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Managers and efficiency in banking

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ABSTRACT

This paper presents evidence on the impact of managers on cost efficiency in banking. Stochastic frontier analysis is applied to a unique Finnish data set. Manager age and education have strong yet complicated effects on efficiency. The impact of age on efficiency depends on education. A university degree is useful mainly in the largest banks of the sample. Educational background seems to be less important for young managers than for mature ones. Managing director changes are systematically followed by efficiency changes. Retirement typically causes an efficiency improvement whereas other manager changes can either improve or weaken efficiency. However, in many cases mature managers outperform their young colleagues.

1. Introduction

Bank efficiency studies have become an established field of empirical economics. These studies have developed a relatively standardised methodology and conceptual framework. A central term in this literature is "managerial efficiency", which simply refers to the ability of a bank to maximise profits or minimise costs under given circumstances. This expression attributes efficiency to managers. Paradoxically, there seem to be almost no empirical studies on the relevance of managers to managerial efficiency in banking.

This paper is an attempt to shed some light on this issue. Following Fries and Taci (2005), Sensarma (2006), Kraft et al. (2006) and Lensink et al. (2008), the stochastic frontier analysis (SFA) method of Battese and Coelli (1995) is used to derive cost efficiency estimates. Bank output is defined according to the production approach. A unique, detailed panel data set on Finnish cooperative and savings banks is used. The data includes detailed personal information on hundreds of bank managers; few data sets of this kind are available.

It is found that age and education affect cost efficiency in a complicated way. University graduates have a comparative advantage in running relatively large banks. Managers with university degrees in business administration or economics seem to outperform their colleagues with a university degree in law or agriculture and forestry. Vocational level qualification in business administration seems an excellent educational background in very small banks. Among young managers efficiency typically improves as a function of age but among the oldest efficiency may deteriorate. An additional year of age can affect expected costs by almost 1%. Manager changes are systematically followed by above average changes in efficiency. If an old manager retires, a significant cost efficiency improvement typically follows. In other cases efficiency is affected, but there is no regularity in the direction of change. Previous literature is reviewed in Section 2. Section 3 describes the data. The method and the specification are presented in Section 4. Empirical results are presented in Section 5. Section 6 summarises and discusses the findings.

2. Literature and the institutional setting

2.1. Bank efficiency literature

Efficiency has different established definitions in previous literature. The most common of them seems to be cost efficiency, which simply refers to the ability of the bank to minimise costs, when input prices and the quantity and composition of output are given. This efficiency concept has often been used as the only definition.[1] Profit efficiency, instead, refers to the ability to maximise profits.[2]

[1] Pi and Timme (1993), Weill (2004), Rezvanian and Mehdian (2002), Humphrey and Vale (2004), Prior (2003), Dietsch and Lozano Vivas (2000), Fries and Taci (2005), Matoušek and Taci (2004), Sensarma (2006), Esho (2001), Girardone et al. (2004) and Kraft et al. (2006), to mention a few.

[2] See e.g. Berger and Mester (1997), Altunbas et al. (2001) and Koetter (2006).

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In most efficiency analyses the logarithmic objective is regressed on variables that would affect the value of the objective function of a fully efficient institution; for instance, logarithmic costs are normally regressed on different transformations and interactions of input prices, output quantities and possible other variables. Stochastic frontier analysis (SFA) is one of the most popular methods. SFA decomposes the error term into the expected value of inefficiency and random variation, such as measurement error. The random error may be either positive or negative. In cost functions the inefficiency term cannot be negative because it increases costs. The cost function of a completely efficient institution is called the efficient frontier.

Many studies on the determinants of efficiency use a two-stage approach. First, efficiency scores are estimated by using the SFA. As a second step the statistical interrelationship between efficiency and its potential determinants is analysed using other methods.[3] This approach may lead to biased results if the determinants of efficiency correlate with variables included in the cost function. The method of Battese and Coelli (1995) estimates the impact of inefficiency determinants simultaneously with the efficient frontier itself by using an iterative maximum likelihood procedure. Each observation of the sample is assigned an inefficiency estimate that partly depends on these determinants. In recent years the method has been gaining ground in bank efficiency literature. Its presumably superior ability to provide estimates on different determinants of banks' cost efficiency has been used by Fries and Taci (2005), Sensarma (2006), Kraft et al. (2006) and Lensink et al. (2008). These papers largely concentrated on the impact of ownership. Williams and Nguyen (2005) used the method in their analysis on profit efficiency and bank governance.

In addition to ownership and governance structures, several other factors have been found to predict bank efficiency. These factors include home country legal traditions, balance sheet structure and size (Pestana Barros et al., 2007), labour, ATMs and the ability to maximise deposits per branch (Valverde et al., 2007) and investments in IT services or computer hardware (Beccalli, 2007).

As to measuring output, banking may be one of the most difficult industries. The production approach assumes that the bank produces certain financial services, such as loans, deposits and payment intermediation. The choice of services included in the output vector is often based on subjective discretion. It has been commonplace to use the number of accounts and loans as output indicators. Bank costs are defined as personnel and other operational costs. Interest expenditure is ignored. This approach used to be very commonplace.[4] Its popularity seems to have declined, but it has been used by at least Prior (2003).

Input prices are essential to efficiency estimations. It has been commonplace to calculate the price of inputs at the bank level. However, in a perfectly competitive market all banks in the same market should face identical factor prices. If the market is not perfectly competitive, factor prices should be endogenous. Mountain and Thomas (1999) may have been the first to discuss these issues in detail. Bank specific input price proxies are particularly misleading in cost function estimations (Koetter, 2006). One method to avoid the problem is to calculate averages for each geographic area and to use the average for all the banks of the region, as Koetter (2006) and Bos and Kool (2006) did.

This paper analyses the impact of manager characteristics on bank efficiency. A few person related factors are measurable. The human capital theory pioneered by Becker (1962) assumes that education creates valuable human capital. The signalling theory, largely due to Spence (1973), assumes that skilled individuals acquire education to signal their type. Testing the theories against each other is difficult because they both yield rather similar empirical predictions. Riley (2001) reviews the empirical evidence and the findings seem to be conflicting. Both theories suggest that manager education should correlate with bank efficiency. Holmstrom (1982) argues that career concerns motivate young employees, making them work hard during the early stages of career. Hence, we might expect young managers to outperform their mature colleagues.

Perhaps surprisingly, there seem to be very little econometric research on the impact of manager characteristics on bank performance. However, CEO shareholdings weaken cost efficiency among US banks (Pi and Timme, 1993). Branch manager turnover correlates with bad loans, presumably because local management gradually accumulates tacit knowledge on local borrowers (Ferri, 1997). As to non-bank financial institutions, the impact of fund manager educational background on the performance of a securities portfolio has been analysed (Gottesman and Morey, 2006; Chevalier and Ellison, 1999).

Cooperative banks may have an informational advantage over limited liability banks because members of credit cooperatives normally live in the same community, and they are often engaged in similar activities. If default by one debtor causes losses to peers, borrowers would monitor each other in joint-liability arrangements (Ghatak, 2000). Alternatively non-borrower members may monitor debtors (Banerjee et al., 1994). Australian credit cooperatives seem to pass on the benefits of cost efficiency to members by lowering their interest rate spreads (Esho, 2001).

2.2. The institutional setting

Finnish cooperative banks belong to two groups. Members of the consortium of cooperative banks (OP group) operate in very close cooperation and they are even responsible for each others' debts. Local cooperative banks did not join the consortium. Both groups are subject to the same Cooperative Bank Act. Each member of a cooperative bank has one vote in the members' meeting. Being the highest decision making body of the institution, the meeting chooses the supervisory board, which chooses the managing director.

The Savings Bank Act stipulates that the objective of these institutions is to promote saving. The managing director is chosen by the board, which is nominated by the trustees of the savings bank. The trustees are elected either directly or indirectly by depositors. Hence, managers' principals represent depositors. Savings banks have no owners in the strict sense of the word.

With the exception of a few savings and local cooperative banks, each bank of the sample has branches in one geographic region only. Their service mixes are rather similar and they offer retail financial services to households and small businesses.

3. The data

The banks of the sample are small by any standards, which is no problem. In a very small organisation every employee may report directly to the managing director, making managerial skills easier to detect than in large organisations. The data set contains information on 309 Finnish savings and cooperative banks for which data are available for the years 1999–2004; this balanced part of the sample consists of 1854 observations. In addition, the 1999 data contains 12 banks that were involved in mergers by December 2004. In each of the six mergers the number of banks was reduced by one, implying that the number of sample banks diminished from 321 to 315. The year during which the merger took place is always excluded from the sample because the treatment of profit

[3] See e.g. Bonin et al. (2005), Bos and Kool (2006), Clark and Siems (2002), Kwan (2006), Carbo et al. (2002) and Girardone et al. (2004).

[4] See Appendix A of the review article of Clark (1988).

and loss account items is complicated, depends on the case and might bias cost data. In total, the sample consists of 1903 observations. The 1999 sample consists of 242 member banks of the consortium of cooperative banks, 42 local cooperative banks and 37 savings banks.

Accounting data are from a confidential Financial Supervision Authority (FSA) database, and they are more detailed than information found in public sources. As explained in Section 2.2, the banks can be divided into three different groups. Two of these three groups are denoted with dummy variables (Group 1, Group 2). Because of data confidentiality the identity of these groups cannot be disclosed. Data on banks' managing directors are also from a confidential FSA database. The data contain the name and the date of birth of former and current board members and managing directors of all the supervised entities. Precise dates when the person assumed the position and when the tenure ended are also recorded. These data are complete. Moreover, the database contains information on managers' education, but unfortunately in about 36% of cases this information has not been reported. In the following analyses, managers' education is characterised by the following six dummy variables; UAgSil = +1 if the manager has a university degree in agriculture and/or silviculture, zero otherwise; UBusEcon = university degree in business administration, economics or finance, ULaw = university degree in law, UOther = university degree in other disciplines (typically in social sciences), VocBus = vocational qualification in business administration, Other = other non-university education (typically in agriculture). Manager specific data always refer to the person who was in charge as of 1st of January (See Table 1).

Managers whose education is not reported are typically in charge of relatively small institutions. The median real Tier1 capital in millions of 2004 euros is 5.0 for banks whose manager's education is not reported, 4.1 for banks with a managing director without university degree and 8.4 for banks whose managers have university degrees. This may imply that relatively many managers whose education is not reported have no university degrees. In the following, this group is the reference case when educational dummy variables are used.

Three manager tenure length dummies are defined. Less2y equals +1 if the manager has held the position for less than two years as of 1st of January. Less5y equals +1 if the manager has held the position for at least two but less than five years. Over15y denotes cases where the manager has held the position for more than 15 years. The age of the manager is calculated by subtracting the year of birth from the current year.

The production approach is used to define bank output. The intermediation approach and the value added approach consider interest expenditure an ordinary cost, which would not be a meaningful assumption in the case of these banks. At least in savings banks, deposit rate maximisation might be a reasonable objective.

Banks are assumed to have four outputs, namely transaction account deposits, other deposits, housing loans and other claims on the public and public sector entities. These outputs are measured in monetary volumes. Transaction accounts may be a satisfactory proxy for the amount of payment services. Housing loans are defined as loans secured by mortgages on residential property. Other loans are calculated by subtracting housing loans from the balance sheet item "*claims on the public and public sector entities*". Each balance sheet item is calculated as the average of the four quarterly observations of the year. Variables are made real by dividing them by the wholesale price index. The data are described in Table 2.

Because exogenous input prices are preferable to bank-specific estimates in cost efficiency estimations (Mountain and Thomas, 1999; Koetter, 2006), input prices are assumed to be equal for all banks in the same region. Unlike in many previous contributions, input prices are from general statistical sources. Labour costs are based on the wage index of financial sector employees. This index is adjusted by taking into account the mandatory pension insurance fee. The GDP deflator of the sector "*services to the business sector and real estate*" is the second input price; it includes services related to IT, marketing, legal issues, real estate, human resources management, security, etc.

Factor price statistics are not available by region. Geographic factors are controlled for by ten dummy variables. Nine dummy variables (G1–G9) denote the first digit of the postal code. Areas close to the capital with postal codes beginning with 0 remain the reference case. Factor prices may differ between urban and other areas; a dummy variable (G-Urban) denotes banks headquartered in urban municipalities with more than 50000 inhabitants. These dummy variables also capture any other type of variation across regions. The geographic distribution of banks is presented in Table 3.

Table 1
Descriptive statistics on managers

	UAgSil	UBusEcon	ULaw	UOther	VocBus	Other	Missing
Share in 1999	4.4%	11.8%	11.5%	4.0%	19.9%	9.7%	38.6%
Share in 2004	5.4%	12.5%	12.8%	5.1%	18.5%	9.9%	35.8%
Average age in 1999	44	46	44	47	49	52	49
Average age in 2004	48	49	48	49	52	52	51

The proportion of different educational achievements in the sample.
The average age of managers according to education.
321 banks in 1999, 315 banks in 2004.

Table 2
Distribution of variables

	10 percentile	Lower quartile	Median	Upper quartile	90 percentile
Loans excl housing loans	4779	9708	16282	29466	56923
Housing loans	4089	7343	13548	29344	76305
Transaction deposits	4221	8604	17983	40320	83840
Other deposits	3928	7625	16187	30567	59192
Tier1 capital	1735	2927	5227	9331	18172
Costs	308	502	822	1504	3314
Age of the manag dir	39	44	50	55	58

Thousands of real 2004 euros, 1903 observations.

Table 3
Geographic distribution of sample banks

Region	Non-Urban	Urban	Banks in total
0	13	0	13
1	26	0	26
2	45	2	47
3	53	1	54
4	16	2	18
5	20	2	22
6	48	1	49
7	27	1	28
8	34	1	35
9	21	2	23
Whole country	303	12	315

Bank costs are measured by the profit and loss account item "*administrative expenses*". This cost item contains personnel costs, ICT costs, marketing expenditure, office supplies, etc. for the whole year; no quarterly data are used. This concept does not include "*other operating expenses*", which mainly consists of real estate costs and statutory fees, such as contributions to the deposit insurance fund and fees charged by the FSA. These statutory fees are not particularly relevant to cost efficiency because they could not be legally avoided without suspending operations. Excluding real estate costs may be more problematic but including them would pose even more problems. Small Finnish banks often use rental real estate, mainly business property, as an investment asset. In the light of book values, about 47% of sample banks' real estate was not used by the banks themselves. Real estate is not necessarily marked to the market, implying that even its true quantity is unknown. It is probably consistent to ignore real estate both as an output and as an input. To make things even more complicated, certain banks own their own offices whereas some of them use rental premises. In the former case the opportunity cost of capital invested in brick and mortar may be substantial, but this cost item cannot be found on the profit and loss account. The interest expenditure of funding these assets is not included in costs in the production approach. Some banks use rented offices, making their real estate expenses more visible yet non-comparable to banks in their own premises. The safest way to avoid these problems is to ignore real estate costs.

4. The model

It is far from obvious that savings banks and cooperative banks would maximise profits. Hence, this paper focuses solely on cost efficiency. Inefficiencies in banks are estimated by applying the Battese and Coelli (1995) stochastic frontier estimation to a cost function. The logarithmic administrative expenses of the bank i period t is assumed to equal

$$\mathrm{Ln}(c_{it}) = f(Q_{it}, p_t, k_t) + V_{it} + U_{it}, \quad (1)$$

where f is the so-called deterministic kernel, i.e. the costs of a fully efficient institution in absence of random factors, which is a function of the output vector Q_{it}, the input price vector p_t and control variables k_t. V_{it} is a normally distributed random error with mean zero. U_{it} is the expected value of undue costs caused by inefficiency conditional on total error, as defined by Jondrow et al. (1982).

$$U_{it} = m_{it} + W_{it}, \quad (2)$$

where W_{it} is a random variable, such that U_{it}s are non-negative truncations of the distribution $N(m_{it}, \sigma^2)$, when m_{it} is defined as

$$m_{it} = \delta_0 + \sum_{j=1}^{N} Z_{jit}\delta_j, \quad (3)$$

where Z_{jit} is the jth inefficiency determinant (Z variable) of the bank i year t and δs (delta coefficients) are parameters to be estimated. If $m_{it} \geqslant 0$, it is also the mode of the distribution. In the following, m_{it} will loosely be called the mode, even though whenever m_{it} is negative it does not even belong to the support of U_{it}.

Possible differences in input prices between regions can be taken into account in the deterministic kernel by introducing geographic effects as simple dummy variables, as interactions with outputs, and as interactions with relative input prices (see Appendix A). Any other regional factors may affect the coefficients of the geographic dummy variables, which should not be a problem.

The cost function is the standard translog specification complemented with trigonometric terms. The importance of trigonometric terms is stressed by e.g. Huang and Wang (2004), Humphrey and Vale (2004) and Kraft et al. (2006). Following numerous contributions,[5] Fourier terms are applied only for outputs. Following Berger and Mester (1997) and Kraft et al. (2006), linear homogeneity in input prices is imposed on the cost function by dividing both costs and other factor prices by one factor price, which in this case is the GDP deflator of services to the business sector (p_2). The final specification is

$$\begin{aligned}
[\mathrm{Ln}(C/p_2) = {} & \beta_0 + \sum_{i=1}^{4}\beta_i \mathrm{Ln}(Q_i/p_3) + \theta_0 \mathrm{Ln}(p_1/p_2) \\
& + \sum_{i=1}^{4}\theta_i \mathrm{Ln}(Q_i/p_3)\mathrm{Ln}(p_1/p_2) + \theta_5\{\mathrm{Ln}(p_1/p_2)\}^2 \\
& + \sum_{i=1}^{4}\sum_{j=i}^{4}\Psi_{ij}\mathrm{Ln}(Q_i/p_3)\mathrm{Ln}(Q_j/p_3) + \varpi_1 T + \varpi_2 T^2 \\
& + \sum_{i=1}^{4}\Lambda_i T\mathrm{Ln}(Q_i/p_3) + \alpha T\mathrm{Ln}(p_1/p_2) + \sum_{i=1}^{10}\varsigma_i G_i \\
& + \sum_{i=1}^{10}\sum_{j=1}^{4}\mu_{ij}G_i\mathrm{Ln}(Q_j/p_3) + \sum_{i=1}^{10}\phi_i G_i \mathrm{Ln}(p_1/p_2) \\
& + \sum_{i=1}^{4}\Omega_i \sin(Y_i) + \sum_{i=1}^{4}\xi_i\cos(Y_i) + \sum_{i=1}^{4}\sum_{j=i}^{4}\eta_{ij}\sin(Y_i+Y_j) \\
& + \sum_{i=1}^{4}\sum_{j=i}^{4}\Gamma_{ij}\cos(Y_i+Y_j) + \sum_{i=1}^{4}\sum_{j=i}^{4}\sum_{k=j}^{4}\{\zeta_{ijk}\sin(Y_i+Y_j \\
& + Y_k) + \gamma_{ijk}\cos(Y_i+Y_j+Y_k)\} + U + V.
\end{aligned} \quad (4)$$

The first five lines include all the terms of the translog cost function. The last three rows include the trigonometric add-on terms. C is the administrative expenses of the bank during the year in question, p_1 is the labour cost index of the financial services sector, p_2 is the GDP deflator of services to the business sector, p_3 is the wholesale price index, Qs are the four outputs, T is the trend (1999 = 1), Y_i is the real output i (Q_i/p_3) scaled between 0.1Π and 1.9Π,[6] G_i is the geographic dummy variable G_i when i < 10, G_{10} = G-Urban, U is the inefficiency term, V is the normally distributed error and all the Greek letters are parameters to be esti-

[5] Altunbas et al. (2001), Girardone et al. (2004), Carbo et al. (2002) and Williams and Nguyen (2005).

[6] For each observation $Y_i = 1.8\Pi[(Q_i/p_3) - \mathrm{Min}(Q_i/p_3)]/[\mathrm{Max}(Q_i/p_3) - \mathrm{Min}(Q_i/p_3)] + 0.1\Pi$, where Y_i is the scaled output item i, Q_i is the original, nominal output, $\mathrm{Min}(Q_i/p_3)$ is the lowest value of real output Q_i/p_3 in the whole sample of 1903 observations, $\mathrm{Max}(Q_i/p_3)$ the largest real output and $\Pi \approx 3.14159\ldots$ Similar transformations have been used in bank efficiency estimations by e.g. Carbo et al. (2002), Altunbas et al. (2001), Williams and Nguyen (2005), Girardone et al. (2004), Berger and Mester (1997) and Kraft et al. (2006). The endpoints close to 0 and 2Π are normally excluded to avoid the problems discussed by Gallant (1981).

mated. The variables C, Q and Y are both bank and year specific whereas the variables p_1, p_2, p_3 and T are year specific but common to all banks.

Efficiency is assumed to be determined as a function of several variables, most of them being related to the managing director. Both the signalling theory and the human capital theory predict that education should improve efficiency. Hence, we may expect that banks run by university graduates are more efficient. At least according to stereotypic beliefs, people may become less energetic and slower to adopt new ideas when they grow older. Moreover, people approaching retirement have almost no career concerns and they have less incentives to build reputation (Holmstrom, 1982). On the other hand, learning by doing has the opposite effect. Mature age persons have accumulated substantial amounts of work and life experience, which may help them to avoid misjudgements. Because this tacit knowledge may have a declining marginal impact on efficiency, and because the effect discussed by Holmstrom (1982) may be particularly relevant only if retirement is relatively close, age is allowed to affect efficiency in a non-linear way; among the youngest efficiency may improve as a function of age, but after a certain number of years efficiency could begin to deteriorate.

Moreover, bank size, the two banking group dummy variables and trend are used as control variables. LnTier1 is the logarithmic real Tier1 capital, which is an indicator of bank size. The Tier1 capital was also calculated as the average of four quarterly observations. At least in the case of lending, it is an essential determinant of capacity. The balance sheet total would probably be a problematic size indicator because it is highly endogenous and largely determined by items classified as outputs, such as deposits and loans. Because there are relatively few hypotheses to be tested, a rather general specification is used. The most comprehensive specification is the following.

$$\begin{aligned} m_{it} = {} & \delta_0 + \delta_1 \,\mathrm{Group1} + \delta_2 \,\mathrm{Group2} + \delta_3 \,\mathrm{Trend} + \delta_4 \,\mathrm{Age} + \delta_5 \,\mathrm{Age}^2 \\ & + \delta_6 \,\mathrm{UAgSil} + \delta_7 \,\mathrm{UBusEcon} + \delta_8 \,\mathrm{ULaw} + \delta_9 \,\mathrm{UOther} + \delta_{10} \,\mathrm{VocBA} \\ & + \delta_{11} \,\mathrm{Other} + \delta_{12} \,\mathrm{LnTier1} * \mathrm{UAgSil} + \delta_{13} \,\mathrm{LnTier1} * \mathrm{UBusEcon} \\ & + \delta_{14} \,\mathrm{LnTier1} * \mathrm{ULaw} + \delta_{15} \,\mathrm{LnTier1} * \mathrm{UOther} + \delta_{16} \,\mathrm{LnTier1} \\ & * \mathrm{VocBA} + \delta_{17} \,\mathrm{LnTier1} * \mathrm{Other} + \delta_{18} \,\mathrm{LnTier1} * \mathrm{Age} + \delta_{19} \,\mathrm{Age} \\ & * \mathrm{UAgSil} + \delta_{20} \,\mathrm{Age} * \mathrm{UBusEcon} + \delta_{21} \,\mathrm{Age} * \mathrm{ULaw} + \delta_{22} \,\mathrm{Age} \\ & * \mathrm{UOther} + \delta_{23} \,\mathrm{Age} * \mathrm{VocBA} + \delta_{24} \,\mathrm{Age} * \mathrm{Other} + \delta_{25} \,\mathrm{LnTier1} \\ & + \delta_{26} \,\mathrm{Less2y} + \delta_{27} \,\mathrm{Less5y} + \delta_{28} \,\mathrm{Over15y}. \end{aligned} \tag{5}$$

Unlike in many other contributions, loan losses and non-performing loans are ignored. Loan losses of all the sample banks were negligible; they declined from 0.1% of claims on customers in 1999 to virtually zero in 2004. The estimation is based on the assumption that manager characteristics affect efficiency, not vice versa. In the light of numerous findings, this assumption is realistic. This issue will be discussed further in Sections 5.2 and 6.

5. Results

5.1. Different specifications and inefficiency determinants

Various model specifications were estimated with the Battese and Coelli (1995) method. Some basic statistics on the results are presented in Table 4. Model 0 has the full deterministic kernel but no manager specific variables as efficiency determinants. In statistical terms, the performance is weak relative to models 1, 2 and 4–7, but efficiency estimates derived without manager specific information are needed in Section 5.2.

The full-scale model 1 includes all the potential variables of the deterministic kernel and all the efficiency determinants of Eq. (5). The lambda coefficients in Table 4 measure the loss of statistical fit when variables are dropped off. In the light of these values, no other variables than the manager tenure length dummies can be excluded; this specification is numbered 2 and it can be used as the main model. Other blocks of Z variables seem to have statistically significant explanatory power. The high lambda value of model 3 indicates that geographic dummy variables are highly significant in the deterministic kernel.

As can be seen in Table 5, manager age seems to affect efficiency in a non-linear way, exactly as expected, even though the evidence is not particularly strong. Among the youngest efficiency improves as a function of age but among the oldest the opposite may be true, depending on education. Small banks are more likely to suffer from

Table 4
Model statistics

Model no.	Excluded variables	Determinants of inefficiency (Z variables)	Explanatory variables in the kernel	Average inefficiency	Log likelihood	Lambda against model 1	P(lambda) χ^2 distribution	Gamma	LR test for one sided error	Prob of one sided error, mixed χ^2
0	All the manager specific inefficiency determinants	4	155	10.2%	1563.0	92.51	0.000	0.33	48.5	0.000
1	Full scale model – nothing excluded	28	155	12.6%	1609.3			0.36	141.0	0.000
2	Managing director tenure length dummies	25	155	12.4%	1607.9	2.71	0.258	0.36	138.3	0.000
3	Tenure length dummies, interactions of geographic dummy variables in the kernel	25	105	13.4%	1438.5	341.47	0.000	0.36	127.1	0.000
4	Tenure length dummies and Ln(Tier1)	24	155	12.0%	1605.1	8.39	0.039	0.34	132.6	0.000
5	Tenure length dummies and interactions between manager education and Tier1 capital	19	155	10.5%	1595.9	26.69	0.001	0.31	114.3	0.000
6	Tenure lenth dummies and interactions between manager age and education	19	155	12.9%	1595.3	27.85	0.001	0.36	113.2	0.000
7	Manager age, manager age squared and tenure length dummies	23	155	11.9%	1604.6	9.25	0.055	0.35	131.8	0.000

Models estimated with the full sample of 1903 observations using the Battese and Coelli (1995) method.
Lambda = −2 [LLF (Model to be tested) − LLF (Model 1)]; the probability values of the last column are based on Kodde and Palm (1986). Gamma $= \sigma^2/(\sigma^2 + \sigma_v^2)$; σ^2 is the variance of the normal distribution on which the truncated distribution is based on, σ_v^2 is the variance of the normally distributed random error V. N = 1903.

cost inefficiency. Efficiency has improved over time. Differences between banking groups seem to matter.

Interestingly, the impact of education on performance is very complicated and not always easy to understand. As the high lambda values of models 5 and 6 in Table 4 indicate, the interactions of education with bank size and manager age are highly significant. Because understanding the impact of different educational variables on efficiency is rather difficult in the presence of all the interaction effects, a few illustrative examples are presented in Table 6. The example values of bank size and manager age refer to the 10th, 50th and 90th percentiles of sample distributions. In the case of a median size bank, the manager should preferably have a university degree in business administration or in fields classified as "other". A non-university degree in business administration can also be a good educational background, especially in the smallest banks of the sample. A degree in jurisprudence does not predict good performance in cost minimisation, except among the youngest. As a rule, university graduates have a comparative advantage in manag-

Table 5
Determinants of inefficiency

	Model 0	Model 1	Model 2	Model 4	Model 7
Constant	0.724	1.420	1.414	0.581	0.597
	(6.1)	(3.4)	(3.5)	(3.0)	(5.3)
Group 1	0.082	0.080	0.078	0.076	0.078
	(4.5)	(4.6)	(4.5)	(4.7)	(4.4)
Group 2	0.039	0.040	0.039	0.039	0.041
	(1.8)	(1.9)	(1.9)	(1.9)	(2.0)
Trend	−0.013	−0.020	−0.019	−0.014	−0.016
	(−1.2)	(−2.1)	(−2.7)	(−1.6)	(−1.8)
Age		−0.023	−0.024	−0.010	
		(−2.4)	(−2.4)	(−1.3)	
Age**2		1.5E−04	1.6E−04	1.8E−04	
		(1.8)	(1.9)	(2.3)	
UAgSil		0.483	0.474	0.530	0.514
		(2.0)	(2.0)	(2.2)	(2.1)
UBusEcon		0.450	0.444	0.514	0.573
		(1.8)	(1.8)	(2.0)	(2.2)
ULAw		0.214	0.217	0.264	0.272
		(1.2)	(1.2)	(1.5)	(1.5)
UOther		1.051	1.059	1.201	1.247
		(2.2)	(2.1)	(2.2)	(2.3)
VocBA		0.214	0.231	0.281	0.265
		(1.5)	(1.6)	(1.8)	(1.6)
Other		0.457	0.455	0.420	0.422
		(2.4)	(2.3)	(2.1)	(2.1)
Ln(Tier1) * UAgSil		−0.092	−0.091	−0.099	−0.092
		(−3.1)	(−3.1)	(−3.5)	(−3.2)
Ln(Tier1) * UBusEcon		−0.060	−0.060	−0.068	−0.065
		(−2.2)	(−2.2)	(−2.4)	(−2.3)
Ln(Tier1) * ULaw		−0.059	−0.058	−0.064	−0.060
		(−2.8)	(−2.8)	(−3.2)	(−2.8)
Ln(Tier1) * UOther		−0.101	−0.104	−0.120	−0.119
		(−1.7)	(−1.6)	(−1.7)	(−1.7)
Ln(Tier1) * VocBA		−0.009	−0.012	−0.016	−0.012
		(−0.6)	(−0.7)	(−1.0)	(−0.7)
Ln(Tier1) * Other		−0.040	−0.041	−0.036	−0.038
		(−1.9)	(−1.9)	(−1.7)	(−1.8)
Ln(Tier1) * Age		1.1E−03	0.001	−9.3E−04	8.3E−05
		(1.2)	(1.2)	(−4.0)	(0.9)
Age * UAgSil		0.006	0.006	0.006	0.005
		(1.8)	(1.7)	(1.8)	(1.5)
Age * UBusEcon		3.3E−04	3.4E−04	3.1E−04	−1.6E−03
		(0.1)	(0.1)	(0.1)	(−0.6)
Age * ULaw		0.006	0.006	0.006	0.005
		(2.7)	(2.6)	(2.7)	(2.2)
Age * UOther		−0.005	−0.005	−0.005	−0.006
		(−1.7)	(−1.5)	(−1.7)	(−1.9)
Age * VocBA		−0.003	−0.004	−0.004	−0.004
		(−2.3)	(−2.3)	(−2.4)	(−2.5)
Age * Other		−0.003	−0.003	−0.003	−0.003
		(−1.4)	(−1.4)	(−1.5)	(−1.3)
Ln(Tier1)	−0.073	−0.109	−0.106		−0.055
	(−5.4)	(−2.3)	(−2.2)		(−3.7)
Less2y		0.011			
		(0.8)			
Less5y		−0.004			
		(−0.3)			
Over15y		0.013			
		(1.3)			

Delta coefficients of models 0, 1, 2, 4 and 7.
Asymptotic *t*-values in parentheses.
Missing information on education is the reference case.
Age**2 = age squared.

Table 6
Expected values of inefficiency

	Tier1 = 5227 Age = 50	Tier1 = 5227 Age = 39	Tier1=5227 Age = 58	Tier1 = 1735 Age = 50	Tier1 = 18 172 Age = 50
UAgSil	11.1%	8.5%	15.2%	22.3%	5.4%
UBusEcon	8.9%	8.9%	9.8%	15.4%	5.2%
ULaw	11.6%	9.0%	15.7%	20.0%	6.5%
UOther	8.3%	10.5%	7.8%	17.9%	4.2%
VocBA	9.2%	11.1%	8.9%	12.6%	6.6%
Other	9.5%	11.1%	9.5%	15.2%	5.9%
Missing	11.4%	11.7%	12.6%	14.9%	8.6%

Examples of average inefficiencies as a function of managing director age and education with different values of Tier1 capital. Figures based on model 2 delta coefficients and inefficiency term std deviation. All the direct and indirect effects of age, education and bank size taken into account. Group 1 = Group 2 = 0, year = 2004.

ing large banks, which is intuitive. Differences between manager groups are not negligible. For instance, in the case of a median size bank, the difference between the lowest and the highest expected value of inefficiency is almost 8%. There is at least one obvious pattern in the manager specific components of efficiency modes. Educational background matters among the oldest, but among the youngest it seems to be of limited relevance.

In the light of model 2 coefficients, cost minimisation is achieved in very small banks if they are run by relatively mature managers with a non-university degree in business administration. The optimal age seems to be almost 60. In larger banks the optimal manager should have a university degree in fields classified as "other" and be about 55–60 years old. Model 2 coefficients imply that young managers with a degree in agriculture or silviculture would also achieve good cost efficiency, but drawing this conclusion might not be safe; few managers with this degree are under 40 and none are under 35. As can be seen in Table 7, choosing a manager with ideal characteristics is especially important in very small banks. This is not particularly surprising. In such banks cost efficiency tends to be far below optimal levels, and the potential for improvement is substantial. Large banks tend to be relatively efficient anyway, and not much further cost efficiency can be achieved.

Model 2 coefficients imply that during the last year of the sample, the impact of one year of additional age on the expected value of costs varied, depending on education, between −0.3% and +0.1% if the bank was run by a 38 years old manager. At the age of 50, the impact of an additional year varied between −0.1% and +0.4%. At the age of 58 the impact varied between 0.0% and +0.7%.

5.2. Managers and efficiency changes

The high lambda value of model 0 in Table 4 implies that certain manager characteristics correlate with efficiency. It has been assumed that the results reflect causalities running from manager characteristics to efficiency, but this is basically a mere assumption. If managers affect efficiency, strong efficiency variation should be more likely if a new manager has recently entered. In some cases a clear deterioration could take place, and in some other cases an improvement might be observed, depending on who is replaced by whom. Instead, if we observe that efficiency variation remains at its average level even after manager changes, we can conclude that the manager is probably irrelevant to cost efficiency, at least in the short run. The 110 banks with full information for the whole period and at least two different managing directors between January 1999 and December 2004 were selected for further analysis.

If two banks have same costs and identical outputs, the Battese–Coelli method may assign them different efficiency estimates. If a bank has efficiency determinants typical for inefficient institutions, the cost function residual is interpreted as inefficiency (U_{it}) rather than mere random noise (V_{it}). Efficiency estimates should not be derived from manager specific information; hence, model 0 estimates were used.

Efficiency seems to have improved during the observation period. Average improvement of efficiency has varied over time. Some banks have experienced stronger efficiency improvements than others. The component of efficiency improvement that cannot be explained by bank and year specific dummy variables must be due to something else, such as manager changes. The deviation of efficiency change from its expected value is defined as the error term of the following regression

$$U_{i,t}^{\text{Model }0} - U_{i,t-1}^{\text{Model }0} = \beta_i + \alpha_t + \varepsilon_{it}, \tag{6}$$

where β is a bank specific and alpha a year specific parameter to be estimated and ε_{it} is the error term. The absolute value of the error term $|\varepsilon_{it}|$ measures unexplained efficiency variation in bank i year t. Because panel estimations with truncated explained variables pose problems (see e.g. Baltagi, 2001, pp. 212–214), the analysis is facilitated by the logarithmic transformation. Hence, in the following analyses, unexpected efficiency variation for bank i year t is the logarithmic absolute value of the residual; the explained variable in Table 9 is Ln ($|\varepsilon_{it}|$). Descriptive statistics on this variable are presented in Table 8, column 1.

This proxy for efficiency variation was regressed on the dummy variable NEWBOSS and the lagged value of efficiency, which was used as a control variable. NEWBOSS equals +1 if a new managing

Table 7
Estimated model 2 efficiency and improvement potential

1 Range of Tier1 capital	2 Number of banks in this size category in 2004	3 Average actual model 2 inefficiency	4 Tier1 capital in calculations	5 Optimal manager, education and age	6 Estimated model 2 inefficiency if optimal manager	7 Potential improvement
1200–2200	18	15.9%	1735	VocBA, 60	11.7%	4.2%
4900–5500	22	7.9%	5227	UOther, 60	7.8%	0.1%
15 000–21 000	18	4.9%	18 172	UOther, 55	4.1%	0.8%

Number of banks in 2004 in the size category of column 1 reported in column 2. The estimated average model 2 efficiency of these banks in 2004 reported in column 3. Column 5 describes the optimal manager in a bank of the size in column 4. The expected value of model 2 inefficiency in column 4 bank with optimal manager reported in column 6. The difference between actual (column 3) and potential (column 6) inefficiency in column 7.

Table 8
Description of efficiency changes

	1 Ln[Abs(ε_{it})]	2 Ln(U_{it}/U_{it-1})
Min	−12.42	−1.74
25 percentile	−5.44	−0.24
Median	−4.63	−0.12
Average	−4.76	−0.04
75 percentile	−4.00	−0.01
Maximum	−2.00	1.66
Skewness	−1.01	−0.03

Distributional data on estimated efficiency changes.
Sub-sample of 110 banks 2000–2004, $N = 550$.
Model 0 estimates.

director took office during the year, zero otherwise. As equation 1 of Table 9 demonstrates, a new managing director may affect efficiency already during the same year, and the impact is even stronger during the following year. The statistical significance of cross-section fixed effects implies that there are relatively persistent differences in efficiency variation across banks.

Unfortunately the data does not tell the reason why a bank got a new managing director. However, if the old manager had reached a certain age, retirement is the most likely reason. The dummy variable RETIRED denotes cases where the exiting manager was at least 60 years old. The variable OTHERCH denotes manager changes in other cases. There are 37 presumed retirements and 84 other manager changes. Equation 2 in Table 9 implies that the impact on efficiency variation is stronger if the manager leaves because of reasons other than retirement. If extreme cases where the explained variable is lesser than −7 are excluded, like in equation 5, this finding is even clearer. Interestingly, manager retirements are not systematically followed by above average efficiency variation.

The same explanatory variables were used to explain the simple logarithmic difference of model 0 inefficiency. Descriptive statistics on this variable are presented in Table 8, column 2. The high significance of cross-sectional fixed effects in equation 1 in Table 10 implies that there are bank-specific trends in levels; certain banks constantly improved their efficiency more than others. As can be seen in equation 1, if anything, efficiency improves when a new managing director enters, but the evidence is weak. Equations 2 and 4 demonstrate that if a manager retires, cost efficiency improves. Equations 2 and 3 find no statistically significant regularity in case of other manager changes. Extreme cases where the absolute value of the difference between U_{it} and U_{it-1} is greater than 0.05 were excluded in equation 5, leaving us 507 observations. The main conclusions remain unaffected. The observation that manager retirement is often followed by efficiency improvement is consistent with the argumentation of Holmstrom (1982); incentives to work hard weaken when retirement approaches. The new manager is typically more efficient than the old manager immediately before retirement.

Manager salary is included in bank costs. Manager retirement may improve cost efficiency because old managers are paid higher wages than young ones. It may be rational to pay senior employees more than what their productivity would justify because young employees are motivated by deferred compensation and hopes of growing old in the firm (Lazear, 1981). If such compensation practices are in place in sample banks, the cost savings due to manager retirement should be particularly strong in small banks where manager salary is probably a more important expenditure item in relative terms. An estimation was run with a sub-sample of observations where the bank had a logarithmic tier1 capital higher than sample average. The results are reported in the 6th equation of Table 10; contrary to expectations, retirement enhances efficiency especially in the largest sample banks.

It is not obvious that manager changes are exogenous events. An endogeneity test was carried out analogously to the conventional Hausman test using the added variable approach. Instruments included manager tenure length dummies, manager age variables, group dummy variables and past inefficiency. There was no statistically significant evidence of manager change endogeneity problems, neither in Table 9, nor in Table 10. Interestingly, past inefficiency seemed useless in predicting manager changes. This finding was corroborated by other tests. If lagged manager changes were replaced by future manager changes in the above

Table 9
Determinants of efficiency variation, panel least squares

	No fixed effects 0	1	2	3	4	$N = 531$ 5
Explained variable Ln[Abs(ε_{it})]						
Constant	−3.11 (−8.0)***	−4.67 (−7.5)***	−4.68 (−3.2)***	−4.67 (−7.5)***	−4.51 (−7.2)***	−4.55 (−8.4)***
NEWBOSS$_t$	0.22 (1.7)*	0.23 (1.9)*				
NEWBOSS$_{t-1}$	0.31 (2.4)**	0.32 (2.5)**				
OTHERCH$_t$			0.34 (2.3)**	0.34 (2.3)**		0.31 (2.3)**
OTHERCH$_{t-1}$			0.30 (2.0)**	0.30 (2.0)**		0.36 (2.6)***
RETIRED$_t$			0.02 (0.1)		0.01 (0.0)	−0.02 (−0.1)
RETIRED$_{t-1}$			0.33 (1.5)		0.33 (1.5)	0.08 (0.4)
Ln(U_{it-1})	0.73 (8.9)***	0.08 (0.3)	0.08 (0.3)	0.07 −0.30	0.11 (0.4)	0.08 (0.3)
LLF	−865.06	−733.75	−732.68	−734.13	−737.46	−629.81
F-stat	21.14	2.40	2.37	2.39	2.32	2.14
R^2	0.16	0.39	0.39	0.39	0.38	0.38

t Statistics in parentheses.
Statistical significance * = 10% level; ** = 5% level; *** = 1% level.
Redundant fixed effects in equation 1, period effects *F*-test 2.3**, χ^2 11.8**; cross-section *F*-test 1.6***, χ^2 188.6***.
Wald test *F* stat for equal coefficients of RETIRED$_{t-1}$ and OTHERCH$_{t-1}$ in equation 2 = 4.20**. 110 cross sections and 550 observations in equations 0–4.
19 extreme observations with explained variable $\leqslant$7 excluded in equation 5.
Fixed cross-section effects and period effects in equations 1–5.

Table 10
Determinants of efficiency improvement, panel least squares

	No fixed effects 0	1	2	3	4	N = 507 5	N = 261 6
Explained variable Ln(U_{it}/U_{it-1})							
Constant	−0.31	−2.17	−2.18	−2.19	−2.18	−1.71	−2.07
	(−7.3)***	(−20.0)***	(−20.1)***	(−20.0)***	(−20.2)***	(−15.4)***	(−11.6)***
$NEWBOSS_t$	−0.03	−0.02					
	(−1.1)	(−0.8)					
$NEWBOSS_{t-1}$	−0.04	−0.04					
	(−1.7)*	(−1.9)*					
$OTHERCH_t$			0.01	0.01		0.01	0.04
			(0.3)	(0.3)		(0.5)	(1.1)
$OTHERCH_{t-1}$			−0.02	−0.02		−0.02	0.01
			(−0.7)	(−0.6)		(−0.7)	(0.3)
$RETIRED_t$			−0.06		−0.06	−0.04	−0.15
			(−1.8)*		(−1.7)*	(−1.5)	(−3.2)***
$RETIRED_{t-1}$			−0.09		−0.09	−0.06	−0.10
			(−2.5)**		(−2.5)**	(−2.0)**	(−2.0)**
Ln(U_{it-1})	−0.08	−0.87	−0.87	−0.87	−0.87	−0.67	−0.77
	(−4.7)***	(−19.0) ***	(−19.1)***	(−19.0)***	(−19.2)***	(−14.5)***	(−11.1)***
LLF	46.22	227.67	230.50	225.57	230.06	324.07	138.50
F-stat	8.54	3.83	3.82	3.77	3.89	2.78	2.85
R^2	0.04	0.51	0.51	0.50	0.51	0.46	0.51

t Statistics in parentheses.
Statistical significance * = 10% level; ** = 5% level; *** = 1 % level.
Redundant fixed effects in equation 1, period effects *F*-test 48.5***, χ^2 203.8***; Cross-section *F*-test 3.6***, χ^2 357.7***.
Full sample of 110 cross sections and 550 observations in equations 0–4.
Extreme changes excluded in equation 5.
Banks with below average Tier1 capital excluded in equation 6.
Fixed cross-section effects and period effects in equations 1–6.

equations, neither efficiency improvements nor efficiency variation preceded manager changes. Hence, the development of efficiency probably does not cause manager changes.

6. Conclusions and discussion

This paper has presented some evidence on the impact of managers on cost efficiency. The sample consists of Finnish savings and cooperative banks in 1999–2004. Each observation is assigned an efficiency estimate by running Battese and Coelli (1995) stochastic frontier translog cost function estimations. Bank output is defined according to the production approach.

There is strong statistical evidence on the impact of manager age and education on performance in cost minimisation, but these effects seem to be rather complicated. In very small banks a vocational level qualification in business administration seems to be the best education, in somewhat larger banks a university degree is preferable. If an old manager retires, a significant cost efficiency improvement typically follows. Non-retirement manager changes also affect efficiency, but both improvements and deteriorations are equally possible. In very small banks, costs could be reduced by several percent by recruiting suitable managers. In somewhat larger banks there is much less potential for cost efficiency improvement, possibly because these banks are already relatively efficient. Even though manager retirement typically improves efficiency, it was found that optimal managers in banks of different sizes are typically over 50. These results may simply imply that experience matters, but serious motivational problems may arise immediately before retirement. The estimated impact of an additional year of age on costs varies between −0.3% and +0.7%, if the tails of the manager age distribution are ignored.

The results were not obtained in controlled experiments. Underlying manager selection and self-selection processes have probably been very complicated. Most mature managers of the sample have been recruited by the industry decades ago. Banking groups' recruitment policies and the attractiveness of the banking industry among young graduates may have varied, implying that if two persons with the same education are born different years, they are not equally likely to have been employed by banks. Employees who have left sample banks are probably no random draw either. Vocational qualifications in business administration may appear well suited for banking because the most skilled of them have been promoted to management. Instead of being promoted, the best lawyers may have left sample banks, creating the illusion that mature lawyers seldom make good managers. It is easy to present a very large number of these kinds of hypothetical selection effects.

Some hypotheses of this kind can be tested (see Appendix B). One might suggest that the sample has been partly selected by boards' practice to lay off poor performers if and only if they have certain observable characteristics, causing correlations between manager characteristics and efficiency. Bank size, geographic location and group dummy variables do not predict manager changes. Inefficiency is not a significant explanatory variable. Interactions of efficiency and university education seem to be irrelevant to manager changes. Having a university degree in law has no interaction effect with inefficiency on manager exit; mature lawyers probably do not appear inefficient because their efficient peers would have left sample banks years ago. There is no evidence on the hypothesis that managers with a non-university degree in business administration would have stayed if and only if their performance is good, which would make mature persons with this education appear efficient. Neither do age and inefficiency have an interaction effect on exit.

It was also tested whether efficient banks tend to recruit certain types of managers. The results are not reported in detail in this paper but some of them may be worth a brief description. It seemed impossible to predict the age and education of entering new managers by using information on the size and efficiency of banks. Past cost efficiency had no explanatory power in predicting whether entering managers have a university degree. Past efficiency did not predict the age of new managers. Cost efficient banks have no particular tendency to recruit mature managers with either a university degree in fields classified as "other" or vocational level qualifications in business administration, even though such managers are commonplace in cost efficient banks. Inefficient banks have no particular tendency to recruit mature lawyers. Relatively large, efficient banks do not systematically recruit managers with university degrees in agriculture, silviculture, law, business administration or economics even though these educational backgrounds seem particularly well suited for large banks.

In addition to differences in skills and efforts, we may have measured differences in objectives. Some managers may not try to minimise costs because they are unwilling to lay off loyal employees in high unemployment areas. Some managers may pursue social status by hiring as many subordinates as possible. It is difficult to test whether these kinds of phenomena are present in the sample.

There are many open questions for further research. The data does not contain much explicit information on experience. Banking groups have internal training programmes, and their impact on efficiency could be estimated. Psychometric test results on cognitive skills and other personality characteristics might also be available, and they might have predictive power as efficiency determinants. Testing these kinds of effects would be relatively simple if suitable data were available.

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Appendix A. Controlling for regional factor price differences

Let us assume the price of the factor 1 in a given geographic area is g_1 times the reference area price, and the price of the factor 2 is g_2 times the reference area price. The relative prices in the equation to be estimated can be decomposed into reference area relative prices and a region specific effect captured by the simple dummy variable.

$$\beta_n \mathrm{Ln}\{g_1 p_1/(g_2 p_2)\} = \beta_n \mathrm{Ln}(p_1/p_2) + \beta_n \mathrm{Ln}(g_1/g_2).$$

If relative input prices in the reference area differ from the national average reported in aggregate statistics, the coefficient β_n captures this difference. The value of $\mathrm{Ln}(g_1/g_2)$ is unknown, but the coefficient of the geographic dummy variable adjusts accordingly.

As to the interaction between factor prices and outputs, the situation is relatively straightforward; the interactions of geographic factors and outputs must be included in the deterministic kernel.

$$\beta_m \mathrm{Ln}\{g_1 p_1/(g_2 p_2)\}\mathrm{Ln}(Q_i) = \beta_m \mathrm{Ln}(p_1/p_2)\mathrm{Ln}(Q_i) + \beta_m \mathrm{Ln}(g_1/g_2)\mathrm{Ln}(Q_i).$$

The logarithmic price squared can be decomposed into the squared logarithmic reference area relative price, the interaction of logarithmic relative prices and the geographic factor and the region specific dummy variable.

$$\beta_v\{\mathrm{Ln}(g_1 p_1/(g_2 p_2))\}^2 = \beta_v\{\mathrm{Ln}(p_1/p_2) + \mathrm{Ln}(g_1/g_2)\}^2 = \beta_v\{\mathrm{Ln}(p_1/p_2)\}^2 + 2\beta_v \mathrm{Ln}(p_1/p_2) * \mathrm{Ln}(g_1/g_2) + \beta_v\{\mathrm{Ln}(g_1/g_2)\}^2.$$

The explained variable can also be decomposed.

$$\mathrm{Ln}[C/p_2 g_2] = \mathrm{Ln}[C/p_2] - \mathrm{Ln}(g_2).$$

The term $\mathrm{Ln}(g_2)$ can be moved to the right side of the equal sign, and it is captured by the simple geographic dummy variable.

Appendix B. Determinants of manager changes

Logit estimations

	1	2	3	4	5	6	7
C	−1.23	−0.25	−0.38	−0.75	−1.15	0.90	0.08
	(−7.4)	(−1.0)	(−0.6)	(−0.5)	(−0.7)	(0.8)	(0.1)
U_{i1999}	−0.04	−0.03	−0.03	−0.06	1.49	−2.60	0.00
	(−0.1)	(−0.1)	(0.5)	(−0.2)	(0.5)	(−1.3)	(0.2)
LnTier1		−0.12	−0.12	−0.10	−0.01		
		(−0.7)	(−0.1)	(−0.6)	(−0.1)		
Group 1			0.58	0.56	0.59	0.57	0.58
			(1.3)	(1.4)	(1.5)	(1.5)	(1.5)
Group 2			0.40	0.34	0.46	0.49	0.49
			(−0.8)	(0.8)	(1.1)	(1.2)	(1.2)
G1				0.62			
				(0.7)			
G2				−0.11			
				(−0.1)			
G3				0.20			
				(0.2)			
G4				0.19			
				(0.2)			
G5				1.12			
				(1.2)			
G6				0.08			
				(0.1)			
G7				0.71			
				(0.8)			
G8				−0.53			
				(−0.6)			
G9				0.06			
				(0.1)			
G-Urban				−1.03			
				(−0.9)			
ULaw							−0.05
							(−0.1)
U_{i1999} * ULaw							−0.06
							(−0.1)
VocBA							0.17
							(0.4)
U_{i1999} * VocBA							−0.60
							(−0.7)
Age						−0.05	
						(−2.0)**	
U_{i1999} * Age						0.05	
						(1.3)	
U_{i1999} * UnivEduc					0.02		
					(0.0)		
U_{i1999} * Ln(Tier1)					−0.19		
					(−0.5)		
UnivEduc					−0.30		
					(−0.8)		
McFadden R_2	0.00	0.00	0.01	0.04	0.01	0.02	0.02
LR Stat	0.02	0.63	3.68	13.47	4.68	7.05	5.96
Prob of LR stat	0.89	0.73	0.48	0.49	0.70	0.22	0.65

Explained variable = 1 if OTHERCH equals 1 at least once in 2000–2004. Cross-section, $N = 309$. In 69 cases explained variable = 1.

t-Stats in parentheses. ** = Statistical significance at the 5% level.

*G*s are geographic dummy variables. All the explanatory variables are 1999 values.

UnivEduc = 1 if the manager has a university degree in any discipline, zero otherwise.

U_{i1999} = Model 2 inefficiency in 1999.

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