Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Journal of Banking & Finance 28 (2004) 2427–2460
Journal of BANKING & FINANCE
www.elsevier.com/locate/econbase

Determining management behaviour in European banking

Jonathan Williams *

Centre for Banking and Finance, School for Business and Regional Development, University of Wales, Bangor, Gwynedd LL57 2DG, UK

Received 9 December 2002; accepted 19 September 2003
Available online 14 January 2004

Abstract

This paper determines management behaviour for European savings banks between 1990 and 1998. Following the Granger causality approach of Berger and DeYoung [Journal of Banking and Finance 21 (1997) 849], we examine the intertemporal relationships between loan loss provision, efficiency and capitalisation for European banks. In so doing, we provide a robustness test of the Berger and DeYoung results for US banks. The possible relationships between the variables imply different modes of management behaviour namely bad management, bad luck, skimping, and moral hazard behaviour. The econometric results suggest that the most pressing management problem for European banks is bad management. Generally speaking, the European findings are inconsistent with previous results from the US. One notable difference in management behaviour between European and US banks is that the former do not appear to engage in skimping behaviour. The European results are sensitive to the number of lags included in the model.

JEL classification: G21; G28; C14; D21
Keywords: X-efficiency; Loan loss provision; Credit risk; Capitalisation; Stochastic frontier analysis; Optimal lags

1. Introduction

In competitive markets, environmental pressures such as bank regulations and the organisational structures of markets and firms condition the response and effort of

* Tel.: +44-1248-382642.
E-mail address: jon.williams@bangor.ac.uk (J. Williams).

0378-4266/$ - see front matter
doi:10.1016/j.jbankfin.2003.09.010

management towards improving X-efficiency (Button and Weyman-Jones, 1992). Differences in bank organisational structures, for instance, in terms of their ownership might explain variations in X-inefficiencies because of principal–agent problems that offset the conditioning effect that environmental pressure brings to bear on managerial effort. [1] This is an empirical issue, which has received considerable attention in the bank efficiency literature albeit yielding somewhat mixed or inconclusive results (see Verbrugge and Goldstein, 1981; Verbrugge and Jahera, 1981; Cebenoyan et al., 1993; Mester, 1993; Berger and Humphrey, 1997; Cummins and Zi, 1998; Altunbas et al., 2001). One limitation of the bank ownership–efficiency literature is that, in general, it simply determines whether banks organised under one ownership model are significantly more efficient than banks organised in another way. Whilst this literature is informative for bank regulators and policy makers especially when subsequent analyses quantifies the differences in the characteristics of efficient and inefficient banks, it says little about management behaviour.

As a complement to those studies that differentiate efficiency levels between ownership models, there is a smaller literature that relates aspects of bank management with efficiency. For instance, DeYoung et al. (2001, pp. 1212–1213) have studied the management structure of small US banks finding that management behaviour is aligned with shareholder interests through incentive and monitoring procedures at the most profit efficient banks. [2] There is empirical evidence of the quiet life hypothesis amongst US banks in the sense that the structure of banking markets, through the level of concentration and its implications for firm behaviour, is positively related to bank cost inefficiency (Berger and Hannan, 1998). Managerial prudence in terms of a higher level of bank capitalisation has been found to be positively related to earnings (expected bankruptcy costs hypothesis) and efficiency (moral hazard hypothesis) (Berger, 1995; Mester, 1996), respectively. These findings are particularly relevant in the light of current regulatory discussions as to what constitutes the optimal amount of bank capital.

A different approach to understanding management behaviour considers the intertemporal relationships between cost efficiency, problem loans, capitalisation,

[1] Principal–agent problems may exist whenever there is a break between ownership and control and they are thought to explain differences in the performance of firms operating under different ownership models. The efficiency–ownership nexus appears to rest on the trading of equities and the transfer of ownership rights. Whereas the capital market disciplines the management of joint stock firms, this has been erroneously misinterpreted to imply that joint stock firms are more efficient than non-joint stock firms. Agency problems are expected to be more severe in mutual financial institutions and they could cause utility maximising managers to pursue individual objectives that do not maximise stakeholder value or enhance firm efficiency (see Altunbas et al., 2001). Some features of agency problems include a captive board of directors, passive or indifferent depositors, and the absence of shareholders, which implies that there is less external discipline applied to mutual banks' management. The resulting agency costs can arise in three different ways: expense preference behaviour, self-selection of management quality, and choice of project risk (see Peristiani and Wizman, 1997).

[2] DeYoung et al. (2001, pp. 1212–1213) suggest that bank owners can incentivise hired managers to align owner and manager interests by granting managers an ownership stake in the bank. However, they find that bank performance is negatively related to the size of managers' stake. Whilst there are difficulties associated with monitoring managerial performance, providing managers with an ownership stake 'underscores the importance of managerial shareholdings as a control mechanism ...'.

and credit risk (see Berger and DeYoung, 1997). The signing and direction of these intertemporal relationships is construed as evidence of specific types of management behaviour, namely bad management, bad luck, skimping and moral hazard behaviour. Granger causality methods show the intertemporal ordering of the variables and can identify which type of management behaviour exists although it is noted that management behaviour is not mutually exclusive and it is possible that banks may display characteristics of more than one behavioural type. Berger and DeYoung (1997) used US commercial banking data from the 1990s to estimate their model, and they found the following results: exogenous increases in problem loans tend to lead to reductions in cost efficiency (support for the bad luck hypothesis); exogenous declines in bank cost efficiency tend to lead to increases in problem loans (support for the bad management hypothesis); among the most efficient banks, exogenous increases in cost efficiency tend to lead to increases in problem loans (support for skimping behaviour); and among the least-well capitalised banks, exogenous reductions in capital tend to lead to increases in problem loans (support for moral hazard behaviour).

This paper extends the existing literature by providing a robustness test of the Berger and DeYoung (1997) results for US banks. We apply the Granger causality framework of Berger and DeYoung to a large sample of European savings banks from 1990 to 1998. The panel dataset contains 6309 observations (before lags are taken) of savings banks from the following European countries; Denmark, France, Germany, Italy, Spain and the United Kingdom. Savings banks constitute an important testing bed for several reasons. As retail bankers to private households, SMEs, and public authorities, they play an important role in allocating credit and thereby contributing to economic activity in the localities and regions in which they operate. On average, savings banks are small institutions measured by total assets that tend to rely on relationship banking to reduce asymmetric information problems in credit allocation. A salient characteristic of this financial group is their extensive branch coverage, which reflects the importance of deposit collection. Indeed, in countries such as Germany and Spain, the savings banks group is the main competitor to commercial banks and their deposit market shares are in the region of 40%, respectively. Another interesting feature of the European savings banks industry is the existence of several organisational structures, which is particularly important in Europe where the choice of organisational structure and company form is unrestricted (Ehlermann, 1992). [3,4]

[3] Organisational structure is defined to incorporate differences in the following: company form, ownership, allocation of profit, and management structure. Similarly, organisational structure reflects the fact that banks from some countries within the sample are a part of financial groups, which tend to operate with either a two or three tiered group structure. There are also particular restrictions that are imposed on banks belonging to different organisational structures, for instance, geographical and operational restrictions. See Tables 10 and 11 in the Appendix for more information about the organisational structures and ownership of European savings banks.

[4] The literature identifies four main organisational models that are followed by European savings banks (see Gardener et al., 1997). The profligate organisational models found in the European savings banks industry (especially regarding ownership rights) could be expected to cause principal–agent problems that might adversely influence management behaviour and lower bank efficiency.

The results of the Granger causality tests for European savings banks are inconsistent with the findings of Berger and DeYoung for US commercial banks. There is significant evidence to suggest that the most pressing problem for European banks is bad management and that the most efficient European banks do not engage in skimping behaviour (the latter contrasts with the most efficient US banks). Whilst there is also evidence of bad luck and moral hazard behaviour at European banks, these findings are statistically weak compared to the significant US results. We attribute this to our specification of loan loss provision as a proxy for problem loans since data limitations prevented the choice of a balance sheet measure of asset quality. [5]

The remainder of the paper is organised as follows. Section 2 has two sub-sections. In sub-section 2.1, the four management hypotheses are reviewed whilst the econometric model used to test the intertemporal relationships between the variables is presented in sub-section 2.2. Section 3 describes the efficiency methodology that is used to estimate operating cost efficiency and alternative profit efficiency. The estimates of the Granger causality tests are discussed in two sub-sections in Section 4; first, at the European level and second, by country. A third sub-section in Section 4 considers the effects of increasing the number of lags in Eqs. (1)–(3) whilst sub-section 4.4 discusses the economic effects of management behaviour are discussed. Section 5 offers some conclusions.

2. Management behaviour

2.1. Expected relationships between variables

Four modes of management behaviour have been identified by Berger and DeYoung (1997). They are so-called bad management, bad luck, skimping behaviour, and moral hazard behaviour. Each behavioural mode maybe identified through the intertemporal ordering of the relationships between loan loss provision, efficiency, and capitalisation. Whilst Berger and DeYoung used the amount of problem loans as their indicator of asset quality, we have selected loan loss provision as our indicator because of data limitations. The discussion below outlines each of the management hypotheses and the expected relationships between the variables.

Bad management implies that low cost efficiency Granger-causes larger amounts of loan loss provision (implying deteriorating asset quality) because management fails to control operating costs, which immediately realises low cost efficiency suggesting that poor managerial practice causes an increase in loan loss provision after a lag. In badly managed banks, low levels of cost efficiency signal poor senior man-

[5] Loan loss provisions are subject to managerial discretion and may be over or under stated in any given year. They have been chosen because of insufficient data on problem loans or loan loss reserves. The use of provisions does present some anomalies. For instance, in Eq. (2) the independent variable LLP is partly endogenous to management behaviour. This implies that bad luck could be deterministic and not random. We thank an anonymous referee for bringing this matter to our attention.

agement quality. Poor managers do not adequately control or monitor operating expenses and loan portfolio management is weak. Specifically, so-called bad managers exhibit the following tendencies. They are not adept at credit scoring and select a relatively high proportion of investments with low or negative net present values; collateral is improperly valued; and customers are not sufficiently monitored in order to ensure compliance with the loan contract. Indeed, several of these characteristics have been identified in the principal agent literature as examples of expense preference behaviour (Peristiani and Wizman, 1997) and the quiet life hypothesis (Berger and Hannan, 1998).

Managers that engage in skimping behaviour reduce the amount of bank resources that are expended on monitoring and underwriting lending business. The outcome affects the quality of loans and the level of cost efficiency because bank managers face a trade-off between short-term operating costs and future loan quality. The decision facing management is should they minimise short-term operating costs through reducing expenditure on monitoring borrowers in an attempt to enhance long-term profitability. Therefore, management postpones dealing with deteriorating asset quality until an unspecified future date. Skimping behaviour gives the misleading impression that banks are cost efficient in the short-term because fewer resources are supporting the same quantity of output, which suggests that the amount of loan loss provision will increase over time. The skimping hypothesis predicts an expected positive relationship between cost efficiency and loan loss provision with the former Granger-causing increases in the latter. The difference between bad management and skimping is that Granger causality from cost efficiency to loan loss provision is negative for the former hypothesis and positive for the latter. Following a recommendation by Berger and DeYoung (1997), we re-test for skimping behaviour using estimated alternative profit efficiency as the measure of bank efficiency in place of estimated operating cost efficiency. [6]

According to the bad luck hypothesis, exogenous events increase loan loss provision (reducing asset quality) that Granger causes a decrease in cost efficiency. As a consequence, management must allocate additional resources including greater managerial effort to deal with this adverse situation, which in turn raises operating costs. Operating costs could increase for several reasons; monitoring delinquent borrowers and valuing collateral; if default occurs, seizing, storing and disposing of collateral; maintaining the bank's record on safety and soundness to regulators and market participants; allocating extra resources to protect the quality of existing loans; and diverting senior management away from their daily responsibilities. Whereas bad luck has the opposite temporal ordering to bad management, both hypotheses predict that loan loss provision is negatively correlated with cost efficiency.

Moral hazard behaviour suggests that managers of thinly capitalised banks are less risk averse because the upside risk of low capitalisation outweighs the downside

[6] We use estimated profit efficiency to re-test for skimping behaviour because skimping behaviour reduces output quality, which affects both costs and revenues. As problem loans increase bank costs rise because, for example, of the need for increased monitoring of borrowers. Revenues, on the other hand, will be lost because of rising problem loans.

risk. In other words, expected return is positively related to the amount of risk assumed by bank management whilst the bank has relatively less capital to lose in the event of default. The moral hazard hypothesis predicts that low bank capitalisation Granger-causes an increase in loan loss provision (a deterioration of asset quality).

2.2. Econometric modelling of management behaviour

We adopt the Granger causality framework used by Berger and DeYoung (1997) in their study of US banks, which implies that our estimates are a robustness test of the results of the former authors. The different types of management behaviour are predicted by the intertemporal relationships between loan loss provision, efficiency, and capitalisation.

The structure of Eqs. (1)–(3) shows that each dependent variable is regressed on annual lags of it and the two other variables. For instance, a significant relationship between current and past (lagged) cost efficiency would imply that the latter contains information that improves our prediction of current cost efficiency. In other words, the level of cost efficiency in period(s) i Granger cause cost efficiency in year j.

Eq. (1) tests the bad management hypothesis. A priori bad management predicts a negative relationship between loan loss provision and lagged X-efficiency. A positive relationship between the two variables, however, suggests skimping behaviour. It is expected that the more efficient banks are most likely to engage in skimping behaviour. Therefore, Eq. (1) is re-estimated for a sub-sample of the most efficient banks. Eq. (1) also tests moral hazard behaviour using a sub-sample of thinly capitalised banks. We expect a negative relationship between loan loss provision and lagged capitalisation. Eq. (2) tests the bad luck hypothesis. We expect an inverse relationship between operating cost efficiency and lagged loan loss provision.

$$\mathrm{LLP}_{i,t} = f_1(\mathrm{LLP}_{i,\mathrm{lag}}, \mathrm{XEFF}_{i,\mathrm{lag}}, \mathrm{CAP}_{i,\mathrm{lag}}, \mathrm{LTA}_{i,\mathrm{lag}}, \mathrm{Yr}_t) + \varepsilon_{1i,t}, \tag{1}$$

$$\mathrm{XEFF}_{i,t} = f_2(\mathrm{LLP}_{i,\mathrm{lag}}, \mathrm{XEFF}_{i,\mathrm{lag}}, \mathrm{CAP}_{i,\mathrm{lag}}, \mathrm{LTA}_{i,\mathrm{lag}}, \mathrm{Yr}_t) + \varepsilon_{2i,t}, \tag{2}$$

$$\mathrm{CAP}_{i,t} = f_3(\mathrm{LLP}_{i,\mathrm{lag}}, \mathrm{XEFF}_{i,\mathrm{lag}}, \mathrm{CAP}_{i,\mathrm{lag}}, \mathrm{LTA}_{i,\mathrm{lag}}, \mathrm{Yr}_t) + \varepsilon_{3i,t}. \tag{3}$$

The bad management, skimping and moral hazard hypotheses are tested using the estimated parameters of Eq. (1) whilst the bad luck hypothesis is tested using the estimated parameters of Eq. (2). Eq. (3) is included to complete the model, and is not used to test any of the four hypotheses. Following Berger and DeYoung (1997), we check to see whether the estimated parameters of Eq. (3) make economic sense in a Granger-causal framework.

Eqs. (1)–(3) are estimated using OLS techniques and they specify the following variables. The ratio of loan loss provision-to-loans ($\mathrm{LLP}_{i,t}$) is an indicator of asset quality. Two estimates of efficiency are used in this study ($\text{X-EFF}_{i,t}$). Following the recommendation of Berger and DeYoung and in addition to estimating operating cost efficiency, we also estimate alternative profit efficiency (see footnote 6). The ratio of equity-to-total assets is the measure of bank capitalisation and indicates the size of banks' financial cushion for absorbing losses emanating from the loan portfolio ($\text{CAP}_{i,t}$). In order to control for risk and other factors we specify two control variables in each equation. The ratio of loans-to-assets ($\text{LTA}_{i,t}$) is a proxy of credit risk. Although in their study Berger and DeYoung (1997) specified the ratio of risk weighted assets-to-total assets, we are limited by data restrictions. A priori loan intensive balance sheets increase credit risk and are more costly to maintain, which should increase the pressure on bank management to improve efficiency. The inclusion of a set of dummy variables (YEAR_t) for each time period (bar one) inter alia controls for changes in the macroeconomic environment like falling interest rates and regulatory changes such as those emanating from European financial deregulation, as well as changes in technology.

3. Cost and profit efficiency

The combination of technical and allocative inefficiencies is commonly referred to as X-inefficiency and is regarded as a measure of the quality of management (see Leibenstein, 1966). Technical inefficiency results from bank management employing too much input to produce output whereas allocative inefficiency arises from management's failure to react optimally to the relative price of input. The concept of cost efficiency measures the distance of a bank's cost relative to the cost of the best practice bank when both banks produce the same output under the same conditions. More specifically, cost efficiency is the estimated cost a particular bank faces if it is to produce its output as efficiently as the most efficient bank divided by the actual cost for the bank adjusted for random error. Profit efficiency is the ratio of predicted actual profit to predicted maximum profit, which could be earned if a bank was as efficient as the best practice bank after adjusting for random error. Profit inefficiency estimates may be interpreted as the amount of profit that is being lost to inefficiency and it emphasises that bank management should pay attention not only to the marginal cost of raising financial resources, but also to the raising of marginal revenue. [7]

Whereas data for loans, assets, capital, and loan loss provision are available from banks' financial statements, efficiency must be estimated. We estimate two types of bank efficiency. The cost efficiency measure is operating cost efficiency, which is chosen over variable cost efficiency because the resources that may be expended because of bad luck, bad management, and skimping and moral hazard behaviour impact either on staff costs or non-interest expenses. In support, the bank efficiency literature reports that operating costs comprise the bulk of bank cost inefficiencies (Berger and Humphrey, 1991). Alternative profit efficiency is chosen over standard profit efficiency because of data limitations.

[7] See Berger and Mester (1997) for a discussion of the relative merits of the concepts of cost efficiency, standard profit and alternative profit efficiency.

Inefficiency is estimated using the stochastic frontier and Fourier flexible form methodologies. Stochastic frontier analysis was proposed by Aigner et al. (1977), Meeusen and van den Broeck (1977) and Battese and Corra (1977). These models have a two component error term. The first error component is symmetric and captures the random variation of the frontier across firms, statistical noise, measurement error, and random shocks that are external to the firm's control. The second error component is a one-sided variable that captures inefficiency relative to the frontier. Jondrow et al. (1982) enhanced the methodology by developing a method for estimating firm-level inefficiency.

We estimate bank efficiency using the stochastic frontier model of Battese and Coelli (1995) in which the inefficiency term is drawn from a truncated normal distribution. The model is a "one-step" procedure in which the stochastic frontier is specified using the Fourier flexible functional form whilst the level of firm inefficiency is determined by a vector of environmental and firm-specific variables that a priori are postulated to affect inefficiency (see Wang and Schmidt (2002), for a discussion of one-step and two-step methods). The importance of specifying environmental variables in order to avoid bias in efficiency models has been noted in the existing literature (see Dietsch and Lozano-Vivas, 2000; Chaffai et al., 2001; Lozano-Vivas et al., 2001; Lozano-Vivas et al., 2002). The vector of environmental and firm-specific variables used herein is described in Table 12 in the Appendix.

The model is written for panel data in Eq. (4) with the inefficiency effects being specified in Eq. (5).

$$Y_{it} = \exp(x_{it}\beta + V_{it} + U_{it}), \tag{4}$$

$$U_{it} = Z_{it}\delta + W_{it}, \tag{5}$$

where Y_{it} denotes the cost for the tth observation ($t = 1, 2 \dots T$) for the ith firm ($i = 1, 2 \dots N$); x_{it} is a $(1 \times k)$ vector of known inputs and outputs associated with the ith observation at the tth period of observation; β is a $(k \times 1)$ vector of unknown parameters to be estimated; V_{it} are independently and identically distributed $N(0, \sigma_v^2)$ random errors that are independently distributed of the U_{it}'s, which are non-negative random variables accounting for the cost of inefficiency in production; U_{it} are independently distributed, such that U_{it} is obtained by truncation (at zero) of the normal distribution with mean, $Z_{it}\delta$, and variance, σ^2, that is $N(m_{it}, \sigma_u^2)$, where $m_{it} = Z_{it}\delta$; Z_{it} is a $(1 \times m)$ vector of firm-specific and environmental variables that are allowed to vary over time; and δ is an $(m \times 1)$ vector of unknown coefficients of the firm-specific inefficiency variables; W_{it} is defined by the truncation of the normal distribution with zero mean and variance, σ^2, such that the point of truncation is $-Z_{it}\delta$. That is, $W_{it} \geqslant -Z_{it}\delta$, which is consistent with the U_{it}'s being non-negative truncations of the $N(Z_{it}, \delta, \sigma^2)$ distribution.

Battese and Coelli (1995) show that when Eq. (4) is assumed, the cost efficiency for the ith firm at the tth observation is defined by Eq. (6).

$$\mathrm{TE}_{it} = \exp(-U_{it}) = \exp(-Z_{it}\delta - W_{it}). \tag{6}$$

The W-random variables are not identically distributed and could be negative if $Z_{it} > 0$, that is, $W_{it} \geqslant -Z_{it}\delta$. The W-random variables are independent truncations of the normal distribution with zero mean and variance, σ^2.

The cost and profit functions are specified using the Fourier flexible functional form. The Fourier is a semi-nonparametric approach and is used to tackle the problem arising when the true functional form of the relationship is unknown. Gallant (1981, 1982), Mitchell and Onvural (1996), Ivaldi et al. (1996), and Berger et al. (1997) note that the Fourier is a global approximation, which can represent a broader range of cost structures than other functional forms. For instance, the Fourier has been shown to dominate the conventional translog functional form that has been commonly applied in bank cost studies (see Mitchell and Onvural, 1996; Berger and Mester, 1997) whereas Ivaldi et al. (1996) finds that the Fourier better captures sample heterogeneity than the translog. In addition, the local point estimate produced by the translog functional form is found to be inappropriate to approximate the true or underlying technology of an industry (Ivaldi et al., 1996). Following Berger and Mester (1997), this study applies the trigonometric Fourier terms only for output, leaving the input price effects to be defined entirely by the translog terms. [8] The bank production process is modelled according to the intermediation approach which considers banks to be financial intermediaries that purchase input in order to generate earning assets (see Sealey and Lindley, 1977). The operating cost efficiency and alternative profit efficiency models have four common outputs but the former model has two inputs compared to three in the latter model. Standard restrictions of linear homogeneity in input prices and symmetry of the second order parameters are imposed.

The model specification for the operating cost function is shown in Eq. (7):

$$\begin{aligned}
\ln \mathrm{OC} = {} & \alpha_0 + \sum_{i=1}^{4} \beta_i \ln Q_i + \sum_{l=1}^{2} \psi_l \ln P_l \\
& + 1/2\left[\sum_{i=1}^{4}\sum_{j=1}^{4} \theta_{ij} + \ln Q_i \ln Q_j + \sum_{l}^{2}\sum_{m}^{2} \psi_{lm} \ln P_l \ln P_m\right] \\
& + \sum_{i=1}^{4}\sum_{m=1}^{2} \eta_{im} \ln Q_i \ln P_m + \sum_{i=1}^{4}[a_i \cos(z_i) + b_i \sin(z_i)] \\
& + \sum_{i=1}^{4}\sum_{j=1}^{4} [a_{ij}\cos(z_i + z_j) + b_{ij}\sin(z_i + z_j)] \\
& + \sum_{i=1}^{4}\sum_{j=1}^{4}\sum_{k \geqslant j, k \neq i}^{4} [a_{ijk}\cos(z_i + z_j + z_k) + b_{ijk}\sin(z_i + z_j + z_k)] + v_i + \mu_i,
\end{aligned} \tag{7}$$

[8] Following Berger and Mester (1997), 10% is cut off each end of the $[0, 2\pi]$ interval so that the z_i span $[0.1\times2\pi,\ 0.9\times2\pi]$ in order to reduce approximation problems near endpoints. The formula for z_i is $0.2\pi - \mu \times a + \mu \times \text{variable}$, where $[a, b]$ is the range of the variable being transformed, and $(\mu \equiv 0.9 \times 2\pi - 0.1 \times 2\pi/(b - a))$.

where $\ln \mathrm{OC}$ is the natural logarithm of operating cost; $\ln Q_i$ is the natural logarithm of bank output (customer loans, securities (and interbank assets), customer deposits and non-interest income); $\ln P_l$ is the natural logarithm of ith input prices (the prices of labour and physical capital; and the price of financial capital for the alternative profit function only); Z_i are the adjusted values of the log of output $\ln Q_i$ such that they span the interval $[0, 2\pi]$; v_i are identical and independently distributed random variables, which are independent of the μ_i, which are non-negative random variables that are assumed to account for inefficiency.

In the alternative profit function, $\ln OP$ is the natural logarithm of operating profit where a constant term, θ, is added if any bank reports an operating loss (is equal to the minimum operating profit plus one so that the natural log is taken of a positive number).

α, β, ψ, θ, η, a and b are the parameters to be estimated using maximum likelihood methods.

The estimated parameters of the cost and profit functions are shown in Tables 13 and 14. We make no attempt to control for asset quality or risk in the arguments of the cost and profit functions. This is because it is unknown if problem loans are exogenous (due to bad luck) or endogenous (due to bad management or skimping). Arguably, problem loans should be controlled for if they are exogenous and cause lower bank efficiency whereas endogenous problem loans should not be controlled because managerial practice lowers efficiency. [9]

4. Empirical results

Eqs. (1)–(3) were estimated for the sample of European savings banks using data from 1990 to 1998. An F-test procedure supported the specification of four lagged periods in each model. Management behaviour is determined by a significant relationship between a dependent variable and the sum of the lagged coefficients on a particular explanatory variable. Subsequently, Eqs. (1)–(3) were re-estimated for each of the six countries.

Generally speaking, there is weak statistical support to suggest the presence of the different types of management behaviour. In some cases, our ex ante predictions were not realised ex post. Possible explanations for the weak statistical associations include the sample size and the use of loan loss provision which may be subject to management discretion and therefore could contain an element of endogeneity.

Table 1 shows the descriptive statistics for the European savings banks sample after four lagged periods. In total, there are 2573 observations. Mean European bank operating cost efficiency at 0.8395 is consistent with estimates in the established bank efficiency literature. Our alternative profit efficiency estimates imply that European banks lose just over 20% of potential profit to inefficiencies. The mean ratio of

[9] For a discussion of the case for specifying asset quality and risk as arguments in cost functions see McAllister and McManus (1993), Mester (1996), Berger and Mester (1997), and Hughes et al. (2001).

Table 1
Descriptive statistics: mean and standard deviation (four lags)

Country	N	Cost efficiency	Profit efficiency	LLP/loans	Equity/assets	Loans/assets
EU-6	2573	0.8395	0.7985	0.0175	0.0729	0.5838
		(0.1117)	(0.1538)	(0.0085)	(0.0498)	(0.1438)
Denmark	470	0.7263	0.9165	0.0219	0.1461	0.4808
		(0.1177)	(0.0552)	(0.0126)	(0.0665)	(0.1300)
France	46	0.8078	0.3854	0.0120	0.0388	0.3073
		(0.0406)	(0.0905)	(0.0016)	(0.0093)	(0.0392)
Germany	1159	0.9054	0.7920	0.0170	0.0427	0.6062
		(0.0710)	(0.1251)	(0.0061)	(0.0080)	(0.0991)
Italy	269	0.8357	0.7057	0.0222	0.0979	0.4754
		(0.0737)	(0.1745)	(0.0109)	(0.0249)	(0.0950)
Spain	249	0.7509	0.7136	0.0166	0.0581	0.5346
		(0.0948)	(0.1764)	(0.0054)	(0.0164)	(0.1020)
UK	380	0.8431	0.8438	0.0116	0.0709	0.7851
		(0.0880)	(0.1229)	(0.0019)	(0.0197)	(0.0379)

Standard deviations are in parentheses.
Source: Building Societies Association (1990–1998), Danish Supervisory Authority (1990–1998), CECA. (1990–1997), BankScope (2000).

loan loss provision-to-loans shows little variation as measured by the standard deviation whereas there is much greater variation in the ratios of equity-to-assets and loans-to-assets. On an individual country basis, the average German bank is the most cost efficient and has the second most loan intensive balance sheet (after the average UK bank). Whereas the average Danish bank loses less potential profit to inefficiencies, it has the highest level of capitalisation (and also the largest standard deviation) but the poorest asset quality (after the average Italian bank). The average French bank is characterised by relatively low profit efficiency, low level of capitalisation, the least loan intensive balance sheet yet the best asset quality (after the average UK bank). Italian banks appear well capitalised but have the poorest asset quality. The cost and profit efficiencies of the average Spanish and UK banks are relatively consistent compared to the average bank in the other countries.

4.1. OLS estimates of Granger causality tests for European banks

We discuss the estimates of the Granger causality tests in Eqs. (1)–(3) for European savings banks. Table 2 shows the OLS estimates of Granger causality tests in loan loss provision Eq. (1). A priori an inverse relationship between loan loss provision and lagged cost efficiency indicates bad management whereas a positive relationship suggests skimping behaviour. The lagged cost efficiency coefficient is found to be significantly negative at the five percent level of significance, which is strong statistical evidence that European bank managers exhibit characteristics of bad management. In other words, a decrease in cost efficiency temporally precedes an increase in loan loss provision (worsening asset quality). The relationship between loan loss provision and lagged loans-to-assets (an indicator of credit risk) is weakly negative. This suggests that banks with more loan-intensive balance sheets have higher asset quality. Possibly, banks that produce better quality information about their customers and market conditions could achieve comparative advantage over their competitors because management uses its information advantage to properly evaluate and effectively manage credit risk. [10,11]

On the recommendation of Berger and DeYoung (1997) we re-test for evidence of either bad management or skimping behaviour using estimated profit efficiency as the efficiency measure instead of cost efficiency. This is done because the concept of cost efficiency classifies banks that increase costs in order to generate higher revenues as inefficient whereas alternative profit efficiency is not beset by this problem (see Berger and Mester, 1997). The parameter estimates are shown in Table 3. The results, however, are not robust to the change in measured efficiency. Table 3 shows no evidence of bad management as the relationship between loan loss provision and lagged profit efficiency is positive although statistically weak.

In order to test for skimping behaviour by European banks, a sub-sample of the most efficient banks is constructed. The sub-sample of the most cost efficient banks comprises banks whose efficiencies are greater than the median efficiency in each of the four lagged periods. A similar sub-sample is constructed using estimated profit efficiency as the efficiency measure. Eq. (1) is re-estimated using the sub-samples of the most efficient banks and the parameter estimates are shown in Table 4. The relationship between loan loss provision and lagged cost efficiency is negative and significant at the ten percent level of significance, which rejects any notion of skimping behaviour by cost efficient European banks. When estimated profit efficiency is the efficiency measure, we note the inverse relationship between loan loss provision and lagged credit risk which we interpret as implying that the most profit efficient managers are adept at managing credit risk. Whilst the empirical findings do not suggest that European banks show any tendencies towards skimping behaviour they tend to suggest that cost efficient banks are subject to bad management (at the ten percent level of significance).

Moral hazard behaviour is tested using Eq. (1) and a different sub-sample of European banks. The moral hazard hypothesis suggests that thinly capitalised banks assume additional portfolio risk, which eventually Granger causes an increase in loan loss provision. We test for evidence that European bank management engages in moral hazard behaviour using a sub-sample of the least capitalised banks, which is defined as those institutions with equity-to-assets below the sample median in the first lagged year. Therefore, we investigate the nature of the relationship between loan loss provision and lagged capitalisation. The parameter estimates of this model are shown in the final two columns of Table 4. In the first of these two columns, estimated cost efficiency is the efficiency measure whilst alternative profit efficiency is the

[10] See Dow and Rodríguez-Fuentes (1997) for a review of the regional finance literature and a more detailed discussion of this point.

[11] A recent stream of literature discusses the importance of information production when banks lend to opaque borrowers. This literature identifies the types of bank organisational structure that best facilitate the production of so-called 'soft' information that is an important aspect of relationship banking (see Berger et al., 2001a,b; Berger and Udell, 2002).

Table 2
OLS estimates of Granger causality tests in loan loss provision equation (1)

	EU-6	DK	FR	GE	ITA	SP	UK
Constant	0.0230**	0.0216**	0.0095	0.0434**	0.0228*	0.0100	0.0006
	10.05	2.83	0.51	10.13	2.47	1.77	0.15
LLP-1	0.2827**	0.3002**	0.407	0.0633*	0.4386**	0.4431**	0.8128**
	14.03	6.13	1.4	1.96	7.86	6.48	14.78
LLP-2	0.3537**	0.2993**	−0.1727	0.3701**	−0.0138	0.1904*	−0.2497**
	14.88	5.54	−0.31	8.51	−0.23	2.29	−3.03
LLP-3	0.1119**	0.0557	−0.0285	0.0905*	0.1171	−0.0556	0.1237
	4.30	0.89	−0.05	2.17	1.89	−0.62	1.08
LLP-4	−0.0070	0.0549	−0.164	0.0724*	−0.0021	0.0178	−0.2111*
	−0.24	0.74	−0.26	1.97	−0.03	0.16	−2.02
LLP-T	0.7413**	0.7101**	0.0418	0.5962**	0.5398**	0.5957**	0.4757**
	14.87	5.86	0.04	7.68	4.37	3.33	2.58
XEFF-1	−0.0021	0.0239	−0.01308	−0.0269**	0.003	−0.0013	−0.0048
	−0.48	1.52	−0.38	−4.92	0.24	−0.12	−1.6
XEFF-2	−0.0307**	−0.0399*	0.00317	0.0014	−0.015	0.0131	0.0043
	−6.29	−2.45	0.09	0.21	−0.99	0.93	1.21
XEFF-3	0.0311**	0.0354	0.0521	−0.0059	0.009	−0.0178	0.0013
	6.67	2.47	1.34	−0.93	0.59	−1.33	0.40
XEFF-4	−0.0199**	−0.0354**	−0.0423	0.0087*	−0.0101	0.0140	0.0028
	−5.85	−3.18	−1.16	2.03	−0.74	1.35	1.28
XEFF-T	−0.0216*	−0.016	−0.0001	−0.0226	−0.0132	0.0081	0.0036
	−2.49	−0.55	0.00	−1.95	−0.46	0.33	0.59
CAP-1	−0.0682**	−0.0719**	−0.296	−0.1941	−0.0142	−0.3046*	−0.025
	−5.14	−2.59	−0.73	−1.81	−0.34	−2.27	−0.63
CAP-2	0.0177*	0.0128	0.911	0.1063	0.0611	0.4527*	0.098
	2.08	0.92	1.12	0.64	1.01	2.29	1.54
CAP-3	0.0352**	0.0146	−0.8353	−0.0226	−0.0831	−0.2960	−0.091*
	4.30	1.08	−1.26	−0.2	−1.26	−1.59	−2.16
CAP-4	0.0229**	0.0097	0.2073	−0.0089	0.0392	0.0874	0.0077
	3.19	0.79	0.5	−0.27	0.67	0.76	0.74
CAP-T	0.0076	−0.0348	−0.013	−0.1193	0.0032	−0.0605	−0.0104
	0.40	−0.97	−0.01	−0.52	0.03	−0.19	−0.12
LTA-1	0.0109	0.0168	0.0498	−0.0154	−0.0045	0.0097	0.0106
	1.69	0.95	0.81	−1.56	−0.26	0.58	1.74
LTA-2	−0.0090	−0.0196	−0.1175	−0.0196	0.0005	−0.0253	−0.0089
	−1.02	−0.92	−1.18	−1.32	0.02	−1.03	−1.29
LTA-3	−0.0263**	−0.023	0.0941	0.0103	−0.0162	0.0127	0.003
	−3.89	−1.36	1.21	0.98	−0.66	0.68	0.48
LTA-4	0.0214**	0.0405**	−0.0092	0.0066*	0.0114	−0.0027	−0.0018
	7.37	4.07	−0.17	2.15	0.61	−0.38	−0.41
LTA-T	−0.0029	0.0148	0.0172	−0.0181	−0.0088	−0.0055	0.003
	−0.22	0.44	0.11	−0.86	−0.21	−0.16	0.25
Year 95	−0.0005	−0.0052	−0.0065	−0.0038*	−0.0014	0.0047*	0.0002
	−0.60	−1.84	−0.79	−2.51	−0.61	2.41	0.46
Year 96	−0.0006	−0.0011	0.0026	−0.0041**	−0.0035	−0.0040*	0.0031**
	−0.74	−0.42	0.25	−3.15	−1.58	−2.24	6.82
Year 97	0.0034**	0.0098**	−0.0001	−0.0006	0.0076**	0.0071**	0.0026**
	4.61	3.31	−0.01	−0.44	3.32	3.81	5.84
Year 98	0.0058**	−0.0001	−0.0018	0.0066**	0.0032	−0.0012	0.001
	7.78	−0.02	−0.18	5.38	1.26	−0.52	1.78

(*continued on next page*)

Table 2 (*continued*)

	EU-6	DK	FR	GE	ITA	SP	UK
R^2 (adj)	46.30	38.60	21.00	51.30	38.60	34.90	58.10
N	2566	464	46	1158	269	249	380

*Statistically significant at 5% level of significance (two-tail test).
**Statistically significant at 1% level of significance (two-tail test).

Table 3
OLS estimates of Granger causality tests in loan loss provision equation (1) using profit efficiency estimates

	EU-6	DK	FR	GE	ITA	SP	UK
Constant	0.0084**	0.0325	0.0149	0.0281**	0.0148**	0.0139**	0.0046
	5.04	1.66	1.25	9.35	3.40	3.28	0.95
LLP-1	0.3030**	0.2864**	0.4140	0.0826*	0.5097**	0.5491**	0.7937**
	13.94	5.77	1.70	2.36	8.99	6.48	14.26
LLP-2	0.3593**	0.3485**	−0.0311	0.3312**	−0.0386	0.1799	−0.2217**
	14.16	6.43	−0.06	6.90	−0.62	1.71	−2.62
LLP-3	0.0844**	0.0321	−0.2308	0.1321**	0.1101	−0.1102	0.1731
	3.03	0.50	−0.43	2.78	1.76	−1.02	1.48
LLP-4	−0.0262	0.0526	−0.1601	0.0328	0.0252	−0.0399	−0.2229*
	−0.86	0.70	−0.23	0.78	0.38	−0.32	−2.10
LLP-T	0.7205**	0.7196**	−0.0080	0.5786**	0.6064**	0.5789**	0.5222**
	13.56	5.85	−0.01	6.66	4.87	2.71	2.78
XEFF-1	−0.0067**	0.0006	−0.0013	−0.0055	−0.0207**	−0.0154**	0.0035
	−2.96	0.04	−0.21	−1.87	−4.15	−2.86	1.35
XEFF-2	0.0051	−0.0118	0.0007	0.0074*	0.0143*	0.0017	−0.0036
	1.90	−0.79	0.08	2.07	2.48	0.26	−1.24
XEFF-3	0.0043	0.0014	−0.0093	−0.0026	0.0008	0.0063	−0.0012
	1.61	0.08	−0.92	−0.80	0.13	0.95	−0.56
XEFF-4	−0.0008	−0.0130	0.0007	0.0029	−0.0004	0.0054	−0.0013
	−0.41	−0.86	0.06	1.32	−0.07	1.07	−0.99
XEFF-T	0.0019	−0.0228	−0.0092	0.0022	−0.0060	−0.0019	−0.0027
	0.39	−0.74	−0.50	0.36	−0.53	−0.16	−0.57
CAP-1	−0.0534**	−0.0651*	−0.2569	−0.0947	0.0045	−0.3163*	−0.0330
	−3.95	−2.28	−0.56	−0.86	0.11	−2.43	−0.83
CAP-2	0.0141	0.0106	0.8023	−0.0192	0.0620	0.4906*	0.0840
	1.62	0.74	0.94	−0.11	1.07	2.51	1.31
CAP-3	0.0401**	0.0169	−0.7556	−0.0367	−0.0939	−0.3007	−0.0660
	4.79	1.20	−1.14	−0.31	−1.47	−1.62	−1.54
CAP-4	0.0240**	0.0087	0.2374	−0.0012	0.0539	0.0793	0.0071
	3.25	0.69	0.54	−0.03	0.94	0.70	0.65
CAP-T	0.0247	−0.0289	0.0272	−0.1518	0.0265	−0.0471	−0.0078
	1.26	−0.78	0.02	−0.64	0.24	−0.15	−0.09
LTA-1	0.0127*	0.0329*	0.0491	−0.0256**	−0.0086	0.0103	0.0042
	2.01	2.17	0.84	−2.57	−0.54	0.68	0.74
LTA-2	−0.0270**	−0.0386	−0.1154	−0.0214	−0.0051	−0.0189	−0.0054
	−3.09	−1.87	−1.32	−1.40	−0.24	−0.84	−0.85
LTA-3	−0.0118	−0.0171	0.1223	0.0099	−0.0142	0.0123	0.0048
	−1.79	−1.09	1.52	0.93	−0.63	0.71	0.81
LTA-4	0.0152**	0.0297**	−0.0418	0.0100**	0.0161	−0.0032	0.0002
	5.90	3.61	−0.70	3.91	0.90	−0.47	0.06
LTA-T	−0.0110	0.0069	0.0142	−0.0271	−0.0118	0.0005	0.0037
	−0.85	0.22	0.10	−1.27	−0.30	0.01	0.34

Table 3 (*continued*)

	EU-6	DK	FR	GE	ITA	SP	UK
Year 95	−0.0012	−0.0029	−0.0102	−0.0045**	−0.0039	0.0045*	0.0003
	−1.33	−0.99	−1.54	−2.89	−1.58	2.29	0.65
Year 96	−0.0024**	−0.0034	0.0003	−0.0052**	−0.0021	−0.0045*	0.0030**
	−3.08	−1.24	0.03	−3.61	−0.93	−2.56	6.40
Year 97	0.0021**	0.0145**	−0.0027	−0.0009	0.0037	0.0067**	0.0022**
	2.83	5.14	−0.37	−0.63	1.64	3.56	4.74
Year 98	0.0039**	−0.0029	−0.0035	0.0062**	0.0009	−0.0017	0.0007
	5.18	−1.01	−0.55	4.41	0.32	−0.75	1.20
R^2 (adj)	43.60	36.50	18.20	49.20	42.30	36.90	58.00
N	2566	464	46	1158	269	249	380

*Statistically significant at 5% level of significance (two-tail test).
**Statistically significant at 1% level of significance (two-tail test).

Table 4
OLS estimates of Granger causality tests in loan loss provision equation (1) for sub samples of the data

Predictor	Skimping	Skimping	Moral hazard	Moral hazard
Constant	0.0214**	0.0247**	0.0334**	0.0159**
	4.28	2.66	8.87	5.47
LLP-1	0.3112**	0.2998**	0.1891**	0.2498**
	9.98	8.93	6.16	7.28
LLP-2	0.2133**	0.3709**	0.3828**	0.3597**
	6.15	10.01	8.66	7.06
LLP-3	0.1264**	0.1002	0.0464	0.0880
	3.87	2.42	0.94	1.49
LLP-4	0.0348	0.0144	0.1390**	0.0789
	1.16	0.31	3.05	1.46
LLP-T	0.6857**	0.7854**	0.7572**	0.7763**
	10.67	9.82	8.81	7.71
XEFF-1	0.0001	0.0029	−0.0257**	−0.0061*
	0.02	0.39	−4.68	−2.08
XEFF-2	−0.0241**	0.0014	0.0021	0.0075 *
	−3.63	0.13	0.30	2.07
XEFF-3	0.0075	−0.0086	−0.0047	−0.0047
	1.11	−0.68	−0.68	−1.30
XEFF-4	−0.0039	−0.0122*	0.0011	0.0010
	−1.03	−2.17	0.25	0.41
XEFF-T	−0.0205	−0.0165	−0.0272*	−0.0022
	−1.77	−0.86	−2.21	−0.35
CAP-1	−0.1539**	−0.3239**	−0.2271**	−0.1120
	−4.60	−7.89	−2.74	−1.31
CAP-2	0.1906**	0.2433**	−0.0677	−0.1254
	4.04	4.31	−0.49	−0.86
CAP-3	−0.0548	0.0577	0.1706	0.1443
	−1.31	1.31	1.49	1.18
CAP-4	0.0326*	0.0494*	0.0044	0.0415
	2.04	2.52	0.11	0.98
CAP-T	0.0145	0.0265	−0.1198	−0.0516
	0.20	0.31	−0.59	−0.24

(*continued on next page*)

Table 4 (*continued*)

Predictor	Skimping	Skimping	Moral hazard	Moral hazard
LTA-1	0.0056	0.0368**	−0.0052	−0.0156
	0.82	3.75	−0.53	−1.57
LTA-2	0.0006	−0.0574**	−0.0154	−0.0186
	0.07	−4.20	−1.03	−1.20
LTA-3	−0.0143*	−0.0051	−0.0004	0.0026
	−2.03	−0.50	−0.04	0.23
LTA-4	0.0082**	0.0139	0.0155**	0.0159**
	3.27	3.12*	4.63	5.34
LTA-T	0.0001	−0.0118	−0.0054	−0.0157
	0.01	−0.58	−0.25	−0.72
Year 95	−0.0004	−0.0017	0.0009	−0.0005
	−0.49	−1.13	0.66	−0.34
Year 96	−0.0005	−0.0024	−0.0004	−0.0032**
	−0.70	−1.73	−0.37	−2.66
Year 97	0.0012	0.0027*	0.0023*	−0.0003
	1.64	1.98	2.09	−0.21
Year 98	0.0058**	0.0008	0.0094**	0.0070**
	8.21	0.51	8.79	5.81
R^2 (adj)	37.60	51.20	47.30	43.90
N	1167	992	1135	1135

Notes: The dependent variables are in the columns whilst the predictors are in the rows.
T-statistics are shown below each predictor.
LLP is the dependent variable used to test for skimping behaviour and moral hazard behaviour.
The sample used to test the skimping hypothesis is above median efficiency across the period lag −1 to lag −4. The first XEFF measure is cost efficiency whilst the latter is profit efficiency.
The sub-sample used to test the moral hazard hypothesis is that of the least capitalised banks, that is, banks with a ratio of equity-assets below the median level of 0.0482 in lag −1.
The XEFF variable in the first column for the skimping hypothesis model and the moral hazard hypothesis model is operating cost efficiency whilst profit efficiency is used in the second column.
*Statistically significant at 5% level of significance (two-tail test).
**Statistically significant at 1% level of significance (two-tail test).

measure in the latter column. The negative parameter estimate of lagged capitalisation implies that increases in bank capitalisation Granger cause a reduction in loan loss provision (interpreted as an improvement in asset quality). Whilst there is only weak statistical evidence of moral hazard behaviour at thinly capitalised European banks, we note the significant inverse relationship between loan loss provision and lagged cost efficiency, which offers strong statistical evidence that thinly capitalised European banks are characterised by bad management (at the five percent level of significance).

Bad luck is modelled using Eq. (2) and it implies that deteriorating asset quality measured as an increase in loan loss provision is exogenous to the influence of management. Thus, an increase in loan loss provision Granger causes a decrease in bank cost efficiency, which suggests that after loans go bad bank management expends additional operating costs in trying to remedy the situation. Bad luck is identified by an inverse relationship between cost efficiency and lagged loan loss provision. We find weak statistical evidence that increases in loan loss provision Granger causes a decrease in measured cost efficiency, which implies that European bank management suffers from bad luck (see Table 5). Furthermore, there is weak statistical evidence that an increase in credit risk Granger causes a decrease in cost efficiency.

In order to complete the econometric model presented in Eqs. (1)–(3) we estimate the capitalisation equation (3) for European banks. There are several possible outcomes that provide useful information to policy makers about management

Table 5
OLS estimates of Granger causality tests in X-efficiency equation (2)

	EU-6	DK	FR	GE	ITA	SP	UK
Constant	0.0436**	0.0647*	0.2340	0.1718**	0.2231**	0.0975**	0.2022*
	3.71	2.09	1.21	7.12	4.16	2.66	2.47
LLP-1	0.0208	0.7265**	−0.9390	−1.4565**	0.2593	0.4512	−0.0460
	0.20	3.66	−0.31	−7.99	0.80	1.02	−0.04
LLP-2	−0.3524**	−0.5616**	8.2560	−0.1480	0.3017	−0.0553	−0.4690
	−2.89	−2.56	1.43	−0.60	0.87	−0.10	−0.28
LLP-3	−0.1612	−0.6538**	−8.9910	0.6577**	−0.1416	−0.3535	0.9350
	−1.21	−2.57	−1.60	2.80	−0.39	−0.62	0.40
LLP-4	0.2400	0.0859	3.0060	0.1278	−0.6810	0.1953	−1.7380
	1.62	0.29	0.46	0.62	−1.70	0.27	−0.81
LLP-T	−0.2528	−0.403	1.3320	−0.8190	−0.2616	0.2377	−1.3180
	−0.99	−0.82	0.12	−1.87	−0.36	0.21	−0.35
XEFF-1	0.6459**	0.6927**	0.9237**	0.5740**	0.5067**	0.4926**	0.6129**
	29.49	10.87	2.60	18.63	6.88	7.06	9.96
XEFF-2	0.1547**	0.1175	0.8592*	0.0644	0.2798**	0.2545**	0.2183**
	6.17	1.78	2.26	1.68	3.16	2.80	2.99
XEFF-3	0.0643**	0.0398	−0.5997	0.1268**	0.1084	−0.0514	0.0484
	2.69	0.68	−1.49	3.55	1.24	−0.59	0.73
XEFF-4	0.0575**	−0.0106	−0.3759	0.0334	−0.1450	0.0701	0.0322
	3.29	−0.23	−1.00	1.38	−1.82	1.05	0.72
XEFF-T	0.9224**	0.8393**	0.8073	0.7987**	0.7499**	0.7657**	0.9118**
	20.71	7.13	1.06	12.22	4.53	4.83	7.33
CAP-1	−0.0475	0.0888	−9.7900*	0.9665	−0.0283	−1.5539	−0.6614
	−0.70	0.79	−2.31	1.60	−0.12	−1.79	−0.81
CAP-2	−0.0435	−0.0343	−0.8320	−0.7493	−0.1758	2.0390	1.6660
	−1.00	−0.61	−0.10	−0.80	−0.50	1.60	1.27
CAP-3	−0.0289	−0.0286	18.1990**	−0.2290	0.2816	0.3760	−1.1613
	−0.69	−0.52	2.64	−0.36	0.73	0.31	−1.34
CAP-4	0.0490	−0.0068	−8.4650*	0.3643	−0.1884	−0.6924	0.4097
	1.33	−0.14	−1.96	1.94	−0.55	−0.93	1.91
CAP-T	−0.0709	0.0192	−0.8880	0.3525	−0.1109	0.1687	0.2530
	−0.72	0.13	−0.07	0.27	−0.17	0.08	0.14
LTA-1	0.1601**	0.1747*	0.9489	−0.0269	0.3217**	0.3913**	−0.0814
	4.83	2.43	1.48	−0.48	3.23	3.64	−0.65
LTA-2	−0.1210**	−0.1532	−0.0570	0.0937	−0.362**	−0.4637**	−0.1936
	−2.69	−1.76	−0.06	1.11	−2.79	−2.93	−1.37
LTA-3	−0.0319	−0.0164	−1.8558*	−0.0517	0.1431	0.1532	−0.1088
	−0.92	−0.24	−2.29	−0.87	1.00	1.27	−0.84
LTA-4	−0.0112	0.0352	0.8777	−0.0240	−0.0578	−0.0427	0.1554
	−0.75	0.87	1.52	−1.38	−0.53	−0.94	1.71
LTA-T	−0.0039	0.0403	−0.0862	−0.0089	0.0450	0.0381	−0.2284
	−0.06	0.29	−0.05	−0.08	0.19	0.17	−0.93

(*continued on next page*)

Table 5 (*continued*)

	EU-6	DK	FR	GE	ITA	SP	UK
Year 95	0.0234**	0.0361**	−0.1359	0.0025	−0.0341*	0.0085	0.0399**
	5.42	3.14	−1.59	0.29	−2.50	0.67	4.39
Year 96	0.0288**	0.0598**	−0.0197	0.0132	−0.0655**	0.0097	0.0445**
	7.23	5.38	−0.18	1.79	−5.07	0.84	4.75
Year 97	0.0268**	0.0147	−0.0514	0.0216**	−0.0294*	0.0533**	0.0416**
	6.99	1.22	−0.48	3.09	−2.22	4.40	4.61
Year 98	0.0372**	0.0339**	−0.0406	0.0247**	−0.0354*	0.0310*	0.0592**
	9.74	2.77	−0.40	3.56	−2.38	2.09	5.23
R^2 (adj)	83.40	69.10	69.60	70.10	54.80	68.00	71.90
N	2566	464	46	1158	269	249	380

*Statistically significant at 5% level of significance (two-tail test).
**Statistically significant at 1% level of significance (two-tail test).

Table 6
OLS estimates of Granger causality tests in capitalisation equation (3)

	EU-6	DK	FR	GE	ITA	SP	UK
Constant	0.0081**	0.0315*	0.0124	0.0032*	0.0009	0.0021	0.0129*
	3.83	4.09	1.17	2.20	0.06	0.59	2.42
LLP-1	0.0597**	−0.0342	0.2396	0.0557**	0.1477	0.1581**	−0.0412
	3.20	−0.7	1.45	5.11	1.75	3.62	−0.56
LLP-2	0.1116**	0.1037	−0.1485	−0.0187	−0.0955	0.0251	0.2481*
	5.07	1.91	−0.47	−1.28	−1.06	0.47	2.25
LLP-3	−0.1671**	−0.1832**	−0.2729	0.0052	−0.0704	−0.1205*	−0.3612*
	−6.94	−2.90	−0.89	0.37	−0.75	−2.12	−2.36
LLP-4	−0.0353	−0.0114	0.3128	−0.0327**	0.0919	0.0580	0.2392
	−1.32	−0.15	0.88	−2.64	0.88	0.81	1.71
LLP-T	−0.0311	−0.1252	0.1310	0.0095	0.0737	0.1208	0.0849
	−0.67	−1.03	0.22	0.36	0.39	1.06	0.34
XEFF-1	−0.0039	−0.0196	0.0069	−0.0008	−0.0361	−0.0026	−0.0034
	−0.98	−1.24	0.36	−0.42	−1.89	−0.38	−0.84
XEFF-2	−0.0216**	0.0007	−0.0105	−0.0010	0.0152	−0.0033	−0.0081
	−4.78	0.04	−0.50	−0.43	0.66	−0.37	−1.72
XEFF-3	0.0232**	0.0111	0.0001	−0.0012	0.0253	−0.0007	0.0056
	5.36	0.77	0.00	−0.56	1.11	−0.09	1.30
XEFF-4	−0.0065*	0.0115	−0.0130	0.0009	−0.0164	−0.0022	0.0025
	−2.07	1.03	−0.63	0.61	−0.79	−0.33	0.85
XEFF-T	−0.0089	0.0037	−0.0165	−0.0021	−0.0121	−0.0089	−0.0035
	−1.10	0.13	−0.40	−0.53	−0.28	−0.57	−0.43
CAP-1	0.9504**	0.8748**	1.4245**	1.0769**	0.7764**	1.1190**	1.1966**
	77.40	31.29	6.14	29.78	12.48	13.03	22.65
CAP-2	−0.0028	0.0020	−0.3482	−0.0865	0.0383	−0.0300	−0.1148
	−0.35	0.14	−0.75	−1.55	0.42	−0.24	−1.35
CAP-3	−0.0047	−0.0064	0.0304	−0.0561	0.1800	−0.1282	−0.1060
	−0.63	−0.47	0.08	−1.46	1.80	−1.07	−1.88
CAP-4	−0.0022	−0.0065	−0.1551	−0.0145	−0.1355	−0.0137	0.0034
	−0.32	−0.53	−0.66	−1.29	−1.53	−0.19	0.24
CAP-T	0.9407**	0.8638**	0.9516	0.9198**	0.8592**	0.9471**	0.9792**
	53.02	23.84	1.40	11.85	4.95	4.56	8.46

Table 6 (*continued*)

	EU-6	DK	FR	GE	ITA	SP	UK
LTA-1	−0.0040	−0.0332	−0.0205	−0.0045	0.0329	−0.0242*	−0.0103
	−0.67	−1.86	−0.58	−1.37	1.27	−2.27	−1.27
LTA-2	0.0047	0.0227	0.0692	0.0059	−0.0161	0.0192	0.0080
	0.58	1.06	1.22	1.18	−0.48	1.22	0.87
LTA-3	−0.0032	−0.0138	−0.0450	0.0004	−0.0795*	0.0015	−0.0057
	−0.52	−0.81	−1.02	0.13	−2.15	0.13	−0.68
LTA-4	0.0013	−0.0149	0.0003	0.0010	0.0701*	0.0068	−0.0043
	0.47	−1.48	0.01	0.99	2.49	1.51	−0.72
LTA-T	−0.0013	−0.0391	0.0040	0.0029	0.0073	0.0033	−0.0123
	−0.11	−1.14	0.05	0.41	0.12	0.14	−0.77
Year 95	0.0029**	0.0115**	−0.0102*	−0.0002	−0.0011	0.0031*	−0.0009
	3.69	4.02	−2.17	−0.31	−0.32	2.50	−1.54
Year 96	0.0035**	0.0050	−0.0028	0.0004	0.0153**	−0.0002	−0.0016*
	4.84	1.83	−0.48	1.00	4.56	−0.20	−2.56
Year 97	0.0035**	0.0098**	0.0017	−0.0003	0.0112**	0.0034**	−0.0026**
	5.00	3.29	0.28	−0.75	3.27	2.84	−4.50
Year 98	0.0026**	−0.0045	−0.0000	−0.0005	0.0164**	0.0039**	−0.0024**
	3.79	−1.47	−0.11	−1.15	4.23	2.64	−3.24
R^2 (adj)	95.30	86.20	96.50	89.90	80.80	89.80	97.60
N	2566	464	46	1158	269	249	380

*Statistically significant at 5% level of significance (two-tail test).
**Statistically significant at 1% level of significance (two-tail test).

behaviour with respect to capitalisation. Should an increase in loan loss provision Granger cause an increase in capitalisation, it could imply that management responds to worsening asset quality by replenishing bank capital. Should a decrease in cost efficiency Granger cause a decrease in bank capitalisation, it could be interpreted as suggesting that cost-inefficient banks have low earnings, which Granger cause a reduction in capital. We find negative but weak relationships between capitalisation and lagged loan loss provision and capitalisation and lagged cost efficiency. An increase in loan loss provision Granger causes a reduction in bank capitalisation, which implies that banks with worsening asset quality problems could face solvency pressures. Similarly, a decrease in cost efficiency Granger causes an increase in bank capitalisation. This could imply that banks respond to efficiency difficulties by boosting their levels of capital as a precautionary step.

The robustness of the estimates from model (3) is tested by dividing the sample into sub-samples of thinly capitalised and high-capitalised European banks. First, we investigate whether management at low and highly capitalised banks responds differently to changes in loan loss provision. Second, these relationships are re-estimated replacing estimated cost efficiency as the efficiency measure with estimated profit efficiency. The results of the re-estimations of Eq. (3) are shown in Table 7.

At thinly capitalised European banks, an increase in loan loss provision Granger causes a statistically significant (at the ten percent level) increase in bank capitalisation when profit efficiency is specified in the model. The positive relationship between capitalisation and lagged loan loss provision suggests that management at thinly capitalised banks either take action or are coerced by regulators to replenish capital

Table 7
OLS estimates of Granger causality tests in capitalisation equation (3) for sub samples of the data

Predictor	Thin	High	Thin	High
Constant	0.0027	0.0115**	−0.0007	−0.0032
	1.87	3.38	−0.71	−1.26
LLP-1	0.0855**	0.0669*	0.1166**	0.0230
	7.38	2.26	9.39	0.76
LLP-2	0.0013	0.1191**	0.0104	0.1434**
	0.08	3.61	0.56	4.32
LLP-3	−0.0616**	−0.1773**	−0.0412	−0.1756**
	−3.32	−5.00	−1.94	−4.87
LLP-4	0.0039	−0.0554	−0.0247	−0.0654
	0.23	−1.36	−1.27	−1.59
LLP-T	0.0291	−0.0468	0.0610	−0.0746
	0.90	−0.67	1.68	−1.06
XEFF-1	−0.0071**	−0.0023	−0.0057**	0.0056
	−3.44	−0.33	−5.38	1.54
XEFF-2	0.0014	−0.0285**	0.0008	−0.0031
	0.52	−3.89	0.63	−0.73
XEFF-3	0.0018	0.0269**	−0.0003	0.0051
	0.69	3.95	−0.27	1.25
XEFF-4	0.0002	−0.0084	0.0025**	0.0081**
	0.15	−1.62	2.80	2.59
XEFF-T	−0.0036	−0.0122	−0.0027	0.0158*
	−0.79	−0.93	−1.18	2.09
CAP-1	1.1157**	0.9462**	1.1245**	0.9331**
	35.73	56.72	36.45	55.57
CAP-2	−0.0975	−0.0010	−0.1076*	−0.0039
	−1.87	−0.09	−2.05	−0.38
CAP-3	−0.0897*	−0.0050	−0.0582	−0.0005
	−2.07	−0.50	−1.32	−0.05
CAP-4	0.0129	−0.0024	0.0067	−0.0063
	0.84	−0.27	0.44	−0.71
CAP-T	0.9414**	0.9378**	0.9655**	0.9224**
	12.35	39.55	12.60	38.77
LTA-1	−0.0020	−0.0070	−0.0023	−0.0110
	−0.56	−0.74	−0.63	−1.28
LTA-2	0.0010	0.0098	0.0027	−0.0055
	0.18	0.81	0.48	−0.48
LTA-3	0.0030	−0.0062	0.0019	0.0051
	0.70	−0.64	0.46	0.56
LTA-4	0.0012	0.0004	0.0012	−0.0014
	0.95	0.09	1.12	−0.30
LTA-T	0.0031	−0.0029	0.0036	−0.0127
	0.39	−0.16	0.45	−0.73
Year 95	0.0007	0.0034**	0.0004	0.0035**
	1.42	2.83	0.89	2.90
Year 96	0.0007	0.0044**	0.0007	0.0037**
	1.70	3.93	1.65	3.34
Year 97	0.0003	0.0044**	0.0007	0.0047**
	0.70	3.96	1.71	4.24
Year 98	0.0002	0.0034**	0.0008	0.0021
	0.53	2.94	1.88	1.85

Table 7 (*continued*)

Predictor	Thin	High	Thin	High
R^2 (adj)	79.40	92.90	79.80	92.90
N	1135	1437	1135	1437

Notes: The dependent variables are in the columns whilst the predictors are in the rows.
T-statistics are shown below each predictor.
The dependent variable is the ratio of equity-to-assets.
Thinly capitalised savings banks are defined as reporting a ratio of equity-to-assets below the median for CAP-1 and high capitalised banks report higher than the median (of 0.0482).
The first XEFF measure is cost efficiency whereas profit efficiency is the second measure.
* Statistically significant at 5% level of significance (two-tail test).
** Statistically significant at 1% level of significance (two-tail test).

after loan loss provision begins to rise. On the contrary, for the sub-sample of highly capitalised European banks an increase in loan loss provision Granger causes a reduction in bank capitalisation though the relationship is not strong statistically. However, there is strong statistical evidence that an increase in profit efficiency Granger causes an increase in bank capitalisation at highly capitalised European banks (at the five percent level). This suggests that profit efficient managers use their additional revenues inter alia to supplement reserves thereby improving the strength of the bank in the eyes of regulators and other market participants. This interpretation is not supported when estimated cost efficiency is the efficiency measure.

4.2. OLS estimates of Granger causality tests for banks at country level

Separate estimates of Eqs. (1)–(3) were carried out for the six countries included in this paper. Whilst the signs of the intertemporal relationships between the variables indicate different types of management behaviour, the statistical relationships are relatively weak (except where noted).

From Table 2, we see the estimates of the Granger causality tests in the loan loss provision Eq. (1) for each country. The negative relationships between loan loss provision and lagged cost efficiency imply bad management for Danish, French, German and Italian banks though the correlation is significant (at the ten percent level) for German banks. For the German, Italian and Spanish banks there is weak evidence that increases in credit risk Granger cause an improvement in asset quality. The finding of bad management is not robust to changes in the efficiency measure. When estimated profit efficiency is used instead of cost efficiency as the efficiency measure, the relationship between loan loss provision and lagged efficiency has the opposite sign for German, Spanish and UK banks (see Table 3).

For Spanish and UK banks, the relationship between loan loss provision and lagged cost efficiency is positive, which might be interpreted as evidence of skimping behaviour though further tests on the most efficient Spanish and UK banks would be required to verify skimping behaviour. Once again, the results are sensitive to the efficiency measure employed in Eq. (1) as the lagged efficiency coefficients are signed differently in Tables 2 and 3.

Table 5 shows the estimates of the Granger causality tests in the X-efficiency equation (2). Specifically, we test for bad luck when [exogenous] increases in loan loss provision Granger cause a reduction in bank cost efficiency. The parameter estimates show a significant relationship (at the ten percent level) for German banks. Furthermore, German banks are the only European banks that show contemporaneous and statistically significant evidence both of bad luck and bad management. Whilst management at Danish banks share this characteristic with their German counterparts, the Danish correlations are insignificant. There is also weak causal evidence of bad luck at Italian and UK banks.

The capitalisation equation (3) is estimated for each country to complete the econometric model. An increase in loan loss provision Granger causes an increase in capitalisation for French, German, Italian, Spanish and UK banks. This suggests that managers respond to deteriorating asset quality by eventually augmenting bank capital. Similarly, managers of banks in the aforementioned countries react to a decrease in bank cost efficiency by capital augmentation. From Table 6, we also note that an increase in the ratio of loans-to-assets Granger causes an increase in capital at the aforementioned banks (except UK). This suggests that as banks assume higher levels of credit risk, managers tend to augment capital stock.

4.3. Robustness tests

The specification of Eqs. (1)–(3) includes four lagged periods. In general, the estimated total coefficients tend to be statistically weak and are inconsistent with estimates derived from equations that include only two lags. Therefore, we test whether our full sample models are better specified with either two or three or four lagged periods. The F-test results strongly reject the null hypothesis that the joint significance of the additional coefficients equals zero thereby supporting the inclusion of three lags over two and four lags over three. However, the general outcome of including more lagged terms weakens the significance of several important relationships though not the signs or the magnitudes of the estimated 'total' coefficients. This suggests there is a trade-off between reducing the unexplained variation in the dependent variables and the significance of the management relationships.

Table 8 shows the total coefficients for the main management hypotheses for the EU sample of banks when the number of lags is increased. Generally, the total coefficients lose their significance as the number of lags increases from two to three and three to four lags although there are exceptions to this generalisation. Eq. (1) is the least sensitive to the number of lags. We note the total coefficient that indicates bad management (cost efficiency) is significant at the 1% level of significance irrespective of increasing the number of lags. There is also strong evidence to support bad management at the most cost efficient banks. However, for this sub-sample of banks the optimal number of lags is three since the level of significance of the total coefficient is greater (at 1%) than when two and four lags are included (at 5% in both cases). Changing the estimate of efficiency from measured cost to measured profit efficiency does not yield any significant evidence of bad management irrespective of the number of lags. Similarly, we find no evidence to support moral hazard behaviour.

Table 8
Robustness tests for the optimal number of lags

Hypothesis	Number of lags on right-hand-side of model		
	2 lags	3 lags	4 lags
Bad management versus skimping	−0.0152**	−0.0155**	−0.0216**
(cost efficiency)	−4.17	−2.59	−2.49
Bad management versus skimping	−0.0130*	−0.0192**	−0.0205*
(above median cost efficiency)	−2.04	−2.53	−1.77
Bad management versus skimping	0.0018	0.0033	0.0019
(profit efficiency)	0.87	0.96	0.39
Bad management versus skimping	−0.0089	0.0063	−0.0165
(above median profit efficiency)	−0.60	0.50	−0.86
Moral hazard	0.0120	0.0156	0.0076
	1.46	1.33	0.40
Moral hazard	−0.1973**	−0.1520	−0.1198
(below median equity-to-assets)	−3.43	−1.31	−0.59
Bad luck	−0.3065*	−0.1985	−0.2528
	−2.40	−1.07	−0.99

* Significant at the 1% level of significance.
** Significant at the 1% level of significance.

However, there is significant evidence of moral hazard (at the 1% level) for the subsample of thinly capitalised banks but this relationship is sensitive to the number of lags since significance is lost when the numbers of lags increases from two to three. The same features are found for bad luck (Eq. (2)), which is significant (at 5%) when two lags are included (see Table 8).

In summary, the significance of the estimated total coefficients is sensitive to the number of lags included in the model. European banks are characterised by bad management, bad luck and moral hazard behaviour (for thinly capitalised banks) when two lags are included. This suggests two lags are optimal in the sense that further increases in the number of lags does not realise any information that improves the predictive power of the models. The exception is bad management where (at least) four lags is optimal for the full sample and three lags is optimal for the most cost efficient banks.

4.4. The economic effects of management behaviour

Our final objective is to examine the economic effects of management behaviour (see Table 9). The economic effects are calculated as follows. For instance, the economic effect of bad management is measured in terms of the effect that a one standard deviation decrease in cost efficiency has on the cumulative increase in loan loss provision over four years.

Focusing attention on European banks, the economic effect of bad management, measured as a one standard deviation decrease in the level of estimated cost efficiency (from 0.8395 to 0.7278), predicts a cumulative increase in loan loss provision of more than 12% over four years. The economic effects of bad luck, however, are much lower. A one standard deviation increase in loan loss provision (from

Table 9
Economic effects of management hypotheses

Economic effects of bad management[a]						
	Sign & sig	Mean XEFF	1 std dev ↓	LLP/L	LLP/L ↑	% change
EU-6	− @ 5%	0.8395	0.7278	0.0175	0.0199	12.12
Denmark	−n.s.	0.7263	0.6711	0.0219	0.0228	3.88
France	+n.s.	0.8078	0.7672	0.0120	0.0120	0.03
Germany	−n.s.	0.9054	0.8344	0.0170	0.0186	8.62
Italy	−n.s.	0.8357	0.7620	0.0222	0.0232	4.20
Spain	+n.s.	0.7509	0.6561	0.0166	0.0158	(4.85)
UK	+n.s.	0.8431	0.7551	0.0116	0.0113	(2.81)
Economic effects of skimping[b]						
			1 std dev ↑			
Cost eff	−n.s.	0.9176	0.9756	0.0165	0.0153	(7.77)
Profit eff	−n.s.	0.8117	0.9384	0.0189	0.0168	(12.44)
Economic effects of moral hazard[c]						
		Mean CAP	1 std dev ↓	LLP/L	LLP/L ↑	% change
Low-cap	−n.s.	0.0420	0.0341	0.0169	0.0178	5.30
Economic effects of bad luck[d]						
		Mean LLP	1 std dev ↑	XEFF	XEFF ↓	% change
EU-6	−n.s.	0.0175	0.0260	0.8395	0.8374	(0.26)
Denmark	−n.s.	0.0219	0.0345	0.7263	0.7212	(0.70)
France	+n.s.	0.0120	0.0136	0.8078	0.8099	0.26
Germany	−n.s.	0.0170	0.0231	0.9054	0.9004	(0.55)
Italy	−n.s.	0.0222	0.0331	0.8357	0.8328	(0.34)
Spain	+n.s.	0.0166	0.0220	0.7509	0.7522	0.17
UK	−n.s.	0.0116	0.0135	0.8431	0.8406	(0.30)

[a] The economic effects of bad management are measured in terms of a one standard deviation decrease in measured efficiency causing an increase in loan loss provision. In the final column, parentheses indicate a reduction in problem loans.

[b] The economic effects of skimping are measured in terms of a one standard deviation increase in measured efficiency causing an increase in loan loss provision. Two sub-samples of the most cost efficient and the most profit efficient European banks are used.

[c] The economic effects of moral hazard behaviour are measured in terms of a one standard deviation reduction in capitalisation causing an increase in loan loss provision. The sub-sample of the least capitalised European banks is used.

[d] The economic effects of bad luck are measured in terms of a one standard deviation increase in loan loss provision causing a decrease in measured XEFF. In the final column, parentheses indicate a reduction in XEFF.

0.0175 to 0.0260) predicts a cumulative reduction in estimated cost efficiency of only 0.26% over four years. Using sub-samples of European banks, we measure the economic effect of skimping behaviour. From Table 4, we recall that there is no evidence of skimping behaviour at efficient European banks. Hence the effect of a one standard deviation increase in cost efficiency (from 0.9176 to 0.9756) predicts a cumulative reduction in loan loss provision of 7.77% (from 0.0165 to 0.0153) over four years. For the most profit efficient European banks (from 0.8117 to 0.9384), the corresponding reduction in loan loss provision (from 0.0189 to 0.0168) is larger at 12.44%. The economic effect of moral hazard behaviour is calculated for the least capitalised sub-sample of European banks. A one standard deviation decrease in capitalisation (from 0.0420 to 0.0341) predicts a cumulative increase in loan loss provision (from 0.0169 to 0.0178) over four years, which constitutes an increase of 5.3%.

Subsequently, we calculate the economic effects of management behaviour for banks in each country. Generally speaking, the economic effects of bad management far outweigh the effects of bad luck. For German banks, bad management predicts a cumulative deterioration in asset quality of 8.62% over four years; for Italian and Danish banks the respective deterioration is 4.20% and 3.88%, respectively. For Spanish and UK banks, however, a one percentage point decrease in mean cost efficiency predicts a cumulative improvement in asset quality of 4.85% and 2.81%, respectively, which is tentative evidence of skimping behaviour. The economic effects of bad luck, on the contrary, predict a change in cost efficiency of less than 1% in each country.

5. Implications and conclusions

We use Granger causality estimates to infer different types of management behaviour at European savings banks. The inference is based on specific intertemporal relationships between loan loss provision, efficiency, and capitalisation. This paper contributes to the existing literature as a robustness test of the Berger and DeYoung (1997) results for US banks. This section will discuss whether the US findings are robust with respect to the European results reported herein.

For European savings banks, there is strong statistical evidence to support the bad management hypothesis (that poorly managed banks tend to make more poor quality loans). Breaking the sample into sub-samples according to the level of bank capitalisation provides further statistically strong evidence of bad management at thinly capitalised European banks. In addition, for the most cost efficient European banks we find strong statistical evidence to reject the skimping behaviour hypothesis. We do not find any strong statistical evidence to suggest that European banks are characterised by bad luck (that banks with high loan loss provision suffer a reduction in operating efficiency); skimping (that efficiently run banks willingly skimp on monitoring costs today in exchange for higher loan loss provision in the future); or moral hazard behaviour (that poorly capitalised banks suffering reductions in capital will take greater risks and hence, on average, end up with higher loan loss provision). At the country level, we note the statistical evidence both of bad management and bad luck at German banks.

In general, the European results are inconsistent with the findings of Berger and DeYoung (1997) for US commercial banks which were found to be affected by bad management and bad luck as well as exhibiting skimping and moral hazard behaviour. The only common finding between the former study and the present one is that there is significant statistical evidence of bad management at US commercial banks and European savings banks. However, the statistical relationships in the US study are much stronger than those reported herein. The relatively weak statistical associations for European banks could be attributable to the specification of variables that only proxy for those used by Berger and DeYoung. Due to limitations in European bank data, we include loan loss provisions, which may be subject to management discretion and could contain an element of endogeneity, rather than the amount of problem loans. Similarly, we specify the ratio of loans-to-assets as an indicator of credit risk although the indicator is not risk-adjusted.

In contrast to Berger and DeYoung's findings, the European results are sensitive to the number of lags included in the models. Although statistical tests support the specification of four lags, we find that increasing the number of lags from two to three and three to four reduces the significance of key management relationships although the signs and magnitudes of the coefficients are similar. Using two lags, and in addition to bad management (found at two, three and four lags) we find strong evidence to suggest European banks are subject to bad luck whereas thinly capitalised banks engage in moral hazard behaviour. However, the latter two relationships are insignificant when three and four lags are included. However, three lags are optimal for the coefficient that tests for bad management or skimping behaviour for the most cost efficient banks.

The finding of bad management at European savings banks has policy implications for bank regulators and supervisors, and bank owners and managers. We concur with Berger and DeYoung (1997) and emphasise the importance of efficiency (and the need to test the robustness of different efficiency measures) in the intertemporal relationships. The policy implication is that bank regulators and supervisors (and bank management) should adopt more sophisticated measures of bank performance for regulatory purposes. For bank owners and managers, bad management might be an outcome of the diverse range of ownership models in European banking. Indeed, several of the characteristics of bad management are associated with agency problems. Notably, European bank managers have faced significant pressures and managerial challenges during the 1990s such as financial deregulation and issues pertaining to capital adequacy. We note that the majority of banks in this study are small in terms of asset size; their ownership structures imply capitalisation is problematic, and a large proportion of these institutions were for many years (and some remain) restricted both geographically and operationally by legislation. Or, it could be the case that adjusting to a continually evolving deregulated and more competitive environment involves a lengthy lag.

Whilst a detailed investigation of these issues lies beyond the scope of this present study, we recommend that the Granger causal framework be applied to a larger sample of commercial banks, savings banks, and cooperative banks in order to determine whether management behaviour is homogenous with respect to bank ownership, and whether behaviour is consistent across countries. There are other related issues that are worthy of future research; for instance, what is the mechanism through which the objectives of bank regulators and supervisors are transmitted to and acted upon by bank management? We also recommend further investigation into the difficulties facing banks in replenishing capital when their organisational structures limit the types of capital raising instruments available to management.

6. Appendix

Tables 10–14.

Table 10
Business forms, structure, ownership and profit allocation

Country	Company structure	Ownership	Allocation of Profits
Denmark	Independent private law foundations. Few joint stock	Independent. Shareholders (joint stock)	Reserves (independents). Dividends to shareholders (joint stock)
France	Non-profit entities under private law	Customers	Deposit insurance fund & to support own growth
Germany	Public law entities. Few private-owned	Municipal (mutual). Shareholders	Owners receive a share of surplus
Italy	Joint stock	Foundations/some private investors	Business objective of limited companies is to distribute dividends to owners
Spain	Non-profit entities	Unclear. No proprietary rights[a]	Reserves and Social Works Funds
UK (building societies)	Mutual, some converted to PLC	Members (mutual), shareholders (PLC)	

Source: Gardener et al. (1999).
[a] According to LORCA Law, Spanish savings banks' Assembly and Management Boards have the following participation: depositors, 44%; local governments, 40%; founding bodies, 11%; employees, 5%.

Table 11
Management structures within European Savings Banks

Country	Highest body	Day-to-day management
Denmark	Board of Representatives elected by depositors and guarantors (independents)	Board of Directors (elected by Board of Representatives)
France	Advisory and Supervisory Board (appointments must be approved by CENCEP—national representative body)	Board of Directors: each director is responsible for a specific aspect of a savings bank's operations
Germany	Advisory Board	Management Board (appointed by Advisory Board)
Italy	Board of Directors (may or may not be shareholders)	Managing Director (appointed by Board of Directors)
Spain	Assembly and Board of Representatives (elected by the Assembly)[a]	Director General and Board of Directors (appointed by Assembly and Board of Representatives)
United Kingdom	Board of Directors (may or may not be shareholders)	Managing Director (appointed by Board of Directors)

Source: Gardener et al. (1999).
[a] According to LORCA Law, Spanish savings banks' Assembly and Management Boards have the following participation: depositors, 44%; local governments, 40%; founding bodies, 11%; employees, 5%.

Table 12
Technical inefficiency effects

Variable	Param	Definition
Constant	$\delta 0$	
Association	$\delta 1$	Business form of Danish & UK savings banks. Founded by private individuals or groups of individuals. Small market shares. Faced significant demutualisation late 1980s/1990s. Deposit market shares less than 10%
Mixed	$\delta 2$	Business form of Italian and Spanish savings banks. A combination of association and foundation forms. Faced domestic financial deregulation late 1980s/early 1990s. Two-tiered group structure. Deposit market shares approximately 25% and 40%, respectively
Foundation[a]	–	Business form of French and German savings banks. Founded by municipal authorities. Three-tiered group organisational structure. Business and geographical restrictions. Continuing state involvement. Deposit market shares approximately 20% and 37%, respectively
Local[b]	$\delta 3$	Operating in local markets
Regional[b]	$\delta 4$	Operating in regional markets
National[a,b]	–	Operating in national markets
EA mark-up	$\delta 5$	Mark up of price-over-marginal cost for earning assets; indicator of competitiveness
PF mark-up	$\delta 6$	Mark up of price-over-marginal cost for purchased funds; indicator of competitiveness
Capitalisation	$\delta 7$	Ratio of equity-assets
Asset quality	$\delta 8$	Ratio of loan loss provisions-loans
Liquidity	$\delta 9$	Ratio of customer loans-customer deposits
Year	$\delta 10$	Time tren
Year^2 [c]	11	Quadratic term of the time trend

[a] Association, mixed and foundation are indicators of savings banks organisational structures whereas local, regional and national reflect banks' geographical segmentation. Organisational structure and geographical segmentation are specified as binary variables. The interpretation of $\delta 1$, for example, is that association forms banks are either more or less cost efficient than foundation form banks depending on the sign of the parameter.

[b] We identify local banks through different methods. First, in countries like Germany (and France) a territorial principle restricts banks operations to their locality (region). Second, we examine the breadth of coverage of a bank's branch network. If the network extends across three localities we classify the bank as regional. Primary sources and an investigation of banks' internet sites also helped classify the sample according to geographic market segments.

[c] Battese et al. (2000) show that the mean function μ_{it} is estimated to have a maximum value with respect to the year of observation when the year is equal to $[\delta_{10}/(\delta_{11} \times 2)]$.

Table 13
Maximum likelihood parameter estimation of the stochastic operating cost Fourier function

Variable	Parameter	Coefficient	Std error	T-statistic	Variable	Parameter	Coefficient	Std error	T-statistic
Constant	α_0	−15.89	0.791	−20.088	Sin (x4+x4)	b_{44}	−0.211	0.045	−4.723
Ln Q1	β_1	−2.065	0.394	−5.239	Cos (x1+x1+x2)	a_{112}	−0.204	0.338	−0.605
Ln Q2	β_2	2.189	0.377	5.799	Sin (x1+x1+x2)	b_{112}	−0.307	0.345	−0.891
Ln Q3	β_3	5.717	0.440	13.000	Cos (x1+x1+x3)	a_{113}	0.010	0.316	0.031
Ln Q4	β_4	0.268	0.433	0.619	Sin (x1+x1+x3)	b_{113}	1.112	0.339	3.278
LnP1	ψ_1	0.790	0.029	27.546	Cos (x1+x1+x4)	a_{114}	−0.202	0.211	−0.961
LnQ1^2	θ_{11}	0.501	0.046	10.870	Sin (x1+x1+x4)	b_{114}	−0.226	0.184	−1.228
LnQ1 lnQ2	θ_{12}	−0.134	0.028	−4.796	Cos (x1+x2+x2)	a_{122}	0.665	0.293	2.268
LnQ1 lnQ3	θ_{13}	−0.369	0.066	−5.560	Sin (x1+x2+x2)	b_{122}	0.689	0.303	2.274
LnQ1 lnQ4	θ_{14}	0.014	0.022	0.642	Cos (x1+x2+x3)	a_{123}	−0.868	0.595	−1.459
LnQ2^2	θ_{22}	−0.089	0.040	−2.241	Sin (x1+x2+x3)	b_{123}	−1.500	0.646	−2.324
LnQ2 lnQ3	θ_{23}	−0.038	0.038	−0.985	Cos (x1+x2+x4)	a_{124}	0.498	0.262	1.899
LnQ2 lnQ4	θ_{24}	−0.071	0.015	−4.831	Sin (x1+x2+x4)	b_{124}	−0.063	0.281	−0.224
LnQ3^2	θ_{33}	−0.253	0.064	−3.948	Cos (x1+x3+x3)	a_{133}	0.360	0.356	1.011
LnQ3 lnQ4	θ_{34}	−0.025	0.031	−0.788	Sin (x1+x3+x3)	b_{133}	−0.540	0.383	−1.411
LnQ4^2	θ_{44}	0.075	0.062	1.200	Cos (x1+x3+x4)	a_{134}	−0.524	0.530	−0.988
LnP1^2	ψ_{11}	0.018	0.004	4.833	Sin (x1+x3+x4)	b_{134}	0.271	0.527	0.515
LnP1 lnQ1	η_{11}	0.088	0.011	8.201	Cos (x1+x4+x4)	a_{144}	0.310	0.099	3.148
LnP1 lnQ2	η_{12}	0.018	0.008	2.359	Sin (x1+x4+x4)	b_{144}	0.013	0.090	0.142
LnP1 lnQ3	η_{13}	−0.078	0.016	−4.905	Cos (x2+x2+x3)	a_{223}	−0.303	0.303	−0.997
LnP1 lnQ4	η_{14}	−0.053	0.004	−12.568	Sin (x2+x2+x3)	b_{223}	−0.853	0.294	−2.897
Cos (x1)	a_1	−5.349	0.699	−7.655	Cos (x2+x2+x4)	a_{224}	−0.314	0.112	−2.794
Sin (x1)	b_1	1.543	0.339	4.558	Sin (x2+x2+x4)	b_{224}	−0.246	0.095	−2.580
Cos (x2)	a_2	3.513	0.602	5.837	Cos (x2+x3+x3)	a_{233}	0.452	0.451	1.002
Sin (x2)	b_2	−0.209	0.214	−0.977	Sin (x2+x3+x3)	b_{233}	1.502	0.463	3.244
Cos (x3)	a_3	7.601	0.788	9.645	Cos (x2+x3+x4)	a_{234}	0.783	0.380	2.062
Sin (x3)	b_3	0.191	0.485	0.394	Sin (x2+x3+x4)	b_{234}	1.074	0.351	3.063
Cos (x4)	a_4	−0.370	0.448	−0.825	Cos (x2+x4+x4)	a_{244}	−0.301	0.061	−4.964
Sin (x4)	b_4	0.025	0.144	0.172	Sin (x2+x4+x4)	b_{244}	0.034	0.059	0.581
Cos (x1+x1)	a_{11}	0.084	0.263	0.320	Cos (x3+x3+x4)	a_{334}	−0.475	0.408	−1.164
Sin (x1+x1)	b_{11}	0.596	0.250	2.385	Sin (x3+x3+x4)	b_{334}	−0.823	0.399	−2.065
Cos (x1+x2)	a_{12}	0.959	0.263	3.650	Cos (x3+x4+x4)	a_{344}	0.020	0.132	0.151

Table 13 (*continued*)

Variable	Parameter	Coefficient	Std error	T-statistic	Variable	Parameter	Coefficient	Std error	T-statistic
Sin (x1+x2)	b_{12}	−0.734	0.245	−2.996	Sin (x3+x4+x4)	b_{344}	−0.226	0.129	−1.752
Cos (x1+x3)	a_{13}	−2.547	0.636	−4.004	Intercept	δ_0	0.460	0.053	8.717
Sin (x1+x3)	b_{13}	−0.258	0.635	−0.406	Association	δ_1	0.257	0.015	16.731
Cos (x1+x4)	a_{14}	−0.120	0.144	−0.831	Mixed	δ_2	0.106	0.015	6.907
Sin (x1+x4)	b_{14}	0.488	0.099	4.925	Local	δ_3	−0.013	0.026	−0.488
Cos (x2+x2)	a_{22}	0.253	0.125	2.017	Regional	δ_4	−0.057	0.026	−2.213
Sin (x2+x2)	b_{22}	−0.716	0.106	−6.778	EA mark-up	δ_5	1.950	0.255	7.652
Cos (x2+x3)	a_{23}	−0.627	0.380	−1.652	PF mark-up	δ_6	0.689	0.245	2.813
Sin (x2+x3)	b_{23}	2.004	0.323	6.200	Capital strength	δ_7	−0.010	0.103	−0.092
Cos (x2+x4)	a_{24}	0.382	0.085	4.497	Asset quality	δ_8	−0.385	0.219	−1.758
Sin (x2+x4)	b_{24}	−0.047	0.069	−0.673	Liquidity	δ_9	−0.679	0.041	−16.618
Cos (x3+x3)	a_{33}	2.829	0.468	6.041	Year	δ_{10}	−0.029	0.007	−4.022
Sin (x3+x3)	b_{33}	−0.638	0.463	−1.377	Year^2	δ_{11}	0.004	0.001	5.931
Cos (x3+x4)	a_{34}	−0.603	0.195	−3.094	$\sigma^2 \equiv \sigma_v^2 + \sigma_\mu^2$		0.021	0.001	24.845
Sin (x3+x4)	b_{34}	−0.174	0.148	−1.177	$\gamma \equiv \sigma_\mu^2/(\sigma_v^2 + \sigma_\mu^2)$		0.894	0.008	108.93
Cos (x4+x4)	a_{44}	−0.154	0.075	−2.045	Log-likelihood		5513.9		

Table 14
Maximum likelihood parameter estimation of the stochastic alternative profit Fourier function

Variable	Parameter	Coefficient	Std error	*T*-statistic	Variable	Parameter	Coefficient	Std error	*T*-statistic
Constant	α_0	−0.987	0.915	−1.079	Cos (x3+x4)	a_{34}	−0.445	0.364	−1.221
Ln Q1	β_1	−1.214	0.421	−2.887	Sin (x3+x4)	b_{34}	−0.650	0.314	−2.070
Ln Q2	β_2	−0.180	0.438	−0.412	Cos (x4+x4)	a_{44}	0.193	0.118	1.637
Ln Q3	β_3	0.545	0.523	1.042	Sin (x4+x4)	b_{44}	0.351	0.094	3.727
Ln Q4	β_4	2.708	0.663	4.081	Cos (x1+x1+x2)	a_{112}	−1.200	0.499	−2.404
LnP1	ψ_1	0.021	0.048	0.440	Sin (x1+x1+x2)	b_{112}	−1.141	0.535	−2.133
LnP2	ψ_2	−0.513	0.052	−9.805	Cos (x1+x1+x3)	a_{113}	0.794	0.463	1.715
LnQ1^2	θ_{11}	0.274	0.059	4.624	Sin (x1+x1+x3)	b_{113}	1.174	0.477	2.459
LnQ1 lnQ2	θ_{12}	0.291	0.047	6.230	Cos (x1+x1+x4)	a_{114}	1.509	0.468	3.222
LnQ1 lnQ3	θ_{13}	−0.396	0.109	−3.629	Sin (x1+x1+x4)	b_{114}	−0.187	0.310	−0.603
LnQ1 lnQ4	θ_{14}	−0.098	0.042	−2.350	Cos (x1+x2+x2)	a_{122}	−1.567	0.418	−3.752
LnQ2^2	θ_{22}	0.145	0.048	3.018	Sin (x1+x2+x2)	b_{122}	−0.963	0.449	−2.145
LnQ2 lnQ3	θ_{23}	−0.461	0.064	−7.265	Cos (x1+x2+x3)	a_{123}	2.984	0.746	4.001
LnQ2 lnQ4	θ_{24}	−0.025	0.029	−0.851	Sin (x1+x2+x3)	b_{123}	2.674	0.902	2.963
LnQ3^2	θ_{33}	0.305	0.096	3.172	Cos (x1+x2+x4)	a_{124}	1.931	0.505	3.827
LnQ3 lnQ4	θ_{34}	−0.018	0.060	−0.297	Sin (x1+x2+x4)	b_{124}	−0.685	0.356	−1.926
LnQ4^2	θ_{44}	−0.174	0.108	−1.612	Cos (x1+x3+x3)	a_{133}	−0.479	0.510	−0.939
LnP1^2	ψ_{11}	0.055	0.012	4.699	Sin (x1+x3+x3)	b_{133}	−1.550	0.536	−2.892
LnP1 ln P2	ψ_{12}	−0.066	0.015	−4.417	Cos (x1+x3+x4)	a_{134}	−3.922	1.061	−3.698
LnP2^2	ψ_{22}	0.063	0.009	7.188	Sin (x1+x3+x4)	b_{134}	1.283	0.678	1.894
LnP1 lnQ1	η_{11}	0.143	0.031	4.570	Cos (x1+x4+x4)	a_{144}	−0.243	0.179	−1.356
LnP1 lnQ2	η_{12}	0.197	0.022	8.893	Sin (x1+x4+x4)	b_{144}	0.613	0.196	3.134
LnP1 lnQ3	η_{13}	−0.263	0.045	−5.846	Cos (x2+x2+x3)	a_{223}	1.539	0.410	3.757
LnP1 lnQ4	η_{14}	−0.013	0.011	−1.136	Sin (x2+x2+x3)	b_{223}	0.670	0.424	1.579
LnP2 lnQ1	η_{21}	−0.097	0.030	−3.206	Cos (x2+x2+x4)	a_{224}	0.236	0.228	1.036
LnP2 lnQ2	η_{22}	−0.147	0.020	−7.426	Sin (x2+x2+x4)	b_{224}	0.360	0.183	1.968
LnP2 lnQ3	η_{23}	0.296	0.042	7.041	Cos (x2+x3+x3)	a_{233}	−2.077	0.554	−3.749
LnP2 lnQ4	η_{24}	0.017	0.010	1.663	Sin (x2+x3+x3)	b_{233}	−0.777	0.614	−1.266
Cos (x1)	a_1	−2.618	0.766	−3.417	Cos (x2+x3+x4)	a_{234}	−2.400	0.752	−3.190
Sin (x1)	b_1	3.504	0.470	7.455	Sin (x2+x3+x4)	b_{234}	0.209	0.541	0.387
Cos (x2)	a_2	−0.967	0.732	−1.321	Cos (x2+x4+x4)	a_{244}	0.108	0.113	0.953
Sin (x2)	b_2	0.540	0.375	1.441	Sin (x2+x4+x4)	b_{244}	−0.100	0.117	−0.848

Table 14 (*continued*)

Variable	Parameter	Coefficient	Std error	T-statistic	Variable	Parameter	Coefficient	Std error	T-statistic
Cos (x3)	a_3	2.565	0.997	2.573	Cos (x3+x3+x4)	a_{334}	2.868	0.740	3.877
Sin (x3)	b_3	−2.443	0.662	−3.693	Sin (x3+x3+x4)	b_{334}	−1.005	0.532	−1.889
Cos (x4)	a_4	1.788	0.732	2.444	Cos (x3+x4+x4)	a_{344}	0.000	0.245	0.002
Sin (x4)	b_4	0.779	0.332	2.348	Sin (x3+x4+x4)	b_{344}	−0.197	0.271	−0.728
Cos (x1+x1)	a_{11}	0.209	0.357	0.586	Intercept	δ_0	0.949	0.109	8.678
Sin (x1+x1)	b_{11}	1.028	0.373	2.757	Association	δ_1	−0.637	0.041	−15.419
Cos (x1+x2)	a_{12}	1.123	0.337	3.334	Mixed	δ_2	−0.048	0.033	−1.434
Sin (x1+x2)	b_{12}	−1.964	0.393	−5.002	Local	δ_3	−0.574	0.054	−10.712
Cos (x1+x3)	a_{13}	−1.197	0.728	−1.644	Regional	δ_4	0.055	0.052	1.046
Sin (x1+x3)	b_{13}	2.240	0.834	2.684	EA mark-up	δ_5	0.635	0.702	0.905
Cos (x1+x4)	a_{14}	−0.200	0.275	−0.728	PF mark-up	δ_6	10.066	0.889	11.325
Sin (x1+x4)	b_{14}	0.492	0.211	2.331	Capital strength	δ_7	−1.871	0.068	−27.657
Cos (x2+x2)	a_{22}	−0.148	0.193	−0.764	Asset quality	δ_8	−18.169	0.503	−36.125
Sin (x2+x2)	b_{22}	0.140	0.206	0.681	Liquidity	δ_9	−0.226	0.051	−4.425
Cos (x2+x3)	a_{23}	−1.594	0.513	−3.108	Year	δ_{10}	−0.012	0.020	−0.578
Sin (x2+x3)	b_{23}	1.805	0.583	3.093	Year^2	δ_{11}	0.005	0.002	3.009
Cos (x2+x4)	a_{24}	0.624	0.153	4.076	$\sigma^2 \equiv \sigma_v^2 + \sigma_\mu^2$		0.132	0.006	21.600
Sin (x2+x4)	b_{24}	0.380	0.149	2.553	$\gamma \equiv \sigma_\mu^2/(\sigma_v^2 + \sigma_\mu^2)$		0.930	0.005	199.92
Cos (x3+x3)	a_{33}	1.546	0.519	2.979	Log-likelihood		1443.4		
Sin (x3+x3)	b_{33}	−2.807	0.606	−4.629					

7. Uncited references

Akella and Greenbaum (1988), Berger and Humphrey (1992).

References

Aigner, D., Lovell, C.A.K., Schmidt, P., 1977. Formulation and estimation of stochastic frontier production models. Journal of Econometrics 6, 21–37.

Akella, S.R., Greenbaum, S.I., 1988. Savings and loan ownership structure and expense preference. Journal of Banking and Finance 12, 419–437.

Altunbas, Y., Evans, L., Molyneux, P., 2001. Bank ownership and efficiency. Journal of Money, Credit, and Banking 33 (4), 926–954.

BankScope, 2000. Banking database. Bureau Van Dijk IBCA, New York.

Battese, G.E., Coelli, T.J., 1995. A model for technical inefficiency effects in a stochastic frontier production function for panel data. Empirical Economics 20, 325–332.

Battese, G.E., Corra, G.S., 1977. Estimation of a production frontier model: With application to the pastoral zone of Eastern Australia. Australian Journal of Agricultural Economics 21 (3), 169–179.

Battese, G.E., Heshmati, A., Hjalmarsson, L., 2000. Efficiency of labour use in the Swedish banking industry: A stochastic frontier approach. Empirical Economics 25 (4), 623–640.

Berger, A.N., 1995. The relationship between capital and earnings. Journal of Money, Credit, and Banking 27 (2), 432–456.

Berger, A.N., DeYoung, R., 1997. Problem loans and cost efficiency in commercial banks. Journal of Banking and Finance 21 (6), 849–870.

Berger, A.N., Goldberg, L.G., White, L.J., 2001b. The effects if dynamic changes in bank competition on the supply of small business credit. European Finance Review 5 (1–2), 115–139.

Berger, A.N., Hannan, T.H., 1998. The efficiency cost of market power in the banking industry: A test of the "quiet life" and related hypotheses. The Review of Economics and Statistics LXXX (3), 454–465.

Berger, A.N., Humphrey, D.B., 1991. The dominance of inefficiencies over scale and product mix economies in banking. Journal of Monetary Economics 28 (1), 117–148.

Berger, A.N., Humphrey, D.B., 1992. Measurement and efficiency issues in commercial banking. In: Griliches, Z. (Ed.), Output Measurement in the Service Sectors, National Bureau of Economic Research. University of Chicago Press, Chicago, pp. 245–279.

Berger, A.N., Humphrey, D.B., 1997. Efficiency of financial institutions: International survey and directions for future research. European Journal of Operational Research 98 (2), 175–212.

Berger, A.N., Klapper, L.F., Udell, G.F., 2001a. The ability of banks to lend to informationally opaque small businesses. Journal of Banking and Finance 25, 2127–2167.

Berger, A.N., Leusner, J.H., Mingo, J.J., 1997. The efficiency of bank branches. Journal of Monetary Economics 40, 141–162.

Berger, A.N., Mester, L.J., 1997. Inside the black box: What explains differences in the efficiencies of financial institutions? Journal of Banking and Finance 21, 895–947.

Berger, A.N., Udell, G.F., 2002. Small business credit availability and relationship lending the importance of bank organisational structure. Economic Journal 112 (477), 32–53.

Building Societies Association 1990–1998. Building Society Annual Accounts Data.

Button, K.J., Weyman-Jones, T.G., 1992. Ownership structure, institutional organisation and measured X-efficiency. The American Economic Review 82 (2), 439–445.

CECA, 1990–1997. Financial Accounts of Spanish Savings Banks.

Cebenoyan, A.S., Cooperman, E.S., Register, C.A., Hudgins, S.C., 1993. The relative efficiency of stock versus mutual S&Ls: A stochastic cost frontier approach. Journal of Financial Services Research 7, 151–170.

Chaffai, M.E., Dietsch, M., Lozano-Vivas, A., 2001. Technological and environmental differences in the European banking industries. Journal of Financial Services Research 19 (2/3), 147–162.

Cummins, J.D., Zi, H., 1998. Comparison of frontier efficiency methods: An application to the U.S. life insurance industry. Journal of Productivity Analysis 10, 131–152.

Danish Supervisory Authority, 1990–1998. Pengeininstitutter m.v. Statistisk Materiale.

DeYoung, R., Spong, K., Sullivan, R.J., 2001. Who's minding the store? Motivating and monitoring hired managers at small closely held commercial banks. Journal of Banking and Finance 25 (July), 1209–1244.

Dietsch, M., Lozano-Vivas, A., 2000. How the environment determines banking efficiency: A comparison between French and Spanish industries. Journal of Banking and Finance 24, 985–1004.

Dow, S.C., Rodríguez-Fuentes, J., 1997. Regional finance: A survey. Regional Studies 31 (9), 903–920.

Ehlermann, C.D., 1992. European community competition policy, public enterprise and the cooperative, mutual and nonprofit sector. Annals of Public and Cooperative Economics 63 (4), 555–571.

Gallant, A.R., 1981. On the bias in flexible functional forms and essentially unbiased form: The Fourier flexible form. Journal of Econometrics 15, 211–245.

Gallant, A.R., 1982. Unbiased determination of production technologies. Journal of Econometrics 20, 285–324.

Gardener, E.P.M., Molyneux, P., Williams, J., 1999. European Savings Banks: Coming of Age? Lafferty Publications, Dublin.

Gardener, E.P.M., Molyneux, P., Williams, J., Carbo, S., 1997. European savings banks: Facing up to the new environment. International Journal of Bank Marketing 15 (7), 243–254.

Hughes, J.P., Mester, L.J., Moon, C.-G., 2001. Are scale economies in banking elusive or illusive? Evidence obtained by incorporating capital structure and risk-taking into models of bank production. Journal of Banking and Finance 25, 2169–2208.

Ivaldi, M., Ladoux, N., Ossard, H., Simioni, M., 1996. Comparing Fourier and translog specifications of multiproduct technology: Evidence from an incomplete panel of French farmers. Journal of Applied Econometrics 11, 649–667.

Jondrow, J., Lovell, C.A.K., Materov, I.S., Schmidt, P., 1982. On estimation of technical inefficiency in the stochastic frontier production function model. Journal of Econometrics 19 (July), 233–238.

Leibenstein, H., 1966. Allocative efficiency vs "X-efficiency". American Economic Review 56, 392–415.

Lozano-Vivas, A., Pastor, J.T., Hasan, I., 2001. European bank performance beyond country borders: What really matters? European Finance Review 5, 141–165.

Lozano-Vivas, A., Pastor, J.T., Pastor, J.M., 2002. An efficiency comparison of European banking systems operating under different environmental conditions. Journal of Productivity Analysis 18, 59–77.

McAllister, P.H., McManus, D., 1993. Resolving the scale efficiency puzzle in banking. Journal of Banking and Finance 17, 389–405.

Meeusen, W., van den Broeck, J., 1977. Efficiency estimation from Cobb–Douglas production functions with composed error. International Economic Review 18, 435–444.

Mester, L.J., 1993. Efficiency in the savings and loan industry. Journal of Banking and Finance 17, 267–286.

Mester, L.J., 1996. A study of bank efficiency taking into account risk-preferences. Journal of Banking and Finance 20, 1025–1045.

Mitchell, K., Onvural, N.M., 1996. Economies of scale and scope at large commercial banks: Evidence from the Fourier flexible functional form. Journal of Money, Credit, and Banking 28 (2), 178–199.

Peristiani, S., Wizman, T.A., 1997. Mutual-to-stock conversions in the thrift industry in the 1990s. Journal of Economics and Business 49, 95–116.

Sealey, C., Lindley, J.T., 1977. Inputs, outputs and a theory of production and cost at depository financial institution. Journal of Finance 32, 1251–1266.

Verbrugge, J.A., Goldstein, S.J., 1981. Risk, return and managerial objectives: Some evidence from the savings and loan industry. Journal of Financial Research 4, 45–58.

Verbrugge, J.A., Jahera, J.S., 1981. Expense-preference behaviour in the savings and loan industry. Journal of Money, Credit, and Banking 13 (4), 465–476.

Wang, H.-J., Schmidt, P., 2002. One-step and two-step estimation of the effects of exogenous variables on technical efficiency levels. Journal of Productivity Analysis 18, 129–144.