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Evidence from Austria

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Abstract

The paper investigates the determinants of banking profitability and banking market conditions in Austria. We conduct a panel econometric analysis which allows for testing the hypotheses which have become the most prominent in the literature on bank profitability: the structure-conduct-performance hypothesis, the efficient-structure hypothesis and the relative-market-power hypothesis. Further, we test whether Austrian banking markets are, on average, contestable. A newly compiled dataset covering more than 700 Austrian banks ranging over the period from 1995 to 2002 is used to carry out these econometric analyses. The empirical findings support the view that the Austrian banks do exert, on average, some local market power. However, the gains in terms of excess profits are rather minor due to low deterrence powers of the incumbent banks.

JEL classification: G21, L13, L25, L44

Keywords: banking performance, banking profitability, banking market structure, panel econometrics

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1. Introduction

Modern economic analysis of the banking industry exclusively builds on the economics of industrial organization. Within the banking literature, theoretically and empirically, the structure-conduct-performance (SCP) paradigm receives the most attention. It is still the leading approach in banking analysis, though the economics of industrial organization has further been developed through the integration of the analysis of strategic behavior of firms with respect to decisions concerning both price and non-price behavior (*Goddard – Molyneux – Wilson*, 2001). New industrial organization uses extensively game theory to examine competitive behavior in situations where threats, commitments, creditability and reputation are important. So far, game-theoretic models have been used quite rarely to analyze banking behavior. As stressed by *Goddard – Molyneux – Wilson* (2001), this is mainly due to the complexity of rivalry behavior between multi-product service firms, where detailed and standardized product and price data are not readily available. Since barriers to entry are likely to be important in banking the notion of contestability has been considered to describe the competitive structure of many banking business areas just as well as, if not better than models of strategic competition between oligopolists.

Since the Austrian banking sector mainly consists of small banks servicing local markets we consider models which refer to the structure-conduct-performance paradigm or related notions such as the relative-market-power hypothesis, and to the notion of contestability as appropriate views for analyzing the determinants of banking performance in Austria. This view is also held by *Mooslechner – Schnitzer* (1994) who explored the profit-structure relationship by using a micro-database for 956 Austrian banks covering the years 1988 and 1989. However, their results drawn from cross-section as well as pooled time-series estimates turned out to be somewhat inconclusive. Unfortunately, due to a lack of reliable local and regional data their treatment of market delineation – the construction of a relevant market area for each individual bank – had to remain rather limited.

This paper is aimed at improving upon *Mooslechner – Schnitzer* (1994) by building on a more comprehensive micro-database for Austrian universal banks covering 1995 to 2002 together with a wider base of local and regional data compiled by the Austrian Institute of Economic Research (WIFO). This allows us to model more carefully the local markets environment of individual banks than in *Mooslechner – Schnitzer* (1994).

The paper is organized as follows. Section 2 outlines the structure-conduct-performance paradigm in banking and its limitations. Section 3 introduces the hypotheses to be tested: the structure-conduct-performance hypothesis, the efficient-structure hypothesis, the relative-market-power hypothesis, and the contestability hypothesis. In Section 4 the data used and the models estimated are presented. Section 5 discusses the empirical findings. Section 6 concludes.

2. The Structure-Performance Framework in Banking and its Limitations

2.1 Motivation

The predominant methodology in Industrial Economics is the structure-conduct-performance (SCP) framework (see, for example, *Waterson,* 1984). The basic idea of this framework is reflected by discussing the standard case of a monopolist maximizing profits by equating marginal cost (MC) with marginal revenue. As known, this is related to price and the elasticity of demand via the well-known condition:

(1) $$\frac{p - MC}{p} = \frac{1}{\eta},$$

where η is the own-price elasticity of demand and p the price of the good produced.

This well-known conditions says that the price-cost margin is equal to the inverse of the elasticity of demand. Obviously, this equilibrium condition becomes a causal relationship by assuming that conduct be determined by structure. In the given example, conduct was embodied in the assumption that the monopolist was able to choose output to maximize profits. Thus, causation runs from structure (monopoly) to performance. Of course, as stressed in *Waterson* (1984) the SCP paradigm had to extend beyond this simple frame in order to become the leading view in Industrial Economics.

In its simplest form, the SCP paradigm views market structure as exogenous, in the sense that it is the structural characteristics of markets that tend to influence or dictate both the conduct and, ultimately the performance of businesses. Most early empirical research based on the SCP paradigm focused on the relationship between concentration and performance measured by profitability. A positive correlation between concentration and profit was typically interpreted as evidence that firms act collusively in order to achieve high profits.

The most rigorous foundation of the SCP paradigm in banking is given in the seminal paper of *Hannan* (1991). In this paper, special emphasis is given to the roles of market concentration and market share (which are allowed to differ across the markets in which banks operate) as implied by the SCP paradigm. The structure of the model refers to that developed by *Klein*

(1971) and is held, in the interest of tractability, rather simply. Though omitting a number of aspects of bank modeling, most notably, intertemporal considerations and the treatment of risk, the model by *Hannan* (1991) allows for deriving the key results of the SCP paradigm rigorously.

In the early empirical literature, this SCP model as motivated by *Hannan* (1991) has been translated into the following specific form (see, *Frame – Kamerschen*, 1997):

$$\Pi_i = a_0 + a_1 CR_j + \sum_{j=2}^{P} a_j Z_{ij} + \varepsilon_i \quad , \tag{2}$$

where Π is an accounting measure of performance (either return on assets or return on equity) for the $i-th$ bank, CR is a measure of market structure usually proxied by either an $n-$bank concentration ratio or the Hirschman-Herfindahl index HHI for the $j-th$ local (deposit) market (the HHI for a market equals the sum of each firm's market share squared, that is, $HHI = \sum_{i=1}^{n} MS_{ij}^2$, MS_{ij} is the market share of the $i-th$ firm in the $j-th$ market), and Z_{ij} are additional explanatory variables included to control for individual bank risks and costs, as well as market demand factors. The term ε represents the usual stochastic disturbance term. Evidently, support for the hypothesis that market structure influences economic performance is found when the coefficient a_1 is, in a statistical sense, larger than zero.

2.2 Limitations

The simple SCP model has been challenged on both grounds, theoretical and empirical. A good discussion of the limitations and shortcomings of the SCP model applied to the banking industry is given, among other, in *Molyneux – Altunbas – Gardener* (1997). The criticism on the bank SCP modeling has, primarily, to be viewed against the background of a rather mixed empirical evidence questioning the robustness and significance of a positive relationship between concentration and performance in banking. The lack of consistent results have led some researchers to argue that the literature contains too many inconsistencies and contradictions to establish a satisfactory SCP relationship in banking. The defects of trying to quantify empirically the relationship between commercial bank performance and market structure are many ranging from the difficulty to define a meaningful market area and a reasonable measure of concentration under a multi-product banking regime, to the incompetence to settle on adequate standards of performance measurements in banking (see, i. e. *Mooslechner – Schnitzer*, 1994).

However, the most profound objection against the SCP paradigm has been raised by researchers associated with the 'Chicago School' such as *Demsetz* (1973) and *Brozen* (1982). Their argumentation rests on the view that an industry's structure may exist as a result of a superior efficiency in production by some firms which enables them to increase market share thus increasing market concentration. This proposition termed as the efficiency structure hypothesis (ESH) suggests that it is not collusion which leads to higher-than-normal profits but rather economies of scale and scope. In response to the ESH, *Shepherd* (1982) introduced the relative market power hypothesis $(RMPH)$ that states that only firms with large shares and well-differentiated products be able to exert market power in pricing these products and earn supernormal profits.

In a seminal paper, *Berger* (1995) proposed a substantial refinement of the ESH by identifying two efficiency explanations of the positive profit-structure linkage: the X-efficiency version of the ESH says that firms with superior management or production technology have lower costs and therefore higher profits. These firms are also assumed to gain large market shares which may result in higher concentration levels. The scale efficiency version of the ESH argues that some firms just produce at more efficient scales than others, resulting in lower unit costs and higher profits. Note that scale efficiency is not identical to scale elasticity (or economies of scale). Scale efficiency, if output-oriented, measures the change in output required to produce at minimum efficient scale, whereas scale elasticity is a measure related to the relative change in costs associated with an incremental change from a particular output level. The latter concept is usually associated with the measurement of economies of scale. Empirically, *Berger* (1995) finds support for this enhanced ESH when using an extensive U.S. dataset.

A major shortcoming of the SCP paradigm in investigation banking performance has also been considered the neglect of the risk-return preference of the bank's management. *Rhoades* (1982) rightly claims that ignoring the possibility of trading off potential profits for lower risk when a bank operates in different concentrated markets may very likely result in biased estimates of the coefficient of the concentration measure. Though neglecting risk preference aspects in the SCP paradigm is viewed as a serious defect enhancing bank SCP modeling into this direction has so far been not a very active area of research. Most empirical work in this strand of the literature is closely related to the so-called quiet-life hypothesis. This hypothesis proposes that banks with larger market power may forego some of their potential profits by choosing safer portfolios than banks with less market power. Thus, the profit rates in the monopolistic markets may not exceed those in the competitive markets but the monopoly profits may be more secure. *Heggestad* (1977) argues that the failure to find convincing evidence supporting the concentration-profitability relationship in banking as suggested by the SCP paradigm may result from greater avoidance of uncertainty by banks exercising large market power. This argument resembles very much the point already raised by *Hicks* (1935) who tartly stated that the best of all monopoly profits be the quiet life.

Likewise, little attention has also been paid to the fact that the propensity of banks with large market power to inflate operating expenses could also be a possible explanation for the failure to find empirical evidence for the concentration-profitability relationship in banking. This point was forcefully raised, among others, by *Leibenstein* (1966). In this paper, neither the 'Hicks' nor the 'Leibenstein' effect will be covered.

Conversely, more attention has been paid to the notion of contestability. According to the theory of contestability, the weak linkage between concentration and profitability in banking is mainly due to the low entry and exit barriers in local banking which forces banks to adopt competitive behavior. Contestability also implies that potential competitors could weaken any non-competitive pricing behavior through the threat of entry, thereby limiting the role of antitrust scrutiny during bank concentration, for example, through bank mergers. Of course, in modern banking the threat of new entry does no longer require the presence of bricks-and-mortar offices, because banks can easily get access to new markets through telephone and Internet banking. As put in *Goddard –Molyneux – Wilson* (2001), nowadays brand image is likely to be more important than a physical presence.

In the following sections, this and the major enhancements of the SCP paradigm will be empirically tested for the Austrian banking system based on an extended dataset of Austrian banks covering the period from 1995 to 2002.

3. Testing for Profitability and Contestability

3.1 Structure-Conduct-Performance, Efficient-Structure and Relative-Market-Power Hypothesis

As outlined above, the traditional SCP paradigm hypothesizes that, where market resources are highly concentrated, collusive behavior among banks will result in supernormal (monopoly) profits. To test this proposition two assumptions are critical: the existence of entry barriers and the correct definition of markets to evaluate market concentration. For the analysis to come, we start with assuming that both assumptions be valid. It is worth noting that the anti-contestability assumption is less serious because it can be checked empirically (we will do so in this paper). The correct delineation of markets is the more demanding challenge since the usual markets concentration measures in empirical work build on the single-product-single-market perception. Needless to state that, in practice, banks usually supply many different products and operate in many markets. In the present study as to the treatment of market delineation we follow *Mooslechner – Schnitzer* (1994) and calculate one market share per bank – derived from deposit holdings. Since less than 20 percent of the Austrian banks entertain operation units outside of the regional district where their head office is located we conclude that this very region provide a good basis for the approximation of the home or local market condition of the banks under study. The definition of a regional district (or a county) is identical with that of an Austrian administrative district, a geographic unit just below the NUTS-III level of EUROSTAT[1]). Thus, geographically a district (Bezirk) is treated as a local banking market, although the demand for banking services, as stressed by *Mooslechner –Schnitzer* (1994), without doubt is not restricted by district borders. However, we hold that the likelihood is relatively high that local banks do provide most of the services demanded by their local clientele. Accordingly, we use this market delineation notion, as proposed by *Mooslechner – Schnitzer* (1994), to form the basis for connecting bank-specific variables to relevant banking markets and allocating 'real' characteristics of these markets (districts) to individual banks.

3.1.1 Variable Definition and Data Sample

To check the proposed hypotheses we use a sample consisting of a balanced panel of annual report data of 747 Austrian banks (unfortunately, access to quarterly or monthly data was not made possible). The bank data were extracted from non-consolidated income statement and balance sheet data ranging over 1995 to 2002. The data set has been drawn from the electronic database of the Oesterreichische Nationalbank (OeNB). We will use this specific balanced dataset for all empirical tests conducted in this paper[2]). The choice of a balanced data set entails the advantage that the empirical analysis is not aggravated by cumbersome sample selection issues which might be somewhat subtle, particularly in our case. However, the balanced data set used may generate a selection bias on its own since it has not been adjusted for bank mergers. Adjusting for mergers would have cut the available sample of Austrian banks over the entire period of investigation by more than a half which we consider to be too high a price in terms of data loss. That is, the data set covers banks, not taken over by another bank since 1995, and banks that have taken over other domestic banks since 1995. Since the majority of the bank mergers in Austria took place among small

[1]) According to *Mayerhofer* (2002) the area of an Austrian administrative district is 847 square kilometers on average, and its population is roughly 87,000.

[2]) All data of this database are deflated by GDP deflator, 1995 = 100.

banks we do not expect a serious selection bias due to severe changes of market behavior of these banks as reflected in changes of business mix and business conduct. What we do expect, however, is a selection bias due to the strong leaning of balanced samples not adjusted for mergers towards overstating well performing firms (i. e., survivor effect). Descriptive statistics of the balanced panel of Austrian banks are given in the Appendix A.

In line with the respective empirical literature, we use the ratio return on assets, denoted ROA as the measure of banking profitability in the following regression analysis[3]). Further, the set of regressors consists of a measure of market concentration proxied by the Hirschman-Herfindahl index for the $i-th$ bank's local market derived from the respective deposit holdings, denoted $HHID$ and the number of branches located in the home district of the $i-th$ bank $(HHIB)$, respectively[4]). In the hypotheses tests conducted we employ the composed concentration measure $CONC$ constructed as interaction variable between $HHID$ and $HHIB$. We expect that this measure reflects the local market concentration more adequately than each index separately. Further regressors are the market share variable (MS) depicting the share of the $i-th$ bank in the local deposit market, capital-asset ratio (CAP), and the fixed cost ratio (FIX) defined as fixed capital expenses over assets.

In following *Berger* (1995), we assess the influence of three types of efficiency: the X-efficiency $(X-EFF)$, scale economies $(SCALE)$ and scale efficiency $(S-EFF)$ on banking profitability. The variable $X-EFF$ measuring managerial quality or technical efficiency is derived from a Data Envelopment Analysis (DEA) model and a Stochastic Frontier Analysis (SFA)-oriented cost function model, respectively. These models are outlined in the Appendix B and C, respectively (for further details, the reader is referred to *Hahn*, 2005). The efficiency measures $SCALE$ and $S-EFF$ are derived from respective DEA models as described in the Appendix D. A detailed description of the variables employed can be found in the Appendix E.

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3) Alternative measures of profitability, such as the ratio return on equity, do not alter the basic findings of the econometric analyses to come.

4) The HHI for a home market is defined as $HHI = \sum_{i=1}^{n} MS_{ij}^2$, MS_{ij} is the market share of the $i-th$ firm in the $j-th$ market, $j =$ deposits and branches, respectively.

3.1.2 Model and Test

The regression model used to test the $SCPH$, the ESH and the $RMPH$ has the following structure:

(3)
$$ROA_{i,t} = b_0 + b_1 CONC_{j,t} + b_2 MS_{j,t} + b_3 (X - EFF)_{i,t} + b_4 SCALE_{i,t} + b_5 (S - EFF)_{i,t} + \sum_{q=6}^{Q} b_q Z_{ij,t} + \lambda_t + \eta_i + \varepsilon_{i,t},$$

where Z_{ij} stands for the variables CAP, FIX, and for indicators proxying the (demand) characteristics of the home market of the $i-th$ bank. The λ_t and η_i are respectively unobserved time- and bank-specific effects, with time periods $t = 1,2,...,T$, and banks $i = 1,2,....,N$, and $\varepsilon_{i,t}$ is the remainder stochastic disturbance term.

As mentioned above, the home market of the $i-th$ bank is defined according to the district-based market delineation in *Mooslechner – Schnitzer* (1994). Due to lack of banking environment-related data we use district-based income level and district-based growth rate as home market indicators, denoted $BRPK$ and $WACHS$, respectively. Both, per capita income and real growth rate of the district in which the $i-th$ bank's head office is located, are applied as proxies for the local demand structure that might determine banking services supply. In so doing, we maintain that, for example, the level of income per capita, by determining the structure of demand for banking services, determine to a large extent the market conditions for banks[5]).

In accordance with the literature, we claim the findings of the econometric analysis based on equation (3) should be read as follows: the traditional structure-collusion hypothesis (i. e., SCP) is supported by the data if the coefficient on $CONC$ is positive and statistically significant ($b_1 > 0$) regardless of the sign on market share and on the direct measures of efficiency, respectively. If the coefficient on $CONC$ is negative or insignificant and the coefficient on MS is positive and statistically insignificant ($b_2 > 0$) this arguably reflects market power and supports the $RMPH$, regardless of the sign on efficiency measures. If profit is driven by productive efficiency as proposed by the ESH, the coefficients on both

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[5]) For example, as compared with low-income customers a high-income clientele is expected to show both, a higher demand for advanced banking services such as investment banking products and a higher product quality awareness. Further, high-income districts are more likely to be economically more developed than low-income regions which again results in higher demand for high-end banking products in the former and for low-end banking products in the latter.

variables, concentration $CONC$ and market share MS should become statistically insignificant when applying direct efficiency measures such as $X-EFF$, $SCALE$, and $S-EFF$.

As known, obtaining consistent estimators of the coefficients in regression models using panel data requires to cope with the so-called omitted variables problem. In the empirical literature on banking profitability, the most preferred estimation technique has long been pooled OLS. Roughly speaking, consistent estimates via pooled OLS can only be obtained if the assumption of orthogonality between the vector of observable explanatory variables $x \equiv (x_1, x_2, ... x_K)$ and the unobservable random variable c is valid, that is, $E(x'_{it} c_i) = 0$, $t = 1, 2, ...T$. However, as the ongoing discussion in the empirical literature on banking performance shows, the likelihood is quite high that this is too strong an assumption. Consequently, in order to make sure that we gain consistent and unbiased estimators for the coefficients in equation (3) both pooled OLS and the fixed effects estimation method are applied. The latter panel data estimation technique deals explicitly with the fact that omitted variables (as represented by c) may be arbitrarily related to the observable regressors x, that is, $E(x'_{it} c_i) \neq 0$. According to *Wooldridge* (2002), in many applications the whole point of using panel data is to allow for c_i to be arbitrarily correlated with the x_{it}. The fixed effects analysis provides consistent estimates of the coefficients on x_{it} in the presence of a time-constant omitted variable that can be arbitrarily related to the observables x_{it}.

When the fixed effect panel estimator is used, we add time dummy variables to account for yearly macro effects. Standard test procedures are conducted to decide whether to apply fixed effects, random effects or pooled OLS estimations. That is, the significance of the individual effects is tested by an F-test for fixed effects estimation and a Breusch-Pagan test for random effects. The Hausman specification test indicates in the case of significant individual effects the use of fixed or random effects. In so doing, we check if the fixed effects estimation, our preferred estimation model, is superior to pooled OLS and random effects estimation, respectively.

In order to evaluate the differences in bank performance between urban and more rural banks we classify the overall bank sample into three sub-groups: $HUMAN$ for banks which are located in districts belonging to Austria's human capital intensive economic regions, $PHYSICAL$ for banks which are located in districts belonging to Austria's capital intensive economic regions, and $RURAL$ for banks which are located in districts belonging to Austria's rural economic regions. This regional classification scheme is built on WIFO's 'district typology' due to *Palme* (1995)[6]. Since the regional classification due to WIFO correlates strongly with regional per capita income, both $BRPK$ and $WACHS$ are omitted from the regression analysis of the sub-groups. For further data details, we refer the reader to the Appendix E.

3.2 Contestability Hypothesis

The approach developed by *Rosse – Panzar* (1977) and *Panzar – Rosse* (1982, 1987) is based on the estimation of the reduced form revenue equation of the market participants $R*(z,r,w)$, with z denoting exogenous variables shifting the firm's revenue function, r denoting exogenous variables shifting the firm's cost function and w representing factor prices (see, for example, *Hempell*, 2002). The reduced form equation is derived from marginal revenue and cost functions and the zero profit constraint in equilibrium. At the center of this approach is the estimation of the elasticities of total revenues of the individual firm with respect to the firm's input prices which are summed up to constitute the so-called $H-statistic$:

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

Panzar – Rosse (1987) show that under certain assumptions (i. e., homothetic productions functions, exogenous factor prices) perfect competition is indicated by H equal to 1 in market equilibrium $(H=1)$. Values for H above 0 but below 1 correspond to the existence of monopolistic competition $(0<H<1)$. Values for H equal or below 0 are related to monopoly or perfectly collusive oligopoly $(H\leq 0)$.

Panzar – Rosse (1987) motivate $H=1$ by stating that in a perfectly competitive equilibrium an increase in input prices and hence in average costs should lead to a proportionate price increase and – at the firm level – to a proportionate rise in revenues, yielding $H=1$. Under a monopoly or perfectly collusive oligopoly H is negative because a rise in input prices increases marginal costs and – by setting them equal to marginal revenues – reduces

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[6]) This WIFO regional classification scheme results in 9 economic regions: metropolitan area, city, suburban, medium-sized town, intensive industrial region, intensive touristic region, extensive industrial region, touristic periphery, industrial periphery. $HUMAN$ encompasses metropolitan districts, city districts, suburban districts, and medium-sized town districts. $PHYSICAL$ encompasses intensive industrial and intensive touristic districts. $RURAL$ encompasses extensive industrial regions and the industrial and touristic periphery.

equilibrium output and the firms revenues, resulting in $H \leq 0$. Consequently, the $H-statistic$ with $0<H<1$ covers the middleground, reflecting monopolistic competition behavior.

Though this approach due to the set of strong assumptions it is based upon needs some care when applied to banking, we share the view expressed, among others, in *Hempell* (2002) that the Panzar-Rosse methodology has proved itself to be a valuable tool in getting a closer look at (bank) market behavior conditions. For a useful and competent discussion of the foundation and limitation of the Panzar-Rosse approach, particularly when applied to banking, we refer the reader to *Hempell* (2002).

3.2.1 Variable Definitions and Data Sample

Using the OeNB dataset consisting of a balanced panel of annual report data of 747 Austrian universal banks ranging over 1995 to 2002 we define total revenue over total assets $(TRTA)$ as dependent variable in the Panzar-Rosse analysis aimed at assessing the adjustment of the banks' revenues in responds to changes in cost conditions. Following the literature, the costs for labor, fixed capital and funding are proxied by personnel expenses over assets (PEA), capital expenses over assets (CEA), and interest expenses over total funds (IEF). Differences in risk are captured by the risk capital ratio due to Basel I (RCA), scale economies are depicted by total assets (TA), and differences in business mix are covered by the ratio customer loans over total assets (CLA) and the ratio interbank deposits to total deposits $(IDTD)$, respectively.

3.2.2 Model and Test

In order to estimate the $H-statistic$, we set up the following estimation equation (similar in specification to that in *Molyneux – Lloyd-Williams – Thornton*, 1994):

(5)
$$\begin{aligned}\ln TRTA_{i,t} &= a_1 + b_1 \ln PEA_{i,t} + b_2 \ln CEA_{i,t} + b_3 \ln IEF_{i,t} + c_1 \ln TA_{i,t} + c_2 \ln RCA_{i,t} \\ &+ c_3 \ln CLA_{i,t} + c_4 \ln IDTD_{i,t} + \lambda_t + \eta_i + \varepsilon_{i,t}\end{aligned},$$

with time periods $t=1,2,...,T$, and banks $i=1,2,....,N$. As indicated above, the λ_t and η_i are unobserved time- and bank-specific effects, respectively, and $\varepsilon_{i,t}$ is the remainder stochastic disturbance term.

As in the previous chapter, the above equation is estimated by both, pooled OLS and two-way error component panel regression. Again, in order to evaluate the differences in competitive behavior between urban and more rural banks we classify the overall bank sample into the three regional sub–groups $HUMAN$, $PHYSICAL$ and $RURAL$ according to WIFO's regional typology.

4. Empirical Findings

The findings based on the estimation procedures discussed are reported in Table 1. The tests show that the fixed effects regression should provide efficient estimates conditioned on the respective structures of the underlying models. Contrary to *Mooslechner – Schnitzer* (1994), on the basis of the extended dataset covering the activities of Austrian banks from 1995 to 2002 we find support for the traditional $SCPH$. Given the regional demarcation within Austria's bank groups preventing them from harshly competing each other within their group, the result is not that surprising that Austrian banks do exert, to some degree, local market power. The coefficient on $CONC$ is larger than zero and significant, at least at the 10 percent significance level, in all model specifications for both, the overall sample and the regional classification except for the economic region denoted $PHYSICAL$ (remember, this regional sub-group encompasses all districts with capital intensive production). However, the fact that the coefficient on $CONC$ is only weakly significant in the model covering local rural banks and highly significant in the model covering local urban banks indicates that the chosen market delineation may lean towards overstating the strength of the concentration-profitability linkage. We get a similarly structured support for the traditional $SCPH$ when $HHID$ and $HHIB$ enter the regression equation separately. The analysis shows very clearly that market power as measured by the market share on local deposits markets does not reflect efficiency. The coefficient on MS is negative and insignificant which, of course, indicates that the $RMPH$ is not supported by the data. The positive and significant influence of X-efficiency, derived from both DEA-oriented and SFA-oriented models, on bank profitability as measured by ROA does not interfere with the structure-collusion proposition. The positive relationship just indicates that X-efficiency exerts a direct and autonomous influence on profitability and does not affect bank performance indirectly via increased market power[7]).

[7]) The difference in coefficient estimates on $X-EFF_{DEA}$ and $X-EFF_{SFA}$, as reported in Table 1, is primarily due to a scale effect.

Table 1: Estimation results from robust fixed effects panel regression
Profit model (3)

Dependent variable: *ROA*	Coefficients	*p-values*	Coefficients	*p-values*
CONC	1.108	*0.000*	0.776	*0.050*
MS	-0.251	*0.562*	-0.287	*0.002*
$X\text{-}EFF_{DEA}$	1.053	*0.000*		
$X\text{-}EFF_{SFA}$			0.244	*0.031*
$SCALE_{DEA}$	-0.350	*0.520*	-0.309	*0.000*
$S\text{-}EFF_{DEA}$	0.412	*0.026*	0.236	*0.078*
FIX	-0.228	*0.000*	-0.302	*0.000*
CAP	0.140	*0.000*	0.093	*0.000*
BRPK	-0.561	*0.001*	-0.541	*0.744*
WACHS	-0.007	*0.429*	-0.018	*0.000*
Constant	-1.379	*0.000*	-1.951	*0.000*
$R^2_{adjusted}$	0.258		0.237	
p (F-test)	0.000		0.000	
p (Breusch-Pagan)	0.000		0.000	
p (Hausman)	0.000		0.000	
Number of banks	747		747	
Number of observations	5,976		5,976	

	HUMAN		PHYSICAL		RURAL	
	Coefficients	*p-values*	Coefficients	*p-values*	Coefficients	*p-values*
CONC	2.222	*0.000*	-1.140	*0.133*	0.924	*0.086*
MS	-0.652	*0.305*	-1.691	*0.065*	0.578	*0.425*
$X\text{-}EFF_{DEA}$	0.987	*0.000*	0.673	*0.000*	1.298	*0.000*
$SCALE_{DEA}$	-0.000	*0.579*	-0.737	*0.006*	-0.389	*0.056*
$S\text{-}EFF_{DEA}$	0.576	*0.075*	0.359	*0.357*	-0.433	*0.427*
FIX	-0.214	*0.000*	-0.331	*0.000*	-0.438	*0.000*
CAP	0.116	*0.000*	0.145	*0.000*	0.211	*0.000*
Constant	-1.748	*0.000*	0.052	*0.916*	-0.868	*0.192*
$R^2_{adjusted}$	0.354		0.316		0.159	
p (F-test)	0.000		0.000		0.000	
p (Breusch-Pagan)	0.000		0.000		0.000	
p (Hausman)	0.002		0.000		0.000	
Number of banks	243		242		262	
Number of observations	1,944		1,936		2,096	

Interestingly, the estimated coefficient on $SCALE$ is insignificant indicating that scale economies have no significant impact on bank profitability in Austria. However, some (though weak) evidence can be detected supporting the view that an increase in scale efficiency $(S-EFF)$ may enhance banking profitability. This is in line with the expectation that banks operating closer to their optimal (cost minimizing) size reap higher profits. The estimates of the coefficients on the remaining variables (CAP, FIX) meet the expectations with a positive impact of the capital ratio and a negative impact of the fixed cost ratio on banking performance, respectively. The impact of the variables $BRPK$ and $WACHS$ on banking profitability in the model specification covering the overall sample is also negative, though in the case of $WACHS$ insignificant (that is, the higher the economic development of the home market, the lower the bank profits).

The findings for the Austrian banking system based on firm-level data resemble to a large degree those gained by *Goddard – Molyneux – Wilson* (2001) for the European banking sector based on banking data from 15 European countries covering the period form 1989 to 1996. However, the explanatory power of the model estimated with the Austrian banks' dataset is significantly higher than that used by *Goddard – Molyneux – Wilson* (2001) to draw conclusions from a supranational dataset. Almost one fourth of the variation in banking profitability in Austria can be explained by the model presented as compared to 5 percent computed by *Goddard – Molyneux – Wilson* (2001) for the sample of European banks. Thus, we hesitate to concur with the concerns, put forward by researchers such as *Berger* (1995), about the capability of such models to explain variations in banking performance.

By supporting, to some degree, the collusion hypothesis, our findings are at odds with the conventional view held in Austria maintaining that the Austrian banking market is overly competitive and, thus, only allows for extremely low banking profitability. In order to empirically assess the actual competitive conditions in the Austrian banking markets we applied the so-called Panzar-Rosse methodology.

As outlined above, this approach, closely related to the New Empirical Industrial Organization literature, enables us to examine more closely the underlying nature of the structure-collusion linkage detected in the Austrian banking system. Starting with the results of the overall sample, the $H-statistic$ reaches a value of 0.68 which is consistent with monopolistic competition as the major characteristic of Austrian banks' behavior (Table 2). Since the reported $H-value$ is closer to one than to zero we conclude that the structure-collusion linkage in the Austrian banking system as established in the previous chapter is rather fragile (the hypothesis of $H=0$ was strongly rejected). According to the common tendency in this literature $H-value$ between 0.5 and 1 suggests a fairly high level of contestability indicating that entry and exit conditions are relatively free. The result obtained for Austria is in line with a broad body of research suggesting that in Europe most banking markets exhibit distinct characteristics of contestability (see, for Europe, *Molyneux –Lloyd-Williams – Thornton*, 1994, and, for Germany, *Hempell*, 2002). Since the legal framework for banking in Europe is aimed at providing a level playing field suitable to ensure a high level of competition, empirical findings like these may be read as an additional piece of evidence corroborating the view that banking profitability in Europe is low because of potential (rather than actual) competition.

Table 2: Estimation results from robust fixed effects panel regression
Contestability model (5)

Dependent variable: ln*TRTA*	Overall sample	HUMAN	PHYSICAL	RURAL
ln*PEA*	0.332	0.371	0.343	0.195
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*
ln*CEA*	0.000	0.022	-0.028	-0.000
	(0.954)	*(0.000)*	*(0.000)*	*(0.167)*
ln*IEF*	0.344	0.330	0.377	0.344
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*
H-statistic	0.676	0.732	0.692	0.539
p (F-test)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
$R^2_{adjusted}$	0.639	0.702	0.616	0.694
p (F-test)	0.000	0.000	0.000	0.000
p (Breusch-Pagan)	0.000	0.000	0.000	0.000
p (Hausman)	0.000	0.000	0.000	0.000
Number of banks	747	243	242	262
Number of observations	5,976	1,944	1,936	2,096

p-values below the H-statistic are the values for the hypothesis H = 1.

As expected, the lowest $H-statistic$ of 0.54 is obtained for the banks operating in rural markets. Rural banking markets are still strongly demarcated and primarily serviced by small cooperative banks with a traditionally low competitive disposition. Banks that are located in urban areas attain the highest $H-statistic$ of 0.73, indicating competitive conditions close to perfect (however, the hypothesis of $H=1$ was rejected).

As in most studies the costs for funds make the largest contribution to the $H-statistic$ with coefficients between 0.33 and 0.38. The lowest elasticity is estimated for the price of fixed capital, partially insignificant and partially of negative sign.

5. Concluding Remarks

In this paper an attempt was made to investigate the determinants of banking profitability in Austria. For that purpose we conducted a panel econometric analysis aimed at testing the most prominent hypotheses in the literature on bank profitability: the structure-conduct-performance hypothesis, the efficient-structure hypothesis and the relative-market-power hypothesis. Covering the activities of Austrian banks from 1995 to 2002 we found support for the traditional structure-conduct-performance hypothesis. Given the regional demarcation within Austria's banking system the result is not that surprising that Austrian banks do exert, to some degree, local market power. In addition, X-efficiency was detected to exert a positive and autonomous influence on banking performance in Austria. By supporting the collusion hypothesis, our findings are at odds with the conventional view held in Austria maintaining that the Austrian banking market is overly competitive and, thus, only allows for extremely low banking profitability. In order to empirically assess the actual competitive conditions in the Austrian banking markets we enhanced the analysis by the so-called Panzar-Rosse methodology. This approach, closely related to the New Empirical Industrial Organization literature, enables us to examine more thoroughly the underlying nature of the structure-collusion linkage detected in the Austrian banking system. The Panzar-Rosse analysis suggests that the likelihood be relatively low that the banking markets in Austria are strongly biased by perfect collusion. Likewise, we can also reject the hypothesis of perfect competition for Austrian banks. In the face of the findings obtained it appears relatively safe to maintain that the Austrian banks do exert, on average, some local market power but the gains in terms of excess profits are rather minor due to low deterrence powers of the incumbent banks.

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Appendix A: Descriptive Statistics

Table A.1: Summary statistics – Balanced sample: DEA

1995		Employee expenses	Non-interest expenses	Risk-weighted assets	Net interest revenue	Net commission revenue	Other income
	Minimum	0.01	0.02	0.66	0.01	0.00	0.00
	Maximum	538.42	301.97	28,232.48	892.29	208.77	378.07
	Mean	3.82	1.92	177.10	6.47	1.55	3.14
	Median	0.87	0.44	34.60	1.73	0.27	0.45
	Standard deviation	22.92	12.92	1,177.09	37.39	9.39	17.90
1996							
	Minimum	0.01	0.02	0.68	0.01	0.00	0.00
	Maximum	559.21	305.30	29,883.57	891.47	214.43	426.54
	Mean	3.86	2.01	186.27	6.49	1.71	3.46
	Median	0.90	0.46	35.76	1.74	0.29	0.53
	Standard deviation	23.45	13.26	1,246.74	37.20	10.11	19.70
1997							
	Minimum	0.01	0.02	0.58	0.01	-0.86	-1.18
	Maximum	543.29	281.68	32,952.66	823.65	224.41	481.82
	Mean	4.08	2.19	217.19	6.65	1.93	4.00
	Median	0.91	0.46	37.16	1.70	0.31	0.55
	Standard deviation	24.87	13.91	1,520.77	37.59	11.64	24.22
1998							
	Minimum	0.01	0.01	0.74	0.01	0.00	0.00
	Maximum	588.59	261.37	30,967.64	800.86	247.07	868.50
	Mean	4.34	2.37	229.51	6.63	2.24	5.16
	Median	0.95	0.49	38.74	1.70	0.37	0.61
	Standard deviation	26.57	14.39	1,506.82	36.78	13.12	38.10
1999							
	Minimum	0.01	0.01	0.74	0.01	0.00	-0.01
	Maximum	679.77	243.28	33,875.82	719.57	257.74	929.22
	Mean	4.53	2.45	252.45	6.50	2.52	5.53
	Median	0.95	0.52	41.02	1.70	0.43	0.70
	Standard deviation	29.06	13.93	1,643.76	33.90	13.59	39.98
2000							
	Minimum	0.01	0.02	0.69	0.02	0.00	0.00
	Maximum	698.36	351.73	38,779.44	754.33	324.60	872.49
	Mean	4.68	2.71	278.63	6.96	2.95	6.03
	Median	0.97	0.53	43.75	1.94	0.51	0.76
	Standard deviation	29.75	16.83	1,839.37	35.28	16.11	39.91
2001							
	Minimum	0.01	0.02	0.70	-1.56	0.00	0.01
	Maximum	765.78	326.14	36,570.80	764.73	292.11	1,125.82
	Mean	4.79	2.81	297.05	7.09	2.84	6.41
	Median	1.00	0.59	46.17	1.85	0.50	0.75
	Standard deviation	31.98	16.05	1,895.68	36.40	15.57	47.60
2002							
	Minimum	0.01	0.02	0.68	-0.21	0.00	0.02
	Maximum	994.87	547.49	50,383.65	1,171.29	551.09	1,011.94
	Mean	5.16	3.20	325.96	7.63	3.09	6.36
	Median	1.00	0.62	46.98	1.84	0.47	0.81
	Standard deviation	39.58	22.93	2,299.62	47.78	22.74	44.31

Source: OeNB; WIFO computations.

Table A.2: Summary statistics – Balanced sample: SFA

		VC	*Q1*	*Q2*	*Q3*	*P1*	*P2*	*P3*
1995								
	Minimum	0.45	2.03	3.12	6.85	34.23	0.027	0.043
	Maximum	1,417.93	10,591.54	8,383.61	10,054.77	122.25	0.213	1.094
	Mean	26.30	223.60	168.95	200.50	49.49	0.042	0.215
	Median	4.07	38.03	27.60	59.60	47.53	0.039	0.198
	Standard deviation	111.66	878.37	714.68	764.38	8.83	0.018	0.100
1996								
	Minimum	0.45	2.32	4.20	7.37	35.88	0.022	0.049
	Maximum	930.67	11,153.55	9,708.14	10,699.72	139.33	0.168	1.416
	Mean	23.40	236.43	174.00	208.21	50.21	0.036	0.228
	Median	3.91	39.42	26.71	60.97	48.34	0.033	0.209
	Standard deviation	90.31	918.00	762.57	796.35	8.91	0.015	0.113
1997								
	Minimum	0.47	2.27	3.50	7.77	13.58	0.020	0.047
	Maximum	2,241.53	18,610.16	19,941.07	12,113.53	101.75	0.161	0.828
	Mean	27.35	281.95	215.87	225.76	51.69	0.032	0.227
	Median	3.89	43.13	27.24	64.09	50.13	0.030	0.209
	Standard deviation	141.52	1,297.10	1,252.23	915.22	8.98	0.014	0.097
1998								
	Minimum	0.45	2.52	3.53	7.87	24.07	0.020	0.042
	Maximum	2,330.48	19,385.59	21,201.88	12,177.93	208.64	0.141	0.908
	Mean	28.67	302.45	233.50	237.19	53.29	0.031	0.236
	Median	4.00	46.50	28.95	66.30	51.08	0.028	0.215
	Standard deviation	147.32	1,366.90	1,354.43	943.09	11.99	0.012	0.105
1999								
	Minimum	0.45	2.51	3.64	8.20	31.74	0.016	0.036
	Maximum	2,214.57	19,620.98	21,056.12	12,296.05	108.00	0.149	1.054
	Mean	28.35	329.62	248.61	247.85	53.44	0.026	0.235
	Median	3.74	50.57	29.73	69.26	52.00	0.024	0.213
	Standard deviation	144.45	1,449.12	1,402.69	966.58	8.28	0.011	0.109
2000								
	Minimum	0.49	2.20	3.98	8.97	31.14	0.017	0.037
	Maximum	2,636.77	20,024.27	27,011.88	12,718.68	113.75	0.167	1.014
	Mean	34.26	355.99	284.19	251.73	53.65	0.028	0.238
	Median	4.05	53.35	29.44	68.59	52.42	0.025	0.219
	Standard deviation	175.80	1,538.33	1,742.29	969.35	8.28	0.014	0.113
2001								
	Minimum	0.54	2.24	3.74	9.87	35.57	0.017	0.049
	Maximum	2,479.39	21,202.94	26,962.61	14,815.10	124.50	0.165	1.029
	Mean	36.46	377.94	333.43	270.71	53.62	0.029	0.255
	Median	4.36	54.18	32.10	72.51	52.25	0.026	0.229
	Standard deviation	182.18	1,694.75	1,987.29	1,067.04	8.18	0.014	0.119
2002								
	Minimum	0.51	2.59	3.73	9.52	36.13	0.014	0.033
	Maximum	2,045.32	19,739.48	30,704.15	14,802.28	132.00	0.161	1.436
	Mean	32.33	385.76	347.82	277.52	53.78	0.025	0.261
	Median	4.25	57.77	34.20	74.83	52.28	0.023	0.235
	Standard deviation	151.25	1,676.44	2,073.96	1,068.43	8.43	0.015	0.132

Source: OeNB; WIFO computations.

Appendix B: The DEA-Model for Measuring X – Efficiency

A still unresolved problem in the banking performance literature is the definition and measurement of the concept of bank output and, of course, bank input. In order to get as much robust information on banking efficiency as possible we employ, within the frame of DEA, a more profit-oriented approach rather than the more production-oriented specification used in the SFA-based analysis. According to *Berger –Mester* (2003) the profit approach has the advantage to focus strongly on the ongoing changes towards higher quality services in banking and the stronger profit-orientation of the banks' management observable since the beginning of the 1990s. Thus, we specify cost components as inputs such as employee expenses, other non-interest expenses and risk-weighted assets as measured by Basel I. The latter input variable is supposed to account for a bank's financial risk exposure which might have a significant impact on relative efficiency scores. The argument is that higher financial risk exposure is likely to elevate the bank's cost of funds (see, for example, *Akhigbe – McNulty*, 2003). The output variables consist of the following revenue components: net interest revenue, net commission revenue, and other income.

In addition, we apply the intermediation approach which views financial institutions as mediators between the supply and the demand of funds. Following *Casu – Molyneux* (2003) we specify an intermediation-oriented model that consists of two outputs (total loans, other earnings) and two inputs (total costs covering interest expenses, non-interest expenses, and employee expenses, respectively, and total deposits)[8].

The DEA model proposed to compute technical efficiency $X - EFF_{DEA}$ is the input-oriented slack-based model (SBM) due to *Tone* (2001). In the most general form, the SBM has the following structure:

$$\min_{t,\lambda,s^-,s^+} \quad \tau = t - \tfrac{1}{m}\sum_{i=1}^{m}\frac{S_i^-}{x_{io}}$$

(B.1)

$$\begin{aligned} \textit{subject to} \quad & 1 = t + \tfrac{1}{s}\sum_{r=1}^{s}\frac{S_r^+}{y_{ro}} \\ & tx_o = \mathrm{X}\Lambda + S^- \\ & ty_o = \mathrm{Y}\Lambda + S^+, \end{aligned}$$

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8) Data and results of the intermediation-related model are not reported but available on request.

with $\mathrm{X} = (x_{ij}) \in \Re^{m \times n}$, $\mathrm{Y} = (y_{ij}) \in \Re^{s \times n}$ representing the set of inputs and outputs, respectively, $S^{-} = ts^{-} \geq 0,$ $S^{+} = ts^{+} \geq 0,$ $\Lambda = t\lambda,$ where t is a positive scalar variable and $\lambda \in \Re^{n}$, s^{-}, s^{+} denote the total (that is, radial and non-radial) input and output slack vectors defined as $x_o = \mathrm{X}\lambda + s^{-}$ and $y_o = \mathrm{Y}\lambda + s^{+}$, respectively[9]). Note that input-orientation requires that the scalar variable t be set equal one.

The DEA-based X-efficiency estimates are not reported here but are available on request.

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[9]) For a definition and related illustration of radial and non-radial input slack, see, for example, *Fried – Schmidt – Yaisawarng* (1999), Figure 1.

Appendix C: The SFA-Model for Measuring X–Efficiency

As already pointed out, since there is no agreement on the perfect production approach in the banking literature (because of a lack of a well-founded and generally accepted theory of intermediation) we use, within the frame of SFA, a variation of the intermediation and the production approach as proposed, among others, by *Williams* (2002) with total customer loans Q_1, other earning assets Q_2, and total customer deposits Q_3 regarded as outputs and with price of labor P_1 (staff expenses per employee), price of funding P_2 (interest expenses over total deposits) and price of fixed capital P_3 (other non-interest expenses over total fixed assets) regarded as inputs. The vector of environmental variables consists of the local market indicators used in the performance analysis covering regional economic conditions such as the income per capita and regional demographic and structure conditions. Since we employ the stochastic cost frontier approach to obtain estimates of X-efficiencies $X-EFF_{SFA}$, total costs VC are represented by the sum of staff expenses, other non-interest expenses and interest paid.

In the SFA-oriented banking efficiency literature the focus is on assessing productive efficiency via the cost function approach. Due to the duality concept the production function and cost function approach contain the same information about the production possibilities of a firm. Thus, both views generate identical efficiency estimates. Since a bank is usually a multi-product firm, the researchers' choice of a stochastic frontier cost model is a quite natural one.

The Fourier flexible functional form is applied to estimate the common cost function for the Austrian banking industry using the stochastic frontier methodology proposed by *Battese – Coelli* (1995). There is consensus that the global approximation of the Fourier-flexible form is superior to the local approximations like the commonly specified translog form (*Casu – Molyneux*, 2004).

The stochastic frontier cost function in the Fourier flexible form to be estimated has the following structure:

(C.1)

$$\begin{aligned}\ln VC = {} & \alpha_0 + \tau_1 T + 1/2\,\tau_2 T^2 + \sum_{i=1}^{3}\alpha_i \ln Q_i + \sum_{j=1}^{2}\beta_j \ln P_j + \sum_{i=1}^{3}\gamma_i T \ln Q_i + \sum_{j=1}^{2}\theta_j T \ln P_j \\ & + 1/2\left[\sum_{i=1}^{3}\sum_{j=1}^{3}\theta_{ij}\ln Q_i \ln Q_j + \sum_{i=1}^{2}\sum_{j=1}^{2}\psi_{ij}\ln P_i \ln P_j\right] + \sum_{i=1}^{3}\sum_{m=1}^{2}\eta_{im}\ln Q_i \ln P_m \\ & + \sum_{i=1}^{3}\left[a_i\cos(z_i) + b_i \sin(z_i)\right] + \sum_{i=1}^{3}\sum_{j=1}^{3}\left[a_{ij}\cos(z_i + z_j) + b_{ij}\sin(z_i + z_j)\right] \\ & + \sum_{i=1}^{3}\sum_{j\geq 1}^{3}\sum_{k\geq j, k\neq i}^{3}\left[a_{ijk}\cos(z_i + z_j + z_k) + b_{ijk}\sin(z_i + z_j + z_k)\right] + v_i + u_i\end{aligned},$$

where VC, P_1 and P_2 are normalized by P_3, T is a time trend, and the z_i are adjusted values of $\ln Q_i$ so that they span the interval $[0.1 * 2\pi, 0.9 * 2\pi]$, with $z_i = 0.2\pi - \mu\, a \ln Q_i$ where $\mu = (0.9 * 2\pi - 0.1 * 2\pi/(b-a))$ and $[a,b]$ is the range of $\ln Q_i$. The specification of z_i is due to *Gallant* (1981) who observed that the given restrictions exposed on z_i reduce the approximation problems near the endpoints. In following *Berger – Mester* (1997) and *Altunbas et al.* (2001) the Fourier terms only encompass the outputs because the input prices show very little variation. The random errors v_i are assumed to be $iid\ N(0, \sigma_v^2)$, independently distributed of the u_i. The technical inefficiency effects u_i are explained by

(C.2)

$$\begin{aligned}E[u_i] = m_i = {} & \delta_0 + \delta_1 \ln RISK_i + \delta_2 \ln BRPK_{ij} + \delta_3 WACHS_{ij} + \delta_4 \ln DICHTE_{ij} \\ & + \delta_5 \ln ALTQ_{ij} + \delta_6 \ln ALQ_{ij} + E[w_i]\end{aligned},$$

where i stand for the $i-th$ bank and j for the district, the $i-th$ bank is located. The variable $RISK$ is the $i-th$ bank's credit risk, $BRPK$ is income per capita of the home district of the $i-th$ bank, $WACHS$ is the economic growth rate of the home district of the $i-th$ bank, $DICHTE$ the population density of the home district of the $i-th$ bank, $ALTQ$ the share of population older than 65 in total population of the home district of the $i-th$ bank, and ALQ is the unemployment rate of the home district of the $i-th$ bank. The random variable w_i is defined by the truncation of the normal distribution $N(0, \sigma_w^2)$, such that the point of truncation is $-\left(\delta_0 + \sum_{j=1}^{M}\delta_j h_{j,it}\right)$. This assumption allows u_i being a non-negative truncation of the $N\left(m_{it} = \delta_0 + \sum_{j=1}^{M}\delta_j h_{j,it}, \sigma_u^2\right)$-distribution as requested by the Battese-Coelli estimation procedure.

As indicated above, we assume that the cost function is linearly homogenous in input prices which is achieved by scaling the dependent variable and the input prices by the price of fixed capital and by imposing the following standard restrictions on equation:

(C.3)

$$\theta_{ij} = \theta_{ji}, \qquad \psi_{ij} = \psi_{ji}, \qquad (i = 1,2,3), \qquad (j = 1,2)$$

$$\sum_{j=1}^{2} \beta_j = 1, \qquad \sum_{j=1}^{2} \psi_{ij} = 0, \qquad \sum_{m=1}^{2} \eta_{im} = 0.$$

As emphasized by *Girardone – Molyneux – Gardener* (2004) and others, in the efficiency literature the consideration of input share equations comprising Shepherd's Lemma restrictions is excluded in order to allow for the possibility of allocative inefficiency.

The parameters of the stochastic frontier cost function represented by equation $(C.1)$ and $(C.2)$ are estimated by applying Maximum-Likelihood estimation as suggested by *Battese – Coelli* (1995). The estimation was carried out using the software package FRONTIER 4.1 (*Coelli*, 1996).

The SFA-based X - efficiency estimates are not reported here but available on request.

At this point of the empirical analysis, it is worth noting that in the applied banking efficiency literature the cost function approach is frequently used to estimate the extent of scale economies based on the elasticity of total cost with respect to output. Economies, diseconomies and constant return-to-scale are assumed to exist if the elasticity estimate is less than one, greater than one, or equal to one, respectively. That is, scale-elasticities are estimated by summing the partial derivatives of the cost function with respect to each output according to the following expression:

(C.4) $$SCALE_{SFA} = \sum_{i=1}^{n} \frac{\partial \ln VC}{\partial \ln Q_i}.$$

The degree of scale economies based on equation $(C.4)$ is usually computed for bank size groups (i.e., small, medium, large) using the mean data level of the respective variables for each bank group. Estimating the degree of scale economies at the firm level using $SCALE$ as computed by equation $(C.4)$ often generates counterproductive results. As noted above, in this paper we evaluate the scale elasticities under the multiple-input-multiple-output framework of DEA which generates meaningful estimates of the degree of scale economies for each single bank under study.

Likewise, the cost function approach is also used to test for the existence of economies of scope at the level of bank groups. According to *Baumol – Panzar – Willig* (1988) a sufficient condition for overall economies of scope is the presence of cost complementarities between outputs. Cost complementarities (and hence the existence of scope economies) implies that the following relation holds:

(C.5) $$\frac{\partial^2 VC}{\partial Q_i \partial Q_j} < 0 \quad for\ i \neq j$$

However, the test for cost complementarities is a local test and in the case of translog cost functions it is impossible to have cost complementarities at every point in time (i.e., *Berger – Hanweck – Humphry,* 1987). Thus, in the empirical literature a more appropriate test due to *Willig* (1979) is applied to identify the existence of scope economies. *Willig* (1979) suggests that scope economies $SCOPE$ be measured as follows:

(C.6) $$SCOPE_{SFA} = \frac{VC(Q_1,0,..,0) + VC(0,Q_2,0,..,0) + ... + VC(0,...,0,Q_n) - VC(Q_1,Q_2...,Q_n)}{VC(Q_1,Q_2...,Q_n)}$$

Overall economies (diseconomies) of scope are indicated by $SCOPE > 0$ $(SCOPE < 0)$.

In this study, contrary to the usance in the respective literature, we refrain from calculating an indicator of economies of scope altogether since we consider the available data based on balance sheets and income statements as not appropriate to compute $SCOPE$ or related measures of scope economies. In the view taken in this paper, product differentiation must be more articulate than usually provided by balance sheets and income statements in order to yield reliable and meaningful scope measurements in banking.

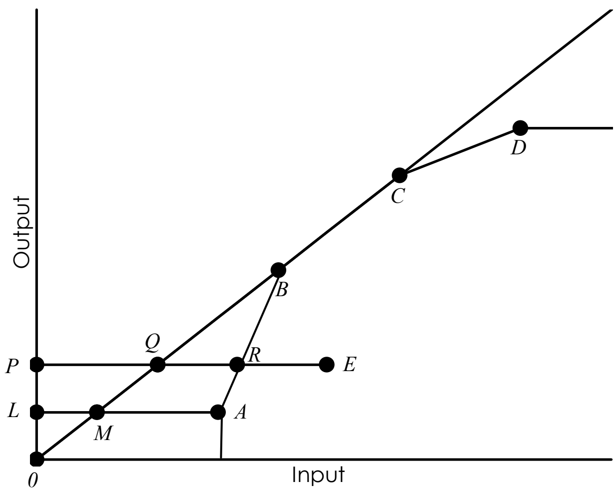
Appendix D: Scale Efficiency and Scale Elasticity

In the DEA methodology there is a natural way to decompose technical inefficiency into scale efficiency and into, what is termed in the DEA literature, 'local' technical efficiency. Formally, scale efficiency for a firm is obtained by conducting both a DEA-based on a 'constant return-to-scale' technology (CRS) yielding global (technical) efficiency scores and a DEA-based on a 'variable return-to-scale' technology (VRS) yielding local (technical) efficiency scores (*Cooper – Seiford – Tone*, 2000). A difference in the CRS and the VRS scores for a particular firm indicates that this firm has scale inefficiency. Let the CRS and VRS scores of a DMU be $X-EFF_{CRS}$ and $X-EFF_{VRS}$, respectively, the scale efficiency $S-EFF_{DEA}$ is defined by the ratio:

(D.1) $$S-EFF_{DEA}=\frac{X-EFF_{CRS}}{X-EFF_{VRS}}$$

It is easy to show that $S-EFF_{DEA}$ is bounded by zero and one. In the one-input-one-output frame, the scale efficiency can be illustrated by Figure D.1 (see, i. e., *Cooper – Seiford –Tone*, 2000).

Figure D.1: Scale efficiency due to DEA



Source: *Cooper – Seiford – Tone* (2000).

For example, the scale efficiency for the CRS efficient firm A is given by $S-EFF(A)=LM/LA<1$, indicating that firm A is operating locally efficient ('pure' technical efficiency is one) but faces technical inefficiency caused by scale inefficiency defined by LM/LA. That is, input-oriented $S-EFF$ measures the change in input required to produce at minimum-efficient scale. We use the relation $(D.1)$ to compute scale efficiency scores for the Austrian banks as covered by the balanced sample ranging from 1995 to 2002.

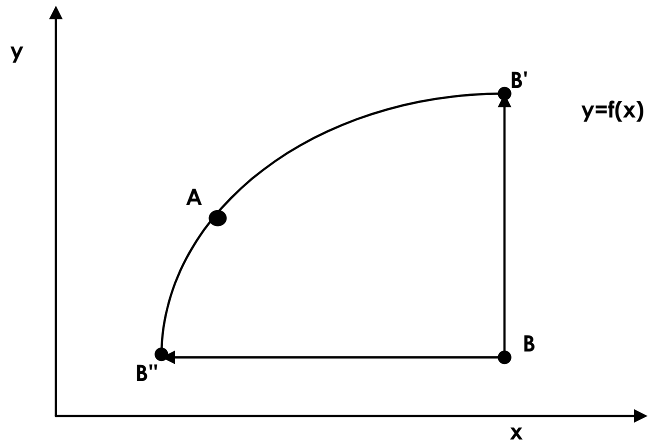
The DEA methodology can also be used to derive measures for scale elasticities, denoted $SCALE_{DEA}$. *Tone – Sahoo* (2005) propose a model that evaluates scale elasticity of production in multiple input/output environments. Scale elasticity is defined as the ratio of marginal product (MP) to average product (AP), and is also called 'degree of scale elasticity' (DSE). This concept is due to *Baumol – Panzar – Willig* (1988) where DSE is discussed in terms of cost and output. *Tone – Sahoo* (2005) apply this concept to a DEA framework with multiple inputs and multiple outputs.

Although the VRS model estimates the returns-to-scale qualitatively, the model by *Tone – Sahoo* (2005) does the same function quantitatively. In a single input-output case, if the output y is produced by the input x, $SCALE_{DEA}$ is defined by:

(D.2) $$SCALE_{DEA} = \mathrm{MP}/\mathrm{AP} = \frac{dy}{dx} \bigg/ \frac{y}{x}.$$

Figure D.2 exhibits a sample curve $y = f(x)$ to demonstrate scale elasticity in production. Scale elasticity is well-defined at a point on the efficient portion of the input-output correspondence, e. g., the point A. For an inefficient DMU operating on a point such as B, input-oriented $SCALE$ is defined on its horizontally projected point B'', while output-orientation calls for upward projection (B').

Figure D.2: Scale Elasticity due to DEA



Source: *Tone – Sahoo* (2005).

We use the model by *Tone – Sahoo* (2005) to compute $SCALE_{DEA}$ for the Austrian banks on the basis of the balanced bank sample ranging from 1995 to 2002. For the computation of input-oriented $S-EFF_{DEA}$ and $SCALE_{DEA}$, respectively we use the software package DEA-Solver-PRO 4.0. Estimations are based on both, the profit-oriented model and the intermediation-oriented model. In the text only the results for the profit-oriented model are reviewed. The estimates for both efficiency measures, $S-EFF_{DEA}$ and $SCALE_{DEA}$ for each year are available on request.

Appendix E: Variables and Definitions

Symbol	Variable	Definition
ALQ	Unemployment rate	Unemployed as % of total labor force in the j-th district
ALTQ	Older population ratio	65 and older as a percentage of total population in the j-th district, 2001
BRPK	Per capita income	Regional GDP per capita in the j-th district, 1995 real term
CAP	Capital ratio	Equity over balance sheet total of the i-th bank
CEA	Costs of fixed capital	Capital expenses over balance sheet total of the i-th bank
CLA	Loan ratio	Customer loans over balance sheet total of the i-th bank
CONC	Concentration	HHID times HHIB
DICHTE	Population density	Population per km2 in the j-th district, 2001
FIX	Fixed costs ratio	Capital expenses over balance sheet total of the i-th bank
HHIB	Branch concentration ratio	Hirschman-Herfindahl index for the i-th bank's j-th local market, based on ranches
HHID	Deposit concentration ratio	Hirschman-Herfindahl index for the i-th bank's j-th local market, based on deposits
HUMAN	Human capital intensive regions	PALME0 plus PALME1 plus PALME2 plus PALME3
IDTD	Interbank deposits ratio	Interbank deposits over total deposits of th i-th bank
IEF	Interest expenses ratio	Interest expenses over total funds of the i-th bank
MS	Market share	Share of the i-th bank's deposit in deposits of all banks in the j-th district
P1	Price of labor	Staff expenses per employee of the i-th bank
P2	Price of funding	Interest expenses over total deposits of the i-th bank
P3	Price of fixed capital	Other non-interest expenses over total fixed assets of the i-th bank
PEA	Costs of labor	Staff expenses over balance sheet total of the i-th bank
PHYSICAL	Physical capital intensive regions	PALME4 plus PALME5
Q1	Loans	Total customer loans of the i-th bank, 1995 real terms
Q2	Securities	Other earning assets of the i-th bank, 1995 real terms
Q3	Deposits	Total customer deposits of the i-th bank, 1995 real terms
RCA	Risk capital ratio	Risk-weighted capital ratio of the i-th bank due to Basel I
RISK	Credit risks	Credit risks of the i-th bank, 1995 real terms
ROA	Return on assets	Profit after tax over balance sheet total of the i-th bank
RURAL	Rural regions	PALME6 plus PALME8 plus PALME9
$SCALE_{DEA}$	Scale elasticity	DEA-based scale elasticity due to *Tone – Sahoo* (2005)
$S\text{-}EFF_{DEA}$	Scale efficiency	DEA-based scale efficiency
TA	Total assets	Balance sheet total of the i-th bank, 1995 real terms

TRTA	Revenue ratio	Total revenue over balance sheet total of the i-th bank
VC	Total costs	Staff expenses plus interest expenses plus other non-interest expenses of the i-th bank, 1995 real terms
WACHS	Regional growth rate	Real growth rate of the j-th district's GDP
$X\text{-}EFF_{DEA}$	Technical efficiency	Gross technical efficiency scores due to DEA of the i-th bank
$X\text{-}EFF^{Ratio}$	Net-gross efficiency ratio efficiency scores	Net technical efficiency scores divided by gross technical
$X\text{-}EFF_{SFA}$	Technical efficiency	Gross technical efficiency scores due to SFA of the i-th bank

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