0.399 (-1.1)	-0.003 (-1.6)	***cashi***	
		trend	-0.013^{+} (-10.9)	-0.014^{+} (-5.0)	-0.009^{+} (-7.8)		0.009^{+} (3.9)
		F-test	2785.2	398.9	6188.0		301.9
		p(Breusch-Pagan)	0.00	0.00	0.00		0.00
		R^2 within	0.89	0.60	0.87		0.72
		R^2 overall	0.78	0.98	0.79		0.98
		p(Hausmann)	0.00	0.00	0.00		1.00

Tab. 24 Main estimation results for foreign banks: (t-values below)

		Eq. 1	Eq. 2	Eq. 3	New
Factor prices	Funds	0.77+	0.70+	0.63+	0.66+
		19.6	11.1	12.4	17.5
	Labor	0.13+	-0.009	-0.24+	0.20+
		3.9	-0.15	-2.6	7.8
	Capital (Other*)	-0.034+	-0.53+	-0.025	-0.036+
		-3.0	-7.8	-0.8	-2.4
H-statistic		0.87+	0.16+	0.36+	0.83+
p(F-Test)		0.00	0.02	0.00	0.00
	R^2 *within*	0.92	0.75	0.87	0.91
	R^2 *overall*	0.96	0.58	0.56	0.85
	p(F-Test), fe	0.00	0.00	0.00	0.00

+ Significance at 5% level.

Tab. 25 Estimation results with time interaction terms for the cooperative banks*:

		Eq. 1	Eq. 2	Eq. 3	New Eq.
1993-1995	*H-statistic* (H_1)	0.51+	0.24+	0.29+	0.54+
	p(F-test)	0.00	0.00	0.00	0.00
1996-1998	*H-statistic* (H_2)	0.55+	0.25+	0.36+	0.51+
	p(F-test)	0.00	0.00	0.00	0.00
H_0: $H_1 = H_2$	p(F-test)	0.00	0.55	0.00	0.02

* Excluding cooperative central banks.
+ Significance on 5% level.

Tab. 26 Estimation results with time interaction terms for the savings banks*:

		Eq. 1	Eq. 2	Eq. 3	New Eq.
1993-1995	*H-statistic* (H_1)	0.68+	0.26+	0.36+	0.68+
	p(F-test)	0.00	0.00	0.00	0.00
1996-1998	*H-statistic* (H_2)	0.61+	0.26+	0.28+	0.59+
	p(F-test)	0.00	0.00	0.00	0.00
H_0: $H_1 = H_2$	p(F-test)	0.05	0.99	0.03	0.00

* Excluding giro central banks.
+ Significance at 5% level.

Tab. 27 Estimation results with time interaction terms for the credit banks*:

		Eq. 1	Eq. 2	Eq. 3	New Eq.
1993-1995	*H-statistic* (H_1)	0.73+	0.12	0.05	0.76+
	p(F-test)	0.00	0.12	0.44	0.00
1996-1998	*H-statistic* (H_2)	0.78+	0.01	- 0.00	0.82+.
	p(F-test)	0.00	0.90	0.99	0.00
H_0: $H_1 = H_2$	p(F-test)	0.28	0.07	0.39	0.08

* Excluding large banks.

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