Total Factor Productivity Change of Greek Cooperative Banks

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Abstract

In this study, we employ the Malmquist index to examine the total factor productivity change in the Greek cooperative banking, using a balanced panel dataset of 78 observations from 13 banks over the period 2000-2005. We estimate two models, one based on the intermediation approach, and one based on the production approach. The results are mixed. The first model indicates a small decrease (3%) in total factor productivity whereas the second model indicates an increase by 6.6%. We also compare the results on the basis of banks' size and find that TFP growth is higher for smaller banks on average over the entire period of our analysis. However, this relationship between size and productivity is not robust across the years. Furthermore, the differences between the groups are not statistically significant.

Keywords: Banks, Cooperative, Greece, Malmquist, Productivity
JEL: D24, G21

 Author for correspondence: f.pasiouras@bath.ac.uk, Tel: +44 (0) 1225384297; The views and conclusions presented in the paper are exclusively those of the authors and not necessarily reflect the position of EFG-Eurobank Ergasias or any other person associated with EFG-Eurobank Ergasias.

1. Introduction

In recent years, several studies have examined the technical, cost, and more recently profit efficiency of banks[1]. A smaller but growing and equally important strand of the literature focuses on productivity change. Casu et al. (2004) highlight the importance of analysing the productivity of banking and mention that it "*…is of interest from a policy perspective because if banks are becoming more productive then one might expect better performance, lower prices and improved service quality for consumers, as well as greater safety and soundness if productivy improvements are channelled towards strengthening capital buggers that absorb risk*" (p. 2522).

Following one of the earliest studies in the field, which examines the Norwegian banking sector (Berg et al., 1992), more recent studies focus on various other countries such as Germany (Lang and Welzel, 1996), Spain (Grifell-Tatje and Lovell, 1997), USA (Wheelock and Wilson, 1999; Mukherjee et al., 2001; Daniels et al., 2005), Australia (Worthington, 1999; Neal, 2004), Portugal (Mendes, Rebelo, 1999), UK (Drake, 2001), Malaysia (Dogan and Fausten, 2003), Japan (Fukuyama and Weber, 2002), Korea (Park and Weber, 2006), Turkey (Isik and Hassan, 2003), Canada (Asmild et al., 2004), India (Galagedera and Edirisuriya, 2004), and Italy (Casu and Girardone, 2004) among others.

There are also a few studies that examine cross-country samples. For example, Casu et al. (2004) focus on large banks from the principal EU banking sectors (i.e. France, Germany, Italy, Spain, UK) over the period 1994-2000. In a latter study, Casu and Girardone (2005) examine the same sample while focusing on the impact of off-balance sheet times on productivity change. Finally, Molyneux and Williams (2005) examine the productivity of cooperative banks operating in ten European banking sectors over the period 1996-2003.

The present study uses the Malmquist TFP index[2] to examine, for the first time, the productivity growth of Greek cooperative banks. Previous studies that examine the productivity of the Greek banking sector are the ones of Noulas (1997), Apergis and Rezitis (2004) and Rezitis (2006). Noulas (1997) examines a sample of 20 commercial banks over the period 1991-1992. Apergis and Rezitis (2004) and

[1] See Berger and Humphrey (1997) and Goddard et al. (2001) for reviews of the literature on banks' efficiency.

[2] The Malmquist total factor productivity (TFP) index is the most commonly used measure of productivity change (Casu and Girardone, 2005, p. 1055) although a few studies use parametric models with a time trend as a proxy for technical change.

Rezitis (2006) investigate 6 commercial banks for the 1982-1997 period. Hence, all these studies focus on commercial banks, and to the best of our knowledge, no study has examined the productivity growth of Greek cooperative banks[3].

The Greek cooperative banking industry has a history of approximately ten years and there are currently 16 banks with a total network of 126 branches, offering their services in the largest part of the country. Only two of these banks are qualified to operate all over the country while another four have reached the required cooperative capital allowing them to extend their operations in the neighbouring regions. Despite the competition that they face, cooperative banks have demonstrated an improvement in most financial aspects over the last years. For example, their net profits before taxes increased by 18.31% (on average) between 2000 and 2004, whereas total assets increased by 30.61% (Association of Co-operative Banks of Greece-ACBG, 2005). Furthermore, over the same period, their branches increased by 16.67%, while their personnel and members experienced an increase around 11.5%.

While cooperative banks hold a relatively small market share in the Greek banking sector, they play an important role in the development of the local economy. They mainly focus on small and medium enterprises and private citizens, provide support, and encourage the development of local enterprises. They attempt to offer competitive banking products adjusted to local conditions and with operational features, with an objective of being established as reliable, friendly, and flexible. Hence, an assessment of their productivity growth over the last years can be of special interest to several stakeholders such as customers-members, bank managers, local community, and of course bank regulators.

The rest of the paper is structured as follows. Section 2 presents the methodology and data. Section 3 discusses the empirical results. Section 4 outlines the concluding remarks.

2. Data and Methodology

2.1. The Malmquist TFP index

Following Fare et al. (1994) the Malmquist (output oriented[4]) TFP change index between period *s* (the base technology period) and period *t* (the reference technology period) is given by

[3] As previously mentioned Molyneux and Williams (2005) examined ten European countries, however Greece was not included in the analysis due to data availability.

$$m_0^t(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s)} \tag{1}$$

In the case that *t* is the base technology and *s* is the base technology (1) becomes

$$m_0^s(y_s, x_s, y_t, x_t) = \frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)} \tag{2}$$

As Coelli et al. (2005) point out, to avoid the necessity of either imposing restrictions or arbitrarily choosing one of the two technologies, the Malmquist TFP index is derived as the geometric mean of these two indices as follows

$$m_0(y_s, x_s, y_t, x_t) = \left[\frac{d_0^s(y_t, x_t)}{d_0^s(y_s x_s)} \times \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s} \right]^{\frac{1}{2}} \tag{3}$$

A value of m_0 greater than one indicates positive TFP growth from period *s* to period *t* while a value less than one indicates TFP decline. An equivalent way of writing the index is

$$m_0(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)} \left[\frac{d_0^s(y_t, x_t)}{d_0^s(y_s x_s)} \times \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s} \right]^{\frac{1}{2}} \tag{4}$$

where the ratio outside the square brackets corresponds to the change in the output-oriented measure of Farrell technical efficiency between periods *s* and *t*. The remaining part of the index in equation (4) is a measure of the shift in technology between the two periods, evaluated at x_t and also at x_s. Hence, we have

$$\text{TFPCH} = \text{EFCH x TCH} \tag{5}$$

[4] The output-oriented productivity measures focus on the maximum level of output that could be produced using a given input vector and a given production technology relative to the observed level of outputs. It is also possible to define an input-oriented TFP index which focuses on the level of inputs necessary to produce observed output vectors under a reference technology.

Where TFPCH is the total factor productivity change, EFCH is technical efficiency change (under CRS technology) and TCH is the technological change. An improvement in TCH shows a shift in the best practice frontier, whereas an improvement in EFCH corresponds to the catch up.

As shown above, if the production technology exhibits constant returns to scale (CRS) there are only two sources of productivity growth: efficiency change and technical change. However, if the production technology exhibits variable returns to scale (VRS) there are two additional sources of productivity growth: pure technical efficiency (PTECH) and scale efficiency (SECH)[5]. The pure efficiency change is given by

$$PTECH = \frac{d_{0v}^{t}(y_t, x_t)}{d_{0v}^{s}(y_s, x_s)} \tag{6}$$

whereas the scale efficiency change is given by

$$SECH = \left[\frac{d_{ov}^{t}(y_t, x_t)/d_{oc}^{t}(y_t, x_t)}{d_{ov}^{t}(y_s, x_s)/d_{oc}^{t}(y_s, x_s)} \times \frac{d_{ov}^{s}(y_t, x_t)/d_{oc}^{s}(y_t, x_t)}{d_{ov}^{s}(y_s, x_s)/d_{oc}^{s}(y_s, x_s)} \right]^{\frac{1}{2}} \tag{7}$$

SECH is actually the geometric mean of two scale efficiency change measures, the first relative to the period *t* technology, the latter relative to the period *s* technology. The subscripts, *v* and *c*, refer to the VRS and CRS technologies, respectively. Hence, we have

$$\text{EFCH} = \text{PTECH} \times \text{SECH} \tag{8}$$

which results in (5) being rewritten as

$$\text{TFPCH} = \text{PTECH} \times \text{SECH} \times \text{TCH} \tag{9}$$

[5] Coelli et al. (2005) mention that this decomposition involving scale efficiency has been widely used and more recently also widely criticized. However, we believe that the discussion of this debate is out of the scope of the present paper and we refer to Ray and Desli (1997), Balk (2003) and Coelli et al. (2005) for further details.

2.2. Data

Our sample consists of a balanced panel dataset of 78 observations from 13 Greek cooperative banks[6] over the period 2000-2005. The financial data were extracted from income and balance sheet statements provided by the ACBG. Additional information about the number of employees was also obtained from ACBG.

As mentioned in several studies, there is no general agreement in the literature as for the proper definition of inputs and outputs. Bergendahl (1998) highlights this issue by mentioning that "*There have been almost as many assumptions of inputs and outputs as there have been applications of DEA*" (p. 235). Berger and Humphrey (1997) identify two main approaches, the *production approach* (PA), and the *intermediation approach* (IA). PA assumes that banks produce loans and deposit account services, using labour and capital as inputs, and the number and type of accounts measure outputs. IA views banks as financial intermediates that collect purchased funds and transform them to loans and other assets.

In the present study, we follow both approaches and compare the results. Under the intermediation approach (Model 1), we use three inputs and two outputs. The three inputs are: fixed assets (X_1), number of employees (X_2), and deposits (X_3). The two outputs are: loans (Y_1), and liquid assets and investments[7] (Y_2). Under the production approach (Model 2), deposits also become an input. Hence, Model 2 has two inputs and three outputs. Table 1 presents descriptive statistics of the inputs and outputs.

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[6] There are 16 cooperative banks operating in Greece. We excluded Cooperative Bank of Serres from the analysis for two reasons. First, because it began its operations in 2004 and as a relatively new bank could have different characteristics and /or follow different strategies. For example, DeYoung and Hassan (1998) report that the average one-year-old de novo US bank is far less profit efficiency than the average established bank. Second, because the estimation of the total productivity factor with the software that we use (DEAP 2.1; Coelli, 1996) requires a balanced panel dataset. We exclude two more banks due to zero values in inputs/outputs which cannot be accommodated in our software. While our sample appears small in absolute terms, it is comparable to previous studies that examine efficiency and productivity issues in the Greek commercial banking sector as well as in other countries. For example, Apergis and Rezitis (2004) and Rezitis (2006) examine six banks, Karafolas and Mantakas (1996) examine eleven banks, while the sample in Pasiouras (2006) ranges between twelve and eighteen banks. Several studies outside Greece have also used relatively small samples, including the study of Chu and Lim (1998) that examines as few as six banks, Drake (2001) that examines only nine UK banks and Neal (2004) that examines twelve Australian banks. After all, one of the most well known advantages of DEA and consequently DEA-like methods as the one used in our study is that they work well with small samples.

[7] These are shares and other variable-income securities and participation in affiliated and non-affiliated companies (i.e. investments) and all investments in fixed income securities as well as government securities (i.e. liquid assets).

[Insert Table 1 Around Here]

3. Empirical Results

Following Fare et al. (1994), Casu et al. (2004), Casu and Girardone (2005) among others, we calculate the output-oriented Malmquist TFP change index. An index greater than one indicates a positive TFP growth while an index lower than one indicates a decrease of TFP over the period. Based on our earlier discussion, TFPCH is then disaggregated into EFCH and TCH, whereas EFCH is decomposed further into PTECH and SECH. Following Isik and Hassan (2003) and Casu et al. (2004) among others we report all these indices.

The indices are calculated relative to the previous year. The annual entries are geometric means of results for individual banks and the period results reported in the last row correspond to geometric means of the annual geometric means. Panel A in Table 2 presents the results of Model 1 (i.e. intermediation approach) whereas Panel B shows the results of Model 2 (i.e. production approach).

[Insert Table 2 Around Here]

The results of Model 1 indicate that the thirteen banks in the panel, experienced an average efficiency decrease of 0.8% and an average technological regress of 2.3% Taking together these changes resulted in a decrease of TFP by an average of around 3% over the period of our analysis. While we observe a decrease in TFPCH in all the years, with 2004-05 being the only exception, the change is inconsistent as it concerns EFCH and TCH. More precisely, we observe a positive change of EFCH during 2002-03 associated with a negative change of TCH, while the opposite occurs during 2003-04 and 2004-05. Decomposition of the EFCH into its two components indicates that pure technical efficiency that measures performance only due to managerial activity decreased by 0.8% whereas scale efficiency decreased on average by 0.3%. Casu et al. (2004) also report a negative scale efficiency change for France, Italy and Spain and interpret it as “wasted expenditure” that is accounted for by uneconomical scale size of the banks. In our case of course, the decrease in SECH is relatively small. Furthermore, investigation of the results by year indicates a positive SECH during 2000-01 and 2002-03.

When TFPCH and its components are estimated with Model 2 that is based on the production approach, a different picture seems to emerge. TFP increases by around 6.6% as a result of an increase in both efficiency change (4.6%) and technological change (1.9%). Both EFCH and TCH are positive in most of the cases, with the exception of 2003-04 and 2004-05 for the former and 2000-01 for the latter. Turning to the decomposition of EFCH into PTECH and SECH we also observe that they are both positive on average with changes equal to 2.0% and 2.5% over the period of our analysis.

To test the statistical significance of the differences between the two models, we use a Kruskal-Wallis test. The results indicate that the differences in EFCH, TCH and TFPCH are statistically significant between the two models, at least at the 5% level, although PTECH and SECH are not statistically significant[8]. As mentioned before, there is no general agreement in the literature as for the most appropriate approach and whether the results of Model 1 are intuitively more appealing than those of Model 2, *and visa versa*, is a matter of subjective judgment. Grifell-Tatje and Lovell (1997) mention that the production approach is preferred when the analysis focuses on bank productivity, while the other approaches are most suitable when the focus is on bank profitability. However, Berger and Humphrey (1997) argue that the intermediation approach may be more appropriate for evaluating entire financial institutions while the production approach may be better for evaluating branches of financial institutions.

Table 3 shows means of total factor productivity change by bank over the period of our analysis. According to Model 1, bank number nine experiences the highest decrease in TFP that is equal to 13% while on the other hand bank number eleven experiences the highest increase that is equal to 7.8%. In total, two banks experience an increase in TFP whereas the remaining eleven experience a decrease. In the case of Model 2, banks nine and eleven are again the ones that experience the highest decrease and increase in TFP these being 11.8% and 21% respectively. However, in this case only two banks record a negative change in TFP.

[Insert Table 3 Around Here]

[8] Chi-square values are as follows: 5.473 (EFCH), 9.459 (TCH), 0.211 (PTECH), 0.933 (SECH), TFPCH (7.780).

Table 4 presents (geometric) means on the basis of banks' size by classifying them in small, medium, and large[9]. Of course, one could argue that categorizing banks on this basis is entirely arbitrary, and various alternative criteria could have been used. However, Worthington (1999) undertook a similar exercise in his study of Australian credit unions and found that larger credit unions tended to exhibit greater efficiency gains over the period, and these could be mainly attributed to improvements in scale efficiency. In the case of smaller credit unions, efficiency increase was mainly attributed to improvements in technical efficiency.

[Insert Table 4 Around Here]

In our case, the results indicate that smaller banks experience lower decrease (Model 1) or higher increase (Model 2) in TFP on average, over the entire period of our analysis. More precisely, Model 1 indicates an average (geometric) mean decrease of TFP by 2.2%, 3.1% and 3.7% for small, medium and large banks respectively. However, the relationship between size and productivity growth is not robust across the years. Small banks outperform the ones from the other two groups only during 2004-05 whereas large banks perform better during 2000-01 and 2002-03 and medium banks during 2001-02 and 2003-04. Model 2 reveals an average increase of TFP for all groups that is equal to 14.1% (small banks), 1.9% (medium banks) and 5.2% (large banks). In this case, small banks perform better in three out of the five periods of our analysis (i.e. 2000-01, 2001-02, 2003-04), whereas medium banks are always the worst performers. However, the results of the Kruskal-Wallis test indicate that for both models, the differences between the different size groups are insignificant[10] in all the case of all indices.

[9] To classify banks as small, medium or large we follow the following approach. First, we calculate average values of total assets for each bank and each one of the five sub-periods for which growth is measured (e.g. 2000-01, 2001-02, etc). Then, we rank banks on ascending order based on their average total assets for each one of the five sub-periods. Banks below the corresponding 33rd percentile are characterized as "small", the ones between the 33rd and 67th percentile as "medium" and those above the 67th percentile as "large".

[10] The chi-square values in the case of Model 1 are 0.108 (EFCH), 0.405 (TCH), 0.540 (PTECH), 0.122 (SECH), 0.037 (TFPCH), while in the case of Model 2 they are 0.0234 (EFCH), 0.849 (TCH), 1.146 (PTECH), 1.542 (SECH), 1.359 (TFPCH).

4. Conclusions

The Greek cooperative banking industry has a history of approximately ten years. Despite the competition that they face and the relatively small market share that they hold in the Greek banking industry, cooperative banks have demonstrated an improvement in most financial aspects and expansion of their branch network over the last years. Furthermore, by focusing on small and medium enterprises and private citizens, they provide support, and encourage the development of local enterprises. Hence, they play an important role in the development of the local economy.

In this study, we used the Malmquist index to examine for the first time the total factor productivity change in the Greek cooperative banking, in contrast to previous studies in Greece that have considered only commercial banks. Our sample consisted of a balanced panel dataset of 78 observations from 13 banks over the period 2000-2005. We estimated two models, one based on the intermediation approach, and another based on the production approach. The results were mixed. The first model indicated a small decrease (3%) in total factor productivity whereas the second model indicated an increase by 6.6%. We also compared the results on the basis of banks' size and found that TFP growth was higher for smaller banks on average over the entire period of our analysis. However, these results were not robust across the years. Furthermore, the differences between the groups were not statistically significant.

Future research could compare the productivity growth of cooperative and commercial banks, examine the cost, and profit efficiency of cooperative banks, and investigate the relationship between corporate governance and productivity.

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Table 1- Descriptive statistics (in thousands euros)

		Loans	Liquid assets & investments	Deposits	Fixed assets	Number of employees
2000	Average	33646.57	3183.80	24043.69	1046.13	27.46
	St dev	40723.11	5217.59	28402.36	1292.82	32.52
	Min	3781.32	78.20	1581.43	40.98	6.00
	Max	146527.53	18830.46	97041.36	4403.15	118.00
2001	Average	43759.85	4539.34	36359.73	1216.87	35.23
	St dev	58480.63	7934.89	48636.43	1733.65	46.04
	Min	4310.40	61.32	2019.90	100.25	6.00
	Max	223479.62	23709.47	181867.71	6157.33	169.00
2002	Average	57964.51	4081.34	50765.91	1492.05	40.77
	St dev	88656.83	6759.93	80859.57	2432.60	56.48
	Min	7906.40	67.58	4948.69	79.29	6.00
	Max	340065.87	22137.57	306968.06	8645.13	210.00
2003	Average	78905.78	3896.58	72128.69	1924.84	48.92
	St dev	125160.60	6106.51	118412.41	3291.02	69.97
	Min	10619.46	69.93	7684.75	62.23	7.00
	Max	480405.03	19484.12	450319.38	11726.15	261.00
2004	Average	101626.21	3601.57	94247.11	2182.12	54.77
	St dev	167894.95	4915.17	160386.70	3531.94	76.94
	Min	14642.27	64.96	10964.61	74.65	9.00
	Max	643855.47	15441.10	610224.81	12741.56	287.00
2005	Average	129452.72	7804.39	123945.00	2499.54	64.31
	St dev	223150.82	13855.83	217567.97	3738.34	92.09
	Min	21459.82	134.31	17583.88	170.89	10.00
	Max	850695.62	50687.47	824118.65	13314.79	343.00
2000-2005	Mean	74225.94	4517.84	66915.02	1726.92	45.24
(Pooled)	St dev	133176.40	7939.50	127578.21	2781.17	64.44
	Min	3781.32	61.32	1581.43	40.98	6.00
	Max	850695.62	50687.47	824118.65	13314.79	343.00

Table 2 – Total Factor Productivity Change
(summary of annual geometric means)

Panel A: Model 1 (Intermediation approach)					
	EFCH	TCH	PTECH	SECH	TFPCH
2000-01	0.979	0.925	0.984	0.995	0.906
2001-02	0.999	0.990	0.996	1.003	0.989
2002-03	1.023	0.939	1.016	1.007	0.961
2003-04	0.975	1.011	0.985	0.990	0.986
2004-05	0.986	1.025	0.996	0.990	1.010
2000-05 (mean)	0.992	0.977	0.995	0.997	0.970
Panel B: Model B (Production approach)					
	EFCH	TCH	PTECH	SECH	TFPCH
2000-01	1.259	0.818	1.129	1.115	1.031
2001-02	1.051	1.074	1.062	0.989	1.128
2002-03	1.001	1.052	0.959	1.044	1.053
2003-04	0.949	1.119	0.973	0.976	1.063
2004-05	0.998	1.059	0.990	1.008	1.057
2000-05 (mean)	1.046	1.019	1.020	1.025	1.066

Notes: Model 1: Outputs: loans (Y1), Liquid assets and investments (Y2), Inputs: Deposits (X1), Number of employees (X2), Fixed assets (X3); Model 2: Outputs: loans (Y1), Liquid assets and investments (Y2), Deposits (Y3), Inputs: Number of employees (X1), Fixed assets (X2); EFCH: Technical efficiency change (i.e. CRS), TCH: technological change, PTECH: pure technical efficiency change (i.e. VRS), SECH: scale efficiency change, TFPCH: total factor productivity change; TFPCH = EFCH x PTECH, EFCH = TCH x PTECH; The annual entries are geometric means of results for individual banks and the period results reported in the last row correspond to geometric means of the annual geometric means; A number higher than one indicates growth whereas a value lower than one decline.

Table 3 – Total Factor Productivity Change (geometric) means by bank (2000-2005)

Panel A: Model 1 (Intermediation approach)					
Bank	EFCH	TCH	PTECH	SECH	TFPCH
1	0.978	0.954	1.008	0.970	0.933
2	0.980	1.013	1.000	0.980	0.993
3	1.022	0.961	1.000	1.022	0.982
4	0.995	0.929	1.000	0.995	0.924
5	1.016	0.973	1.011	1.005	0.989
6	0.991	0.981	0.978	1.007	0.966
7	0.980	1.080	0.996	0.985	1.059
8	1.000	1.018	1.000	1.000	1.018
9	0.963	0.903	0.980	0.983	0.870
10	0.991	0.907	1.000	0.991	0.898
11	1.018	1.059	1.000	1.018	1.078
12	0.989	0.962	0.980	1.010	0.952
13	0.984	0.979	0.987	0.997	0.963
Mean	0.992	0.977	0.995	0.997	0.970
Panel B: Model 2 (Production approach)					
Bank	EFCH	TCH	PTECH	SECH	TFPCH
1	0.944	1.049	0.969	0.974	0.990
2	1.030	1.054	1.000	1.030	1.086
3	1.007	1.053	1.000	1.008	1.061
4	0.997	1.037	0.946	1.054	1.034
5	1.062	1.038	0.949	1.119	1.102
6	1.056	0.948	0.971	1.087	1.001
7	1.065	1.046	1.026	1.037	1.114
8	1.132	0.981	1.065	1.062	1.110
9	0.978	0.901	0.981	0.998	0.882
10	1.093	1.033	1.097	0.997	1.130
11	1.171	1.033	1.171	1.000	1.210
12	1.061	1.017	1.090	0.974	1.079
13	1.027	1.064	1.026	1.001	1.093
Mean	1.046	1.019	1.020	1.025	1.066

Notes: Model 1: Outputs: loans (Y1), Liquid assets and investments (Y2), Inputs: Deposits (X1), Number of employees (X2), Fixed assets (X3); Model 2: Outputs: loans (Y1), Liquid assets and investments (Y2), Deposits (Y3), Inputs: Number of employees (X1), Fixed assets (X2); EFCH: Technical efficiency change (i.e. CRS), TCH: technological change, PTECH: pure technical efficiency change (i.e. VRS), SECH: scale efficiency change, TFPCH: total factor productivity change; TFPCH = EFCH x PTECH, EFCH = TCH x PTECH; The annual entries are geometric means of results for individual banks and the period results reported in the last row correspond to geometric means of the annual geometric means; A number higher than one indicates growth whereas a value lower than one decline.

Table 4 – Total Factor Productivity Change by banks' size groups (summary of annual geometric means)

Panel A: Model 1 (Intermediation approach)						
	Bank size	EFCH	TCH	PTECH	SECH	TFPCH
2000-01	SMALL	0.989	0.907	1.000	0.989	0.896
	MEDIUM	0.966	0.855	0.968	0.998	0.826
	LARGE	0.987	1.040	0.987	0.999	1.026
2001-02	SMALL	1.004	0.987	1.000	1.004	0.991
	MEDIUM	0.972	1.086	0.973	0.998	1.055
	LARGE	1.029	0.883	1.021	1.008	0.909
2002-03	SMALL	1.025	0.932	1.000	1.025	0.955
	MEDIUM	1.043	0.917	1.038	1.005	0.957
	LARGE	0.995	0.976	1.005	0.991	0.971
2003-04	SMALL	0.993	1.023	0.981	1.013	1.016
	MEDIUM	0.955	1.073	0.990	0.965	1.024
	LARGE	0.983	0.928	0.984	1.000	0.912
2004-05	SMALL	0.987	1.049	0.994	0.993	1.036
	MEDIUM	0.981	1.017	0.987	0.994	0.998
	LARGE	0.991	1.010	1.010	0.981	1.001
2000-05	SMALL	1.000	0.978	0.995	1.005	0.978
(mean)	MEDIUM	0.983	0.985	0.991	0.992	0.969
	LARGE	0.997	0.966	1.001	0.996	0.963
Panel B: Model 2 (Production approach)						
	Bank size	EFCH	TCH	PTECH	SECH	TFPCH
2000-01	SMALL	1.422	0.832	1.610	0.884	1.183
	MEDIUM	1.240	0.721	0.978	1.268	0.894
	LARGE	1.137	0.944	0.947	1.200	1.072
2001-02	SMALL	1.250	1.096	1.397	0.895	1.370
	MEDIUM	0.953	1.161	0.952	1.001	1.106
	LARGE	0.998	0.956	0.925	1.078	0.953
2002-03	SMALL	0.924	1.064	0.762	1.213	0.983
	MEDIUM	1.073	0.988	1.095	0.980	1.060
	LARGE	0.993	1.127	1.021	0.972	1.118
2003-04	SMALL	1.036	1.063	0.996	1.041	1.102
	MEDIUM	0.935	1.154	0.974	0.960	1.079
	LARGE	0.886	1.134	0.949	0.934	1.005
2004-05	SMALL	0.979	1.126	1.009	0.970	1.103
	MEDIUM	0.961	1.012	0.976	0.985	0.973
	LARGE	1.066	1.054	0.988	1.079	1.124
2000-05	SMALL	1.107	1.030	1.115	0.994	1.141
(mean)	MEDIUM	1.027	0.993	0.994	1.033	1.019
	LARGE	1.012	1.040	0.965	1.049	1.052

Notes: Model 1: Outputs: loans (Y1), Liquid assets and investments (Y2), Inputs: Deposits (X1), Number of employees (X2), Fixed assets (X3); Model 2: Outputs: loans (Y1), Liquid assets and investments (Y2), Deposits (Y3), Inputs: Number of employees (X1), Fixed assets (X2); EFCH: Technical efficiency change (i.e. CRS), TCH: technological change, PTECH: pure technical efficiency change (i.e. VRS), SECH: scale efficiency change, TFPCH: total factor productivity change; TFPCH = EFCH x PTECH, EFCH = TCH x PTECH; The annual entries are geometric means of results for individual banks and the period results reported in the last row correspond to geometric means of the annual geometric means; A number higher than one indicates growth whereas a value lower than one decline; Banks below the 33rd percentile in terms of total assets per year are characterized as "small", the ones between the 33rd and 67th percentile as "medium" and those above the 67th percentile as "large" ones.

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