The structure–performance relationship for European banking

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Abstract

The relationship between market structure and performance has been studied extensively for American banking. In contrast, little work has been done to investigate this relationship for European banking. Two explanations of a positive correlation between profitability and concentration have been advanced the traditional structure-performance hypothesis (SCP) and the efficient-structure hypothesis. Previous empirical tests of the alternative hypotheses have yielded mixed results but the tests were not robust because they did not incorporate measures of efficiency directly in the model. This study applies a stochastic cost frontier as proposed by Aigner et al. (1977) to derive measures of X-inefficiency and scale-inefficiency, under the assumption that the errors are distributed half-normal. We incorporate these measures of inefficiencies directly into the tests as proposed by Berger and Hannan (1993). We do not find a positive and significant relationship between concentration and profitability for a sample of banks across 11 European countries over a four year period, 1988-91. However, we do find evidence to support one of the two versions of the efficient-structure hypothesis for banks located in countries with low concentration of banks. Since little support is found for either of the SCP hypotheses, a simple policy of strict limitations on cross-border acquisitions and growth is not warranted.

JEL classification: G21

Keywords: Structure-performance hypothesis; Efficient-structure hypothesis; European banking; Concentration; Profitability

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1. Introduction

The structure-performance relationship has been extensively examined for American banking but research has only just begun to investigate this relationship for European banks. The positive relationship which is frequently found between market concentration and profitability for American banks has been interpreted in different ways. One interpretation, the structure-conduct-performance (SCP) hypothesis, asserts that banks are able to extract monopolistic rents in concentrated markets by their ability to offer lower deposit rates and charge higher loan rates. This hypothesis is derived from the model of oligopolistic behavior of firms which implies that collusive arrangements are less costly to maintain in concentrated markets (Stigler, 1964). Empirically, the SCP relationship is usually tested by examining the relationship between profitability and market concentration with a positive relationship indicating non-competitive behavior in concentrated markets.

A second interpretation, the efficient-structure (EFS) hypothesis, states that efficient firms increase in size and market share because of their ability to generate higher profits, which usually leads to higher market concentration. Thus, the positive relationship between profits and concentration is explained by lower costs achieved through either superior management or production processes. To distinguish between the two hypotheses, past researchers have included market share as an independent variable, with a positive coefficient usually supporting the efficient-structure hypothesis (Smirlock, 1985). However, this conclusion depends on whether market share can be considered as a proxy for efficiency of larger firms rather than as a measure of market power (Shepherd, 1986).

An obvious solution to this problem is to include a measure of efficiency directly into the model. Berger (1995) and Berger and Hannan (1993) formulated such a model by including two measures of efficiency, X-efficiency and scale-efficiency, to test the structure-performance relationship. An advantage of this model is that by testing the relationship between performance and efficiency directly, the relationship between performance and concentration has a clear-cut interpretation.

This paper uses the test developed in Berger and Hannan (1993) to examine the relationship between concentration and performance for European banks. The issue is specially important today because the Second Banking Directive now allows banks chartered in one country to open branches in other EC countries. Although there is general agreement that the recent liberalization will result in cross-border mergers and alliances, especially between large banks such as in the Dresdner-BNP alliance, it is still unclear whether the banking industry in Europe will eventually be dominated by a few supra-national banks. The nature of the structure-performance relationship must be uncovered in order for the EC and European governments to determine whether to strengthen or weaken existing antitrust laws. If the SCP hypothesis is supported for European banking, then regulators may have to be more cautious in approving cross-border mergers,
especially among the larger banks. On the other hand, if the alternative EFS is supported, no application of antitrust measures is required.

The next section surveys the previous attempts to test the structure-performance relationship in banking, including the limited research on European banks. The Berger and Hannan (1993) model, which incorporates efficiency directly in the tests, is discussed in Section 3. Section 4 discusses the data and defines the explanatory variables, including the efficiency variables. Unlike Berger and Hannan (1993), who use deviations from the average residual over a time horizon to estimate measures of efficiency, this paper first estimates deviations from a stochastic cost frontier, as developed by Aigner et al. (1977), which assumes the errors are distributed half-normal. The error terms are then used to obtain measures of X-inefficiency for each bank, using the method proposed by Jondrow et al. (1982). The stochastic cost frontier is also used to obtain measures of scale-inefficiency. Section 5 presents the results of the tests using the derived inefficiency variables. Section 6 summarizes and presents the implications of the results for European banking in its new regulatory environment.

2. Previous literature

The bulk of the studies examining bank performance and market concentration have been on U.S. banking markets. In contrast to the national markets used in industrial studies, banking markets that are examined for U.S. studies are generally local markets which service individuals and small businesses. The banking studies have not found a positive relationship between concentration and profitability as consistently as has been found in the inter-industry studies. Although Rhoades (1982) concluded that most of the previous studies found a positive relationship, Gilbert (1984), in a survey article, finds only 27 of 56 studies to have produced the expected relationship. Osborne and Wendel (1982) also conclude that problems with past studies are so great that there is insufficient evidence of a positive relationship.

The main problem has been the interpretation of the positive relationship between profitability and concentration (when it can be found), and whether it supports the SCP or EFS hypothesis. Several methods have been proposed to resolve this issue. For example, Smirlock (1985) models bank profitability as a function of market share, concentration, and an interaction term between market share and concentration (as well as several control variables). He finds that market share is positively related to profitability while there is no relationship between concentration and profitability, and concludes that this provides evidence in favor of the efficient-structure hypothesis. As mentioned earlier, Shepherd (1986) questions this conclusion because it assumes that market share is a proxy for efficiency of larger firms rather than a measure of market power. ¹ Berger and Hannan (1989) try to provide a cleaner test by using price data

¹ See Smirlock et al. (1986) for a conflicting view on this issue.
rather than profit data as the dependent variable. Since the SCP hypothesis implies that consumers will be treated less favorably in more concentrated markets, they examine whether retail deposit rates are negatively related to market concentration. They find evidence to support the traditional SCP hypothesis. Even though they question the appropriateness of including market share in their model because of its endogeneity, market share does have a positive coefficient when included in the model. The authors say that this result may be due to firms providing different levels of quality of service or to offering higher deposit rates, allowing banks to increase their market share. However, the coefficient of concentration still remains negative.

Jackson (1992) questions whether these results validate the traditional hypothesis by dividing the sample into three ranges of concentration. He finds that the sign and significance of the coefficient of concentration differ by sub-sample, suggesting a non-linear relationship between concentration and price. Only for the lowest concentration sub-sample does he find the negative relationship between deposit rates and profitability needed to validate the traditional hypothesis. He asserts that these results support the efficient-structure hypothesis by arguing that levels of concentration signal an optimal structure. Jackson's (1992) results also contradict an earlier study by McCall and Peterson (1980) who find the relationship holds in high concentration rather than in low concentration markets. Berger and Hannan (1992) in a reply find that some of Jackson's results are not robust, but they do agree that the relationship varies for different concentration levels and for different time periods. Consequently, our study of European banks examines the time period 1988-91, and splits the banks into two sub-samples, high concentration and low concentration.

Studies using international databases are limited with the majority supporting the SCP hypothesis. Ruthenberg (1994), using survey data from 1984-88, finds concentration increases profitability, especially if barriers to entry are high. Molyneux and Teppet (1993) examined the SCP hypothesis for 5 EFTA countries (Sweden, Norway, Finland, Austria and Switzerland) and find support for the SCP hypothesis. Molyneux (1993) also finds similar results for banks located in Portugal, Spain, Sweden, UK and Turkey. Lloyd-Williams et al. (1994) also find support for the SCP hypothesis for Spanish banks for the period 1986-88. Except for Vander Vennet (1993), none of the above papers incorporates efficiency measures directly in the model. Vander Vennet's (1993) results indicate that in some European countries, Belgium, Ireland, Portugal and Spain, collusion appears to be predominant. This paper incorporates two measures of efficiency into the model, X-inefficiency and scale-inefficiency. But unlike Berger and Hannan (1993) who use deviations from the average cost frontier to represent measures of inefficiency, this
paper estimates X-inefficiency using a stochastic cost frontier under the assumption that the error terms are distributed half-normal. As will be explained later, in empirical testing it is more convenient to substitute estimates of inefficiency as opposed to estimates of efficiency. Similarly, scale-inefficiency is also derived from the parameters of the estimated stochastic cost function. An advantage of this method is that X-inefficiency is strictly defined as the systematic deviation away from an efficient cost frontier which is not fixed but varies for each bank.

3. The Berger and Hannan (1993) model

Berger and Hannan (1993) develop a series of tests to incorporate efficiency directly into the model to resolve the conflict between SCP and EFS hypotheses.\(^2\) Four testable hypotheses are specified (instead of the usual two), SCP, RMP, ESX and ESS. The traditional SCP hypothesis remains unchanged, i.e. higher profits are the result of anti-competitive price settings in concentrated markets. A related hypothesis is the relative market power hypothesis (RMP) which states that firms with large market shares are able to exercise market power to earn higher profits. The difference between SCP and RMP is that the latter need not occur in concentrated markets.

The remaining two hypotheses relate to the efficient-structure hypothesis which posits that the larger market share is the result of efficient operations of the firms. Efficiency, however, is broken into two components. Under the X-efficiency hypothesis (ESX), the firms with superior management or production processes operate at lower costs and subsequently reap higher profits. The resulting higher market shares may also lead to higher market concentration. The scale-efficiency hypothesis (ESS) states that firms have similar production and management technology but operate at different levels of economies of scale. Firms operating at optimal economies of scale will have the lowest costs and the resulting higher profits will lead to higher market concentrations. Both versions of the efficient-structure hypothesis provide an alternative explanation for the positive relationship between profit and market structure.

To determine which of the four hypotheses is valid, the following reduced form equation is tested:\(^3\)

\[ P_i = f(X \text{- EFF}_i, S \text{- EFF}_i, \text{CONC}_m, \text{MS}_i, Z_i) + e_i \]  

where \(P_i\) is a measure of performance such as return on equity, return on assets or

\(^2\) Their model is a revised version of the model developed by Berger (1995).

\(^3\) The readers are referred to Berger and Hannan (1993) and Berger (1995) for a complete description of the derivation of the models.
net interest margin of bank \( i \),\(^4\) X-EFF\(_i\) is a measure of X-efficiency, reflecting the ability of banks to produce a given bundle of output at minimum cost through superior management or technology, S-EFF\(_i\) is a measure of scale-efficiency, reflecting the ability of banks to produce at optimal output levels (economies of scale), given similar production and management technology, CONC. is a measure of concentration in market \( m \), MS\(_i\) is market share of bank \( i \) in market \( m \), \( Z_i \) is a set of control variables for each bank \( i \), and \( e_i \) is an error variable for each bank \( i \).

Under the efficient-structure hypothesis, causation is expected to run from efficiency to profits and prices and then to market structure. Hence, the expected signs of the coefficients in the estimation of Eq. (1) are as follows: X-EFF\(_i\) > 0, S-EFF\(_i\) > 0, CONC = 0 and MS = 0. More efficient firms will have higher profits and the signs of the coefficients of X-EFF, and S-EFFI should be positive. If net interest margin is used as the measure of performance, the signs of the efficiency measures should be negative because more efficient banks should be able to offer more attractive loan and deposit rates to customers. In spite of the competitive interest margins, banks will still generate larger profits than those that are operating inefficiently. Although efficiency leads to higher market shares and market concentration, the zero coefficients indicate that market structure has no direct effect on prices and profits. By using a model which incorporates efficiency directly, we assume the following: prices are set competitively and efficiency is a function of strictly lower costs and banks operating at efficient scale levels; and market structure variables CONC and MS have no relationship with profits \textit{conditional} on efficiency (Berger and Hannan, 1993).

A necessary condition for the efficient-structure hypothesis to hold is that efficiency affects market structure. The following two equations are also tested to ensure that the necessary conditions hold:\(^5\)

\[
\begin{align*}
\text{MS}_i &= f(X\text{-EFF}_i, S\text{-EFF}_i, Z_i) + e_i \\
\text{CONC}_m &= f(X\text{-EFF}_i, S\text{-EFF}_i, Z_i) + e_i 
\end{align*}
\]

The unconditional relationship between market structure and efficiency will establish that efficient firms will gain market shares and will also be responsible for higher market concentration. Thus, the coefficients of X-EFF\(_i\) and S-EFF\(_i\), should be positive in Eqs. (2) and (3). In essence, the efficient-structure hypothesis

\(^4\) Berger (1995) and Berger and Hannan (1993) also used individual price data to supplement their results which we omit because, as will be explained later, we use net interest margin as a proxy for the ability of banks to affect prices.

\(^5\) Berger and Hannan (1993) specify the second equation as CONC\(_m\) = \( f(\text{EFF-X}_i, \text{EFF-S}_i, Z_i, e_i) \), with the error term multiplicative rather than additive. This is because if the Herfmdahl Index is used as a measure of concentration, then CONC. will be the sum of squared MS\(_i\), over all \( i \) in \( m \). We ignore this specification because in the empirical testing, the results using CR3 and HERF are similar, making the specification of the error term irrelevant.
is strictly valid if it can be established that more efficient firms are profitable [Eq. (1)] and more efficient firms will have larger market shares [Eqs. (2) and (3)].

On the other hand, if either of the market power hypotheses holds true, i.e. SCP or RMP, then the expected signs of the coefficients for Eq. (1) are: CONC > 0 or MS > 0. The CONC variable has a positive coefficient if the SCP holds and MS is positive if the RW hypothesis holds. Thus, the difference between the SCP and RMP is that in the case of the latter, anti-competitive advantages due to size can exist even in markets that are not concentrated.

Additional relationships are tested to support the market power hypothesis:

\[ X\text{-EFF}_i = f(CONC_m, MS_i, Z_i) + e_i \]  
\[ S\text{-EFF}_i = f(CONC_m, MS_i, Z_i) + e_i \]

Berger and Hannan (1993) refer to these conditions as testing Hicks (1935) 'quiet life' hypothesis. This hypothesis predicts a reverse causation, that is, as firms enjoy greater market power and concentration, inefficiency follows not because of non-competitive pricing but more so because of a relaxed environment that produces no incentives to minimize costs. An example would be in small concentrated rural markets where price competition still exists because of spatial competition but where cost efficiency is unimportant.

This paper applies the above methodology to test the structure-performance paradigm for European banks over a four-year period. It differs from the Berger and Hannan (1993) methodology in that it uses different measures of X-efficiencies and scale-efficiencies. The efficiency measures in this paper are derived from a stochastic cost frontier as developed by Aigner et al. (1977), which assumes that the error terms are distributed half-normal. This is the first paper to test the structure-performance paradigm using such efficiency measures for European banks. The results will be compared to the conclusions reached by other researchers such as Molyneux (1993), Molyneux and Teppet (1993) and Vander Vennet (1993).

4. Data and variables

The dearth of SCP studies for European banking may partially be explained by the non-availability of data for most of the countries. This trend has changed with the advent of several new international databases. This study uses Compustat's Global Vantage database, which contains data for the largest banks in Europe. Differences in accounting practices and flexibility in reporting makes comparison a difficult task but Global Vantage has managed to standardize most of the relevant data.

The paper only examines the large banks in each country. Since the European banking industry is dominated by large banks with branching networks spread
across the country, it is unlikely that individual branches have the ability to significantly affect any prices, either loan or deposit rates. Within a country, it is more likely for the corporate headquarters to determine the pricing and cost strategies for the whole country, which are heavily influenced by the bank's ability to borrow long- and short-term funds in the wholesale market. Thus, we rule out using data of individual bank branches or very small banks. Secondly, since the regulatory authorities are concerned with the effects of market concentration on consumer welfare, mergers between the large banks are of primary concern to them. With the EC having substantial power to make policies to curtail cross-country merger activities, evidence supporting the SCP will buttress antitrust sentiment against acquisitions by large banks.

A brief description of the variables are given below while a more complete description is provided in Appendix A. Appendix B provides a list of the names of banks included in the 1990 data. The sample of banks differs slightly for the other years.

4. 1. Measures of performance

Four measures of performance are used: ROA = Net Income/Total Assets, ROE = Net Income/Stockholder's Equity, NIM = Net Interest Margin/Total Assets, and NIR = \((1 + ROA)/(1 + NIM)\). ROA and ROE have been used in most structure-performance studies but this paper also includes NIM as a proxy for the pricing ability of banks. Berger and Hannan (1989) have argued that if the SCP hypothesis reflects anti-competitive pricing, then banks will be able to charge lower deposit rates and/or charge higher loan rates. However, examining either deposit rates or loan rates separately may not present the full picture because banks could operate competitively with one rate and behave non-competitively with the other. Thus, net interest margin captures the pricing ability of banks for both services, deposits and loans. If banks are able to price their products anti-competitively, then net interest margin will be higher because it indicates an ability to charge lower deposit rates and higher loan rates. Note that we do not have access to rate information by bank. Thus, NIM provides a measure of their pricing ability while ROA and ROE include the ability to generate fees through other services. NIR is a measure of non-interest returns.

4.2. Measures of concentration

Two popular measures of concentration, the three-bank concentration ratio, CR3, and the Herfindahl Index (HERF), are also employed in this paper. CR3 is defined as the ratio of the total deposits of the three largest banks to the total deposits of all the banks in a given country. Similarly, HERF is defined as the sum of squared market shares of deposits of all the banks in each country. In analyzing market structure we consider each country to be a market as in Molyneux (1993).
Table I
Measures of market concentration of commercial and savings banks for 11 European countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Commercial banks only</th>
<th>Commercial + savings banks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>CR3</td>
</tr>
<tr>
<td>UK</td>
<td>68</td>
<td>0.60</td>
</tr>
<tr>
<td>Germany</td>
<td>121</td>
<td>0.31</td>
</tr>
<tr>
<td>France</td>
<td>119</td>
<td>0.51</td>
</tr>
<tr>
<td>Swiss</td>
<td>118</td>
<td>0.63</td>
</tr>
<tr>
<td>Belgium</td>
<td>35</td>
<td>0.71</td>
</tr>
<tr>
<td>Finland</td>
<td>7</td>
<td>0.91</td>
</tr>
<tr>
<td>Austria</td>
<td>39</td>
<td>0.49</td>
</tr>
<tr>
<td>Italy</td>
<td>41</td>
<td>0.33</td>
</tr>
<tr>
<td>Sweden</td>
<td>5</td>
<td>0.70</td>
</tr>
<tr>
<td>Denmark</td>
<td>26</td>
<td>0.85</td>
</tr>
<tr>
<td>Spain</td>
<td>59</td>
<td>0.45</td>
</tr>
</tbody>
</table>

CR3 = three-bank concentration ratio. HERF = Herfindahl Index, defined as the sum of the squares of market shares of total deposits. 'Commercial banks only' includes foreign commercial banks. Year = 1990 (estimates for 1988, 1989 and 1991 were qualitatively similar to 1990). Source: Sheshunoff's Information Service.

Cutoff for rankings: countries with CR3 of 0.50 and HERF of 0.12 were classified as having high concentration of banks, else as having a low concentration.

France has a ranking of 1 if only commercial banks are examined and a ranking of 2 if all savings banks are included. Tests were conducted using France with both rankings and the results are qualitatively similar.

Since banks branch throughout each country unlike in the United States and since entry has until recently been restricted by national borders, a national market is appropriate. Moreover, it is not possible to obtain market shares by local market for European countries.

Since our database consists of only the largest banks in each country, the estimation of CR3 and HERF is not possible using the Global Vantage data. Consequently, customized data were purchased from Sheshunoff's Investment Services which provided deposit data for all banks, including non-commercial and foreign banks, for each country. Table I provides the estimates of the three-bank concentration ratio (CR3) and the Herfindahl index (HERF) for each of the countries in 1990. Columns 3 and 4 provide the estimates of CR3 and HERF using only commercial banks while columns 7 and 8 provide the estimates for commercial and savings banks. As Table I shows, some countries have a significant number of savings banks. For example, in the case of Germany, there were data available for 214 commercial plus savings banks of which only 121 were classified as commercial banks (the latter includes foreign commercial banks).\(^6\)

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\(^6\) Sheshunoff’s Investment Services did not include any data on non-commercial banks for two countries, Finland and Sweden.
However, and this will be elaborated upon next, the ranking of banks into high and low concentrated countries (columns 5 and 9) is mostly unaffected by whether or not savings banks are included. Consequently, subsequent analyses were performed using concentration ratios based only on commercial banks.

The estimates of CR3 range from 31% to 91% when only commercial banks are examined and range from 26% to 91% when savings banks are included in the sample. The comparable numbers for HERF are between 0.06 to 0.30 for commercial banks and 0.04 to 0.29 when savings banks are included. The ratios were similar for the other three years. In order to distinguish between countries with high and low concentrations of banks, a cutoff of 0.50 for CR3 and 0.12 for HERF was used to rank banks. Thus, banks in countries with CR3 of 0.50 and above or with HERF of 0.12 or above were ranked as high concentration countries. The only borderline case is France which would be classified as a high concentration market if the sample included only commercial banks and low concentration market if all savings banks are included. In the results presented in the following tables, we count UK, Switzerland, Belgium, Finland, Sweden and Denmark as having high concentration of banks and the rest as having low concentration. The same analysis using France as a high concentration country did not affect the results significantly. Since the empirical results are similar employing either HERF or CR3, we only report results using HERF.

4.3. Measures of efficiency

4.3.1. X-efficiency

X-efficiency provides a measure of how effectively banks are using their inputs to produce a given level of output. Since efficient cost frontiers can vary for banks in different countries, it is necessary to specify a stochastic cost function. This paper uses the stochastic cost frontier proposed by Aigner et al. (1977) to investigate cost efficiencies. This method has been used by Mester (1993) and Cebenoyan et al. (1993) for the savings and loan industry in the U.S. The basic model assumes that total cost deviates from the efficient cost frontier by a random noise, \( v_i \), and an inefficiency component, \( u_i \). Thus, the efficient cost frontier is defined as:

\[
\ln t_c = f(y_i, p_i) + \varepsilon_i
\]

where \( \varepsilon_i = u_i + v_i \) and \( y_i \) is the output of each bank, \( p_i \) is the cost or price of input \( i \), \( v_i \) is statistical noise distributed normal \( (0, \sigma^2) \), and \( u_i \) is one-sided inefficiency measure, distributed half-normally. Here \( u_i \) represents the individual firm's deviations from the efficient cost frontier and serves as a proxy for both technical and allocative efficiency. The log-likelihood function is given by:

\[
\ln L = \frac{N}{2} \ln \frac{2}{\pi} - N \ln \sigma - \frac{1}{2\sigma^2} \sum_{i=1}^{N} \varepsilon_i^2 + \sum_{i=1}^{N} \ln \left[ \psi \left( \frac{\varepsilon_i}{\sigma} \right) \right]
\]

(6)
where $N$ is number of firms and $\psi$ is the standard normal cumulative distribution function. Jondrow et al. (1982) show that the ratio of variability, $\alpha$, can be used to measure a firm's mean inefficiency by:

$$E(u_i|\epsilon) = \left[ \frac{\sigma\lambda}{1 + \lambda^2} \right] \left[ \frac{\phi(\epsilon_i\lambda/\sigma)}{\psi(\epsilon_i\lambda/\sigma)} + \frac{\epsilon_i\lambda}{\sigma} \right]$$

(7)

where $\sigma^2 = [\sigma_u^2 + \sigma_v^2]$, $\lambda = \sigma_u / \sigma_v$ and $\phi(.)$ is the standard normal density function. Inefficiency measures are derived for each of the four years for each bank.

In order to estimate the frontier, it is necessary to specify a cost function. This paper uses a standard translog cost function because of its flexibility in allowing the estimation of scale efficiencies. This paper uses two outputs, loans as the primary output ($y_1$) and all other earning assets as the secondary output ($y_2$), and three inputs with prices defined as the price of labor ($p_1$), capital ($p_2$) and borrowed funds ($p_3$)

$$\ln tc = \alpha_0 + \sum_{i=1}^{2} \alpha_i \ln(y_i) + \sum_{j=1}^{3} \beta_j \ln(p_j) + 1/2 \sum_{i=1}^{2} \sum_{k=1}^{2} \alpha_{ik} \ln(y_i) \ln(y_k)$$

$$+ 1/2 \sum_{j=1}^{3} \sum_{h=1}^{3} \beta_{jh} \ln(p_j) \ln(p_h) + \sum_{i=1}^{3} \sum_{j=1}^{3} \delta_{ij} \ln(y_i) \ln(p_j) + \epsilon$$

(8)

where $tc$ is total operating and interest costs, $y_i$ is total loans, $y_2$ is all other earning assets, $p_i$ is the price of labor, defined as staff expenses divided by the number of employees, $p_2$ is the price of fixed capital, defined as capital and occupancy expenses divided by fixed assets, and $p_3$ is the price of borrowed funds, defined as total interest expenses divided by interest bearing liabilities.

Unlike in the estimation of traditional cost functions, the share equations are not included when estimating stochastic cost functions. In addition, the linear homogeneity conditions are imposed by normalizing total costs (TC), price of labor ($p_1$) and price of capital ($p_2$) by the price of deposits ($p_3$) (see Cebenoyan et al. (1993) for details). The usual symmetry restrictions are imposed, i.e. $\alpha_{ik} = \alpha_{ki}$ and $\beta_{jh} = \beta_{hj}$. Maximum likelihood estimation techniques are used to estimate the coefficients.

The empirical tests substitute inefficiency variables (X-INEFF) for efficiency variables (X-EFF), defined in Eq. (1). The estimate of X-INEFF, derived from the stochastic cost frontier, represents an inefficiency measure for each bank. Consequently, the coefficient of X-INEFF in the regression of the efficient-structure hypothesis will have the opposite sign as X-EFF specified in Eqs. (1), (2) and (3). Therefore, the predicted sign of the coefficient of X-INEFF is negative when

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7 See Bauer (1990) for a discussion of the problems in relating the inefficient cost measure with the share equations.
either ROE or ROA is the dependent variable, i.e. the lower the inefficiency, the larger the profits. When NIM is the dependent variable, the relationship is positive, i.e. the greater the inefficiency the larger the net interest margin.

4.3.2. Scale efficiency

Scale efficiency indicates whether banks with similar production and management technology are operating at optimal economies of scale. Economy of scale is given by:

\[
SCALE = \sum_{i=1}^{2} \frac{\delta (\ln c)}{\delta y_i} \\
= \sum_{i=1}^{2} \alpha_i + \sum_{k=1}^{2} \alpha_{ik} \ln y_k + \sum_{j=1}^{2} \beta_{ij} \ln p_j
\]

(scale - 1)

Where SCALE measures are estimated for each bank at its respective output levels, y, and Y2'. If SCALE < 1 then banks are operating below optimal scale levels and have the ability to lower costs by increasing output further, while if SCALE > 1 then banks are required to downsize in order to achieve optimal input combinations. Since SCALE > 1 and < 1 both imply inefficiencies, a measure of inefficiency, S-INNEFF, is used in the actual regressions, i.e. 8

\[
S-INNEFF = SCALE - 1 \text{ if } SCALE > 1 \\
S-INNEFF = 1 - SCALE \text{ if } SCALE < 1.
\]

As in the case of X-INNEFF, the sign of the coefficient will be opposite to that predicted in Eq. (1). For example, the predicted relationship between profitability and S-INNEFF is negative, i.e. the further a bank is from efficient scale, the lower the profitability. When NIM is the dependent variable, the relationship is positive, i.e. the larger the S-INNEFF, the larger the net interest margin.

4.4. Control variables

The four control variables in Z_i used in this study were selected from those used in previous studies and are detailed in Appendix A. PCI or per capita income of a country affects numerous factors related to the supply and demand for loans and deposits. In this paper it is hypothesized that the coefficient will be negative because countries with higher PCI are assumed to have a banking system that

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8 Berger and Hannan (1989), for example, used the two measures separately, S-EFFE if SCALE < 1 and S-EFFD if SCALE > 1. However, this paper assumes that as banks deviate from efficient scale, the impact of inefficiency is similar, i.e. banks profitability increases monotonically whether they are downsizing or increasing in size towards the optimal scale.
The log of assets is used instead of assets in order to reduce the scale effect. The WAGE coefficient, defined as total wages and salaries divided by the number of employees, is expected to be negative under the efficient-structure hypothesis because efficient banks are expected to operate at lower costs. The same argument can also be applied if the market power hypothesis holds, because banks may be able to behave monopsonistically in concentrated markets.

The size variable, LTA or the log of total assets, controls for cost differences related to bank size and for the greater ability of larger banks to diversify. The first factor would lead to positive coefficients for NIM, ROA and ROE if there are significant economies of scale and the second to negative coefficients if increased diversification leads to lower risk and thus lower required returns. The risk measure, RISK or the total liability to total asset ratio, LA/TA, indicates the level of capital in the bank and can be either negative or positive. This is because higher RISK ratios indicate less capital and greater leverage which could result in increased borrowing costs, leading to lower interest margins (NIM) and profits. At the same time, higher leverage indicates aggressive asset/liability management which leads to higher interest margins (NIM) and profits.

A number of papers have also used public ownership as an additional control variable with the expected sign of the coefficient negative, to indicate that government controlled banks are run less efficiently and consequently are less profitable. However, the results in other studies using this variable have been inconclusive. For example, Molyneux (1993) finds the coefficient of public ownership to be insignificant while Molyneux and Thornton (1992) find a positive relationship and Short (1979) and Bourke (1989) find a negative relationship. As a result, and because it is difficult to trace ownership unambiguously, we avoid using a dummy variable for government ownership as in Molyneux and Teppet (1993) and Vander Vennet (1993).

Data are pooled for all four years and dummy variables are employed for 1989, 1990, and 1991. Table 2 provides summary data for many of the variables used in the analysis for the year 1990. Total assets (column 3) and total deposits (column 4) refer to the totals of the banks used in the study. Total country deposits (column 5) refers to the total deposits of the banking industry in the country, as provided by Sheshunoff’s Information services. The number of banks used to arrive at this total is given in parentheses in column 5. The HERF and CR3

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9 The log of assets is used instead of assets in order to reduce the scale effect.


11 It should be noted that a number of banks had to be dropped from the original sample because of the specific data required to estimate the efficiency measures. For example, Deutsche Bank did not provide the labor costs for the estimation of the translog function. Similarly, banks in the Netherlands do not report interest expense separately as it is required for the translog, but rather only report net interest margin.
Table 2
Summary statistics of data for 1990

<table>
<thead>
<tr>
<th>Country</th>
<th>N</th>
<th>Total assets ($MIL)</th>
<th>Total deposit ($MIL)</th>
<th>Total country deposits (N)</th>
<th>X-INEFF S-INEFF</th>
<th>Mean net marg.</th>
<th>Per capita income ($1000)</th>
<th>LA/TA</th>
<th>Mean wage ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>8</td>
<td>972932.7</td>
<td>791845.0</td>
<td>855849.1 (68)</td>
<td>0.076 0.264</td>
<td>0.023</td>
<td>16248</td>
<td>0.949</td>
<td>33707</td>
</tr>
<tr>
<td>Germany</td>
<td>7</td>
<td>647934.3</td>
<td>361707.6</td>
<td>1210035 (121)</td>
<td>0.039 0.275</td>
<td>0.017</td>
<td>22632</td>
<td>0.963</td>
<td>56563</td>
</tr>
<tr>
<td>France</td>
<td>6</td>
<td>765388.5</td>
<td>514180.2</td>
<td>1164741 (119)</td>
<td>0.056 0.367</td>
<td>0.032</td>
<td>19535</td>
<td>0.952</td>
<td>62501</td>
</tr>
<tr>
<td>Switz.</td>
<td>12</td>
<td>542735.8</td>
<td>392149.2</td>
<td>457177.3 (118)</td>
<td>0.081 0.230</td>
<td>0.014</td>
<td>34472</td>
<td>0.925</td>
<td>69925</td>
</tr>
<tr>
<td>Sweden</td>
<td>4</td>
<td>160579.0</td>
<td>114170.2</td>
<td>122336.1 (5)</td>
<td>0.082 0.243</td>
<td>0.022</td>
<td>23987</td>
<td>0.982</td>
<td>61599</td>
</tr>
<tr>
<td>Denmark</td>
<td>4</td>
<td>148202.9</td>
<td>107861.8 (53052.4)</td>
<td>60681.5 (26)</td>
<td>0.036 0.237</td>
<td>0.026</td>
<td>23364</td>
<td>0.946</td>
<td>43305</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
<td>73144.9</td>
<td>54477.1 (32598.6)</td>
<td>150505.2 (35)</td>
<td>0.033 0.222</td>
<td>0.015</td>
<td>19083</td>
<td>0.973</td>
<td>59210</td>
</tr>
<tr>
<td>Finland</td>
<td>5</td>
<td>124833.8</td>
<td>68905.5 (28901.4)</td>
<td>37301.3 (7)</td>
<td>0.048 0.221</td>
<td>0.019</td>
<td>23757</td>
<td>0.941</td>
<td>48835</td>
</tr>
<tr>
<td>Austria</td>
<td>5</td>
<td>91375.0</td>
<td>68660.1</td>
<td>154664.3 (39)</td>
<td>0.058 0.187</td>
<td>0.020</td>
<td>19060</td>
<td>0.948</td>
<td>49352</td>
</tr>
<tr>
<td>Italy</td>
<td>15</td>
<td>454876.3</td>
<td>343931.1 (190243.6)</td>
<td>731262.1 (41)</td>
<td>0.082 0.335</td>
<td>0.030</td>
<td>17500</td>
<td>0.940</td>
<td>73632</td>
</tr>
<tr>
<td>Spain</td>
<td>12</td>
<td>330784.1</td>
<td>268307.9 (185783.1)</td>
<td>275698.0 (59)</td>
<td>0.038 0.267</td>
<td>0.048</td>
<td>11861</td>
<td>0.939</td>
<td>46246</td>
</tr>
</tbody>
</table>

MIL = millions. 'Total assets' and 'Total deposits' refer to the total of only the subset of banks used in the regression analysis. 'Total country deposits' refers to the total deposits of all commercial banks in a country as reported by Sheshunoff's Information Services Inc. N = number of banks used in estimating total deposits of banks (and for estimating three-bank concentration ratio (CR3) and Herfindahl Index (HERF) in Table 1). X-INEFF and S-INEFF refer to X-inefficiency and scale-inefficiency, respectively. Mean net marg. = average net interest margin defined as net interest income over total assets, as reported by the banks, of all the banks in a country. Mean LA/TA = average total liabilities over total assets of banks in the country. Mean wage = average total wages and salaries divided by total employees, as reported by the banks.

Sources: Compustat's Global Vantage, Sheshunoff's Information Service Inc. and International Financial Statistics. All data converted to U.S. dollars using year-end rates reported in the Wall Street Journal.

* The data for 'Total country deposits' does not include inter-bank deposits.
measures for each country were estimated using this larger set of banks provided by Sheshunoff’s Information Services. For three of the countries, Denmark, Belgium and Finland, total deposits of the banks used in the study (column 4) exceed the total banking deposits of the country (column 5). This is because Sheshunoff’s database does not include inter-bank deposits in their total deposits. To provide meaningful comparisons, the total deposits without inter-bank deposits are listed in parentheses in column 4 for all 5 of the countries for which these data were available.\textsuperscript{12}

Column 6 provides the average measures of X-inefficiency and scale-inefficiency of banks within each country. Banks in Germany, Denmark, Belgium and Spain are operating with the smallest deviation from the efficient cost frontier (X-efficient), while banks in Italy and France are operating the furthest from the optimal scale (scale-inefficient). Mean net interest margins in column 7 show that the average spread is high in Spain and France while it is very competitive in Germany, Switzerland and Belgium.

5. Empirical results

The empirical analysis focuses on the estimates of Eqs. (1)-(5). Table 3 presents the results of estimating reduced form Eq. (1) using ROE, ROA and NIM as the dependent variables. Table 4 presents the results of estimating Eqs. (2) and (3) while Table 5 presents the results of estimating Eqs. (4) and (5). Table 6 provides estimates of Eq. (1) for an additional dependent variable, NIR. Since there is very little difference between the ROE and ROA results, we only report the former. The overall results are not unambiguous, similar to many of the previous studies. If only Eq. (1) is used as is approximately done in the other studies, the results appear to be sensitive to the choice of the dependent variable. When ROE is the dependent variable, the results provide support for the RMP hypothesis. When NIM is the dependent variable, the results are more supportive of the ESX version of the efficient-structure hypothesis. However, when the additional conditions are tested, i.e. Eqs. (2)-(5), the results support the ESX hypothesis for only one group of banks, those located in the LC countries. The concentration measures, HERF and CR3, were not statistically significant in the expected direction in any of the equations. Details of the tests are presented below.

Columns 2-4 and 5-7 of Table 3 report the results of ROE and NIM as the dependent variables, respectively. When ALL banks are considered, columns 2 and 5, there is evidence supporting the RMP hypothesis. Both columns show ROE

\textsuperscript{12} It should be noted that column 5 is used suictly to calculate concentration ratios and mark-et shares. Sheshunoff’s database, although not complete, provides a much larger set of banks, which is important for the measurement of HERF
Table 3
Regression results of return on equity (ROE) and net interest margin (NIM) on the Herfindahl index (HERF), market share (MS), X-inefficiency (X-INEFF), scale-inefficiency (S-INEFF) and other control variables

<table>
<thead>
<tr>
<th></th>
<th>Dep var = ROE</th>
<th></th>
<th>Dep var = NIM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>ALL</td>
<td>HC</td>
</tr>
<tr>
<td>INT</td>
<td>0.623 (3.10)</td>
<td>0.237 (0.49)</td>
<td>0.493 (2.06)</td>
</tr>
<tr>
<td>HERF</td>
<td>-0.118 (-1.54)</td>
<td>-0.424 (-2.80)</td>
<td>-0.230 (-1.08)</td>
</tr>
<tr>
<td>MS</td>
<td>0.187 (3.19)</td>
<td>0.288 (3.18)</td>
<td>-0.220 (-2.11)</td>
</tr>
<tr>
<td>X-INEFF</td>
<td>0.007 (0.15)</td>
<td>0.004 (0.03)</td>
<td>-0.013 (-0.33)</td>
</tr>
<tr>
<td>S-INEFF</td>
<td>-0.016 (-0.93)</td>
<td>-0.195 (-0.93)</td>
<td>0.079 (0.58)</td>
</tr>
<tr>
<td>WAGE</td>
<td>-0.000006 (-0.02)</td>
<td>0.0002 (0.30)</td>
<td>-0.0004 (-1.03)</td>
</tr>
<tr>
<td>LTA</td>
<td>-0.005 (-0.96)</td>
<td>-0.022 (-1.98)</td>
<td>0.02 (3.87)</td>
</tr>
<tr>
<td>RISK</td>
<td>-0.416 (-1.96)</td>
<td>0.382 (0.94)</td>
<td>-0.558 (-2.24)</td>
</tr>
<tr>
<td>PCI</td>
<td>-0.003 (-3.09)</td>
<td>-0.003 (-1.00)</td>
<td>-0.011 (-7.32)</td>
</tr>
<tr>
<td>YR89</td>
<td>-0.011 (-0.97)</td>
<td>-0.041 (-2.15)</td>
<td>0.00007 (0.007)</td>
</tr>
<tr>
<td>YR90</td>
<td>-0.011 (-0.92)</td>
<td>-0.046 (-2.04)</td>
<td>0.028 (2.49)</td>
</tr>
<tr>
<td>YR91</td>
<td>-0.006 (-0.52)</td>
<td>-0.032 (-1.39)</td>
<td>0.033 (2.70)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.08</td>
<td>0.104</td>
<td>0.346</td>
</tr>
<tr>
<td>$F$</td>
<td>3.48 a</td>
<td>2.39 a</td>
<td>9.14 a</td>
</tr>
</tbody>
</table>

ALL = all banks in the sample; HC = banks located in countries with high market concentration (Rank 1 in Table 1); LC = banks located in low market concentrations (Rank 2 in Table 1); INT = intercept, MS = market share, X-INEFF = X-inefficiency, S-INEFF = scale-inefficiency, WAGE = average wages and salary, LTA = natural log of total assets, RISK = total liabilities over total assets, PCI = per capita income, YR89, YR90 and YR91 = dummies for 1989, 1990 and 1991 with 1988 serving as the base year. Dep var = dependent variable. Source: Compustat’s Global Vantage and International Financial Statistics.

a, b Significant at the 5% and 10% levels, respectively.
<table>
<thead>
<tr>
<th></th>
<th>Dep var = MS</th>
<th></th>
<th></th>
<th>Dep var = HERF</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALL</td>
<td>HC</td>
<td>LC</td>
<td>ALL</td>
<td>HC</td>
<td>LC</td>
</tr>
<tr>
<td>N</td>
<td>303</td>
<td>133</td>
<td>170</td>
<td>303</td>
<td>133</td>
<td>170</td>
</tr>
<tr>
<td>INT</td>
<td>-0.954 (-4.16) (^a)</td>
<td>-2.71 (-5.85) (^a)</td>
<td>-0.737 (-4.0) (^a)</td>
<td>-0.194 (-1.07)</td>
<td>-0.129 (-0.47)</td>
<td>0.140 (1.56)</td>
</tr>
<tr>
<td>X-INEFF</td>
<td>-0.062 (-1.14)</td>
<td>-0.118 (-0.83)</td>
<td>-0.069 (-2.16) (^a)</td>
<td>0.111 (2.57) (^a)</td>
<td>-0.073 (-0.85)</td>
<td>0.046 (2.92) (^a)</td>
</tr>
<tr>
<td>S-INEFF</td>
<td>-0.083 (-0.63)</td>
<td>-0.307 (-1.51)</td>
<td>0.355 (3.28) (^a)</td>
<td>-0.294 (-2.81) (^a)</td>
<td>-0.835 (-6.85) (^a)</td>
<td>0.014 (0.27)</td>
</tr>
<tr>
<td>WAGE</td>
<td>-0.0009 (-2.34) (^a)</td>
<td>0.0002 (2.31) (^a)</td>
<td>-0.0008 (-2.59) (^a)</td>
<td>-0.003 (-9.83) (^a)</td>
<td>0.0006 (0.98)</td>
<td>-0.0007 (-4.83) (^a)</td>
</tr>
<tr>
<td>LTA</td>
<td>0.036 (8.67) (^a)</td>
<td>0.056 (7.45) (^a)</td>
<td>0.036 (11.65) (^a)</td>
<td>-0.017 (-5.07) (^a)</td>
<td>-0.034 (-7.67) (^a)</td>
<td>-0.0005 (-0.32)</td>
</tr>
<tr>
<td>RISK</td>
<td>0.475 (1.94) (^b)</td>
<td>1.95 (4.58) (^a)</td>
<td>0.327 (1.60)</td>
<td>0.680 (-3.51) (^a)</td>
<td>1.12 (4.40) (^a)</td>
<td>0.020 (0.20)</td>
</tr>
<tr>
<td>PCI</td>
<td>0.003 (2.77) (^a)</td>
<td>-0.0007 (-0.24)</td>
<td>-0.005 (-4.27) (^a)</td>
<td>0.007 (9.67) (^a)</td>
<td>-0.005 (-2.90) (^a)</td>
<td>-0.002 (-3.42) (^a)</td>
</tr>
<tr>
<td>YR89</td>
<td>-0.003 (-0.20)</td>
<td>-0.002 (-0.09)</td>
<td>-0.008 (-0.92)</td>
<td>-0.005 (-0.48)</td>
<td>0.002 (0.13)</td>
<td>-0.010 (-2.18) (^a)</td>
</tr>
<tr>
<td>YR90</td>
<td>-0.006 (-0.45)</td>
<td>-0.017 (-0.65)</td>
<td>0.008 (0.83)</td>
<td>-0.012 (-1.11)</td>
<td>0.022 (1.43)</td>
<td>-0.004 (-0.78)</td>
</tr>
<tr>
<td>YR91</td>
<td>-0.001 (-0.09)</td>
<td>-0.023 (-0.87)</td>
<td>0.013 (1.27)</td>
<td>-0.0004 (-0.04)</td>
<td>0.015 (0.94)</td>
<td>0.0004 (0.08)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.37</td>
<td>0.50</td>
<td>0.58</td>
<td>0.35</td>
<td>0.47</td>
<td>0.29</td>
</tr>
<tr>
<td>$F$</td>
<td>20.9 (^a)</td>
<td>15.4 (^a)</td>
<td>27.3 (^a)</td>
<td>18.7 (^a)</td>
<td>13.9 (^a)</td>
<td>8.75 (^a)</td>
</tr>
</tbody>
</table>

ALL = all banks in the sample; HC = banks located in countries with high market concentration (Rank 1 in Table 1); LC = banks located in low market concentrations (Rank 2 in Table 1). INT = intercept, WAGE = average wages and salary, LTA = natural log of total assets, RISK = total liabilities over total assets, PCI = per capita income, YR89, YR90 and YR91 = dummies for 1989, 1990 and 1991 with 1988 serving as the base year. Years = 1988–91.


\(^a\) and \(^b\) Significant at the 5% and 10% levels, respectively.
Table 5
Regression results of X-inefficiency (X-INEFF) and scale-inefficiency (S-INEFF) on market share (MS), market concentration (HERF) and other control variables

<table>
<thead>
<tr>
<th></th>
<th>Dep var = X-INEFF</th>
<th></th>
<th>Dep var = S-INEFF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALL</td>
<td>HC</td>
<td>LC</td>
</tr>
<tr>
<td>N</td>
<td>303</td>
<td>133</td>
<td>170</td>
</tr>
<tr>
<td>INT</td>
<td>-0.059 (-0.25)</td>
<td>0.691 (2.18) a</td>
<td>0.631 (3.37) a</td>
</tr>
<tr>
<td>HERF</td>
<td>0.323 (3.65) a</td>
<td>0.0008 (0.009) a</td>
<td>-0.383 (-6.96) a</td>
</tr>
<tr>
<td>MS</td>
<td>-0.206 (-2.89) a</td>
<td>-0.041 (-0.64) a</td>
<td>0.075 (1.96) a</td>
</tr>
<tr>
<td>WAGE</td>
<td>0.004 (8.04) a</td>
<td>0.004 (6.53) a</td>
<td>0.00002 (0.05) a</td>
</tr>
<tr>
<td>LTA</td>
<td>0.021 (4.14) a</td>
<td>0.004 (0.54) a</td>
<td>-0.031 (-8.13) a</td>
</tr>
<tr>
<td>RISK</td>
<td>-0.158 (-0.61) b</td>
<td>-0.541 (-1.85) b</td>
<td>0.081 (0.47) a</td>
</tr>
<tr>
<td>PCI</td>
<td>-0.007 (-6.95) a</td>
<td>-0.010 (-6.73) a</td>
<td>-0.002 (-2.66) a</td>
</tr>
<tr>
<td>YR89</td>
<td>0.015 (1.09)</td>
<td>0.014 (1.01) a</td>
<td>0.002 (0.18) a</td>
</tr>
<tr>
<td>YR90</td>
<td>0.045 (3.20) a</td>
<td>0.068 (4.56) a</td>
<td>0.018 (1.99) a</td>
</tr>
<tr>
<td>YR91</td>
<td>0.039 (2.65) a</td>
<td>0.085 (5.63) a</td>
<td>0.009 (1.05) a</td>
</tr>
<tr>
<td>R²</td>
<td>0.26</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td>F</td>
<td>12.7 a</td>
<td>12.6 a</td>
<td>14.6 a</td>
</tr>
</tbody>
</table>

ALL = all banks in the sample; HC = banks located in countries with high market concentration (Rank 1 in Table 1); LC = banks located in low market concentrations (Rank 2 in Table 1). INT = intercept, HERF = Herfindahl index, MS = market share, WAGE = average wages and salary, LTA = natural log of total assets, RISK = total liabilities over total assets, PCI = per capita income, YR89, YR90 and YR91 = dummies for 1989, 1990 and 1991 with 1988 serving as the base year. Years = 1988–91. Source: Compustat’s Global Vantage and International Financial Statistics.

a, b Significant at the 5% and 10% levels, respectively.
and NIM are negatively and insignificantly related to HERF but both are positively related to market share, MS, and statistically significant. Both the X-IN-EFF and S-INEFF variables are insignificant in the ROE equation, which indicates that neither X-inefficiency nor scale-inefficiency plays a role in explaining changes in profitability. In the case of NIM, the variable X-IN-EFF is positive, indicating that more inefficient banks had higher net interest margins (or conversely, more efficient banks operated with low interest margins), supporting the ESX version of the efficient-structure hypothesis.

Although the conclusions are similar, the signs of the coefficients are not similar when the data are partitioned between banks located in high and low concentration countries, HC and LC, respectively (columns 3, 4, 6, and 7). As suggested by Jackson (1992), this may indicate non-linearity in the relationship between performance and concentration. In the ROE equation for banks in HC countries, the HERF coefficient is negative and the MS coefficient positive and both are statistically significant, supporting the RMP hypothesis. In the case of
banks located in LC countries, the HERF coefficient is insignificant and the MS coefficient is negative and significant. However, since the X-INEFF and S-INEFF coefficients are both insignificant, the efficient-structure hypothesis cannot be supported for the LC banks. When the sample is subdivided into HC and LC countries with NIM as the dependent variable, the market structure variables are statistically insignificant except for the LC banks where the MS coefficient is negative and significant. In addition, both inefficiency measures are positive for banks in LC countries, while only X-INEFF is positive and significant for HC banks. These results strongly support the ESX version of the efficient-structure hypothesis for HC banks and the ESX and ESS versions for the LC banks.

Methodologically, if there are significant relationships between the market structure and efficiency variables, then Eq. (1) may be subject to multicollinearity problems. As a test of robustness, we test Eq. (1) in two components in order to remove the effects of multicollinearity:

\[ P_i = f(X - EFF_i, S - EFF_i, Z_i) + e_i \]  
\[ (la) \]

\[ P_i = f(CONC_m, MS_i, Z_i) + e_i \]  
\[ (lb) \]

The results of Eqs. (la) and (lb) are not qualitatively different from those of Eq. (1) (results not shown). Two of the coefficients changed in statistical significance. First, the HERF coefficient is positive and significant at the 10% level, for the LC banks with NIM as the dependent variable (t = 1.80 instead of 0.73). Second, the MS coefficient with NIM as the dependent variable for ALL banks is no longer statistically significant (t = 1.61 instead of 2.58).

The coefficients of the control variables are also mixed, with the results depending on whether ROE or NIM is used. When ROE is the dependent variable, WAGE rates are insignificant for all three groups. They are negatively correlated for all three groups when NIM is the dependent variable, consistent with the SCP and EFS hypotheses. The coefficients are negative for the size factor (LTA, or the natural log of total assets) for ALL banks, but statistically significant only when NIM is the dependent variable. When the sample is partitioned, the coefficient is negative for the HC banks (diversification effect) and positive for the LC banks (scale effect) when ROE is the dependent variable. Since the coefficients are sensitive to the dependent variable, the results cannot be generalized with confidence.

The RISK coefficient is also negative and significant for ALL banks as well as for banks located in LC countries. This would indicate that higher leverage in banks is associated with higher borrowing costs and not with the alternative prediction of aggressive asset-liability management. Similarly, the coefficient is negative for per capita income, PCI, for all groups (except for HC banks when ROE is the dependent variable). These results support the maturity hypothesis, i.e. banks in countries with higher PCI are likely to have more competitive environments which generate lower interest and profit margins.
The dummy variables show that ROE and NIM have changed significantly over the years, although not in the same direction. NIM declined in 1989 relative to 1988 (YR89) for all three group of banks while ROE declined only for HC banks. Thereafter, NIM increased over the next two years for all three group of banks but ROE only increased for LC banks in 1990 and 1991, relative to 1988. Regressions were run separately for each year to check for yearly differences, but the results do not change significantly.

Thus, so far the results indicate that when ROE is the dependent variable, there is some support for the RW hypothesis for ALL and HC banks. When NIM is the dependent variable, there is support for both the RW and ESX hypotheses for ALL banks, strong support for the ESX hypothesis for HC banks, and strong support of ESX and ESS hypotheses for LC banks. In order to establish the results more firmly, the additional conditions specified in Eqs. (2)-(5) are examined next.

Table 4 shows the results for Eqs. (2) and (3), which set the necessary conditions for the efficient-structure hypothesis. Estimates of market share (MS) and market concentration (HERF) are regressed against X-INEFF and S-FNEFF and other control variables. Under the efficient-structure hypotheses, it is necessary that the relationship be negative between inefficiency and concentration or market share. For ALL banks, X-INEFF and S-INEFF are insignificant when MS is the dependent variable, which does not support the earlier result of the ESX version found for ALL banks. Partitioning the sample yields one negative and statistically significant coefficient in the MS equation for X-INEFF and one positive relationship for S-INEFF, both for the LC banks. This adds support to the ESX result found for the LC group in Table 3 but not for the ESS result, since the S-INEFF coefficient is positive. When BERF is the dependent variable, the coefficient of X-INEFF is positive for ALL and LC and the coefficient of S-INEFF is negative for ALL and HC. These mixed results do not add anything conclusive to our analysis. Note that there are no multicollinearity problems because the correlation between X-INEFF and S-INEFF is approximately -0.02. None of the control variables contribute any more to the results. The dummies for the years YR89, YR90 and YR91 are all insignificant except for 1989 for the LC countries in the HERF equation, indicating that the market shares and concentrations have not significantly changed over the years.

Table 5 reports the results for Eqs. (4) and (5) which test Hicks 'quiet life' hypothesis. Dependent variables X-INEFF and S-INEFF are regressed against MS, HERF and the control variables. The signs of MS and HERF should be positive if the RMP conclusions are to be supported, indicating that larger market shares or concentrations should result in greater X- and scale inefficiencies. The results do not generally support the RMP hypothesis because the coefficients are not consistently positive. Importantly, relating to the results of Table 3, the MS coefficient is negative and significant for ALL banks (t = -2.89) and insignificant for the HC banks (t = -0.64) in the X-inefficiency equation. This is in spite of an increase in the level of inefficiencies in 1990 and 1991, as shown by the
significant dummy coefficients YR90 and YR91 for the X-INEFF equation (except for LC banks in 1991). These results indicate that banks are operating further from the efficient cost frontiers relative to 1988. The coefficients for HERF are not consistent, but this is not particularly important since we did not find any evidence of the traditional SCP hypothesis in Table 3.

To clarify the previous results an additional test is performed. Eq. (1) is re-estimated with NIR = (I + ROA)/(I + NIM) as dependent variable. This isolates the efficiency effect on ROA through non-interest factors such as better management, high productivity, and better use of technology and capital. The results are reported in Table 6 and as expected reveal less ambiguous efficiency effects than before. The coefficient of X-INEFF is negative and statistically significant for ALL, HC, and LC. The coefficient of S-INEFF is negative for each category and is statistically significant for low concentration countries. These results are consistent with the NIM results and indicate that ROA results, once adjusted, are consistent. The only coefficient of the structure variables that is significant in the expected direction is the positive coefficient of MS in the LC equation. This formulation provides more evidence in favor of the EFS hypothesis than the SCP hypothesis.

Thus, when all the results are integrated, they only provide conclusive support for the ESX version of the efficient-structure hypothesis for banks located in low concentration countries. For the rest of the banks, there is some evidence for the EFS hypothesis. If only Eq. (1) is used (as done in other studies), the results support the RMP hypothesis which is consistent with the results of Molyneux (1993), Vander Vennet (1993) and others. However, the use of the additional tests as specified by Berger and Hannan (1993) invalidates some of the results of Eq. (1).

In addition, three other results are observed for this group of European banks: a) concentration plays a less significant role as opposed to market share in explaining profitability; b) the results appear to be very sensitive to the measure of performance used; and c) performances of banks vary with respect to X-efficiency and scale-efficiency. The correlation between the two efficiency measures is -0.02, suggesting some banks are X-inefficient and others are scale-inefficient, but not necessarily both.

6. Summary and conclusion

This paper tests the structure-performance hypotheses for the largest banks located in 11 European countries. Unlike conventional tests, the Berger and Hannan (1993) model is used which incorporates two estimates of inefficiency, X-inefficiency and scale-inefficiency, directly into the test. In addition, four hypotheses are specified, two related to the market power paradigm (SCP and RMP) and two to the efficient-structure paradigm (ESX and ESS). Using data from Compustat's Global Vantage, a total of 303 observations across 11 European countries were usable covering the period 1988-91.

The sample was also divided between banks located in countries having a high and low concentration, and the results conformed with Jackson's (1992) contention that performance and concentration may be related in a non-linear fashion. In addition, the

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13 We thank an anonymous referee for suggesting this line of inquiry.
paper uses a stochastic cost frontier, as proposed by Aigner et al. (1977), to derive X-
inefficiency and scale-inefficiency estimates under the assumption that the error terms are half-normal. An advantage of using this method is that it allows us to derive inefficiency estimates for each bank using its own operating costs and without assuming that the efficient cost frontier is common to all banks.

As has been the case for most of the recent structure-performance papers, the results are not very robust, and are sensitive to the measure of performance used. This study only supports the ESX version of the efficient-structure hypothesis for the banks located in low concentration countries. When only Eq. (1) is used, as done in other studies, there is support for the RMP hypothesis for ALL banks and those located in high concentration countries. However, Hannan and Berger’s (1993) method requires that additional tests be performed in order to validate the results. The results of the additional tests do not support the RMP results found for ALL and HC banks. The concentration coefficients, CR3 and HFRF, also play a very small role in explaining performance. Thus, we conclude that there is evidence to support the ESX hypothesis for banks located in low concentration countries. For the rest of the banks none of the four hypotheses can be confidently substantiated.

The results are in contrast to studies that have examined the structure-performance relationship for European banking. Both Molyneux and Teppet (1993) and Molyneux (1993) find evidence of anti-competitive behavior, although they do not include efficiency in their tests. Vander Vennet (1993) uses estimates of efficiency and economies of scale in his test, but his results support the SCP hypothesis in contrast to ours. This may be due to the different methods of estimating inefficiencies employed in the two papers.

This evidence has implications for the regulatory treatment of banks in the new European environment. The relationship between concentration levels and net interest margins appears to be non-linear. A simple policy of strict limitations on cross-border acquisitions and growth which might increase concentration is not warranted. Further work might justify limitations on acquisitions in certain circumstances. It also does not appear that the larger institutions are more efficient. Therefore, the growth in multinational large banks in Europe may not necessarily lead to more efficient operation. Additional evidence is needed in order for us to have more confidence in these conclusions.
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Appendix A. Detailed description of the variables

Source: Compustat's Global Vantage unless otherwise indicated.

ROA
net income/total assets.
Net income is defined as total revenue less all expenses, including allocations to untaxed reserves, income taxes and minority interest but before provision for dividends and any extraordinary items.

ROE
net income/stockholders equity (book value).
Stockholder's equity, as reported by the banks, include common and ordinary shares, retained earnings, paid-in capital, preferred stock, participation rights certificates such as Germany's GenuB scheine (dividend rights certificates) and Namengewinnscheine (registered profit sharing certificates), equity reserves and cumulative translation adjustment less treasury stock.

NIM
net interest margin/total assets.
Net interest margin is defined as total interest and dividends received from earning assets less total interest paid on deposits and debt. Dividend income refers to those earned on investment securities held but excluding any permanent investments. Interest expense includes those incurred for both short and long term debt.

Total Loans: total loans is defined as all loans, claims and advances made to commercial, consumer and government borrowers including leases and mortgages, less reserves for credit losses and unearned income.

Total Deposits: total deposits is defined as total demand, time and savings deposits held on account for individuals, partnerships, corporations as well as short-term demand and long-term time deposits with other banks.

WAGE
total wages and salaries/number of employees.
Total wages and salaries includes incentive compensation, pension costs, profit sharing and benefit plans. Number of employees include part-time employees but excludes consultants and contract workers.

LA/TA
total liabilities/total assets.
Total liabilities is defined as the sum of total deposits (including inter-bank deposits) and short-term (including repurchase agreements and commercial paper) and long-term liabilities (including convertible bonds and long-term lease obligations).

PCI
per capita income.
Per capita income is defined as national income divided by population. Data was obtained from the International Financial Statistics and the U.S. Department of State.
Ms  
market share.  
MS is defined as the ratio of individual bank's total deposits to the total deposits of all banks in a given country.

HERF  
Herfindahl index.  
Is the sum of squares of market shares of total deposits of banks in a given country. Customized data were obtained from Sheshunoff’s Information Services.

CR3  
three-bank concentration ratio.  
CR3 is defined as the ratio of the deposits of the three largest banks divided by total deposits in a given country. Source is Sheshunoff’s Information Services.

Appendix B. List of banks in sample: year = 1990

_Austria_ 
Bank für Tirol und Vorarlberg  
Bank für Oberösterreich  
Bk für Kärnten & Steier  
Creditanstalt Bankver  
Z-Länderbank Bank Aus

_Switzerland_ 
Baer Holding LTD  
Banq Cant Vaudoise  
Banque Paribas Suisse SA  
Bsi Banca Della Svizzera  
Cs Holdings  
Gotthard Bank  
Gzb Genossenschaftl  
Leu Holdings AG  
Neue Aargauer Bank  
Schweiz Bankverein  
Schweizerische Bankges  
Schweizerische Volksbank

_Finland_ 
Affarsbkn Unitas  
Alandsbanken AB  
Kansallis-Osake-Pankki  
Okobank  
Skopbank

_France_ 
Banque Nat de Paris  
Cetelem  
Comp Finance de Paribas  
Compagnie Bancaire SA  
Comptoir des Entrepreneurs  
Société Générale

_United Kingdom_ 
Abbey National Plc  
Bank of Scotland  
Barclays Plc/England  
Lloyds Bank Plc  
Midland Bank Group
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