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THE EFFICIENCY OF CYPRIOT COMMERCIAL BANKS: COMPARISON WITH GREECE AND THE UK

Theofanis Mamuneas
Department of Economics and Economics Research Centre

Christos S. Savva
Economics Research Centre

No. 04-07

June 2007

Publication Editors: Costas Hadjiyiannis, Theodoros Zachariadis

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THE EFFICIENCY OF CYPRIOT COMMERCIAL BANKS: COMPARISON WITH GREECE AND THE UK

Abstract

This study suggests that during the period 1995-2005 the average cost of Cypriot commercial banks is close to that of Greek but higher than the average cost of UK commercial banks, albeit the latter difference declines over time. In addition, Cypriot (and UK) commercial banks operate in positive economies of scale, so that they can improve their competitiveness by further expansion. As far as the technological progress is concerned, Cypriot banks appear to be at the same level as the UK ones, while the Greek banks appear to have a higher rate of technological progress. The improvement in the competitiveness of the Greek banks is probably due to their lower efficiency point at the beginning of the period, allowing them more room to benefit from modernisation.

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ΑΠΟΤΕΛΕΜΑΤΙΚΟΤΗΤΑ ΚΥΠΡΙΑΚΩΝ ΕΜΠΟΡΙΚΩΝ ΤΡΑΠΕΖΩΝ: ΣΥΓΚΡΙΣΗ ΜΕ ΕΛΛΑΔΑ ΚΑΙ ΜΕΓΑΛΗ ΒΡΕΤΑΝΙΑ

Θ. Μαμουνέας και Χ. Σ. Σάββα

ΠΕΡΙΛΗΨΗ

Ανάμεσα στα βασικά συμπεράσματα αυτής της μελέτης είναι ότι κατά τη διάρκεια της περιόδου 1995-2005 οι Κυπριακές εμπορικές τράπεζες έχουν περίπου το ίδιο μέσο κόστος με τις Ελληνικές, αλλά υψηλότερο από τις Βρετανικές. Ωστόσο, η διαφορά μέσου κόστους μεταξύ των Κυπριακών και Βρετανικών τραπεζών παρουσιάζει πτωτική τάση στη διάρκεια της υπό εξέταση περιόδου. Ένα άλλο σημαντικό εύρημα της μελέτης είναι ότι στη διάρκεια της υπό εξέταση περιόδου οι Κυπριακές, όπως και οι Βρετανικές, τράπεζες είχαν μεγάλες οικονομίες κλίμακας. Με άλλα λόγια, η επέκταση των Κυπριακών εμπορικών τραπεζών είχε σημαντική επίδραση στη βελτίωση της ανταγωνιστικότητάς τους, κάτι το οποίο δεν παρατηρήθηκε σε ανάλογο βαθμό ανάμεσα στις Ελληνικές εμπορικές τράπεζες. Από την άλλη, οι Ελληνικές τράπεζες βελτίωσαν την ανταγωνιστικότητά τους λόγω της μεγαλύτερης τεχνολογικής προόδου που παρουσίασαν την ίδια περίοδο. Αυτό πιθανό να οφείλεται σε μεγάλο βαθμό στο ότι οι Ελληνικές εμπορικές τράπεζες ξεκίνησαν από ένα συγκριτικά χαμηλό επίπεδο αποτελεσματικότητας, ώστε να έχουν μεγαλύτερα περιθώρια οφέλους από εκσυγχρονιστικές μεταρρυθμίσεις του τραπεζικού συστήματος.

1. INTRODUCTION

It has been established that commercial banks (especially in developed countries), contribute significantly to economic activity in a number of ways. For instance, the banking sector finances infrastructure and helps enterprises in finding resources to finance their activities. In addition, an efficient banking sector is better able to withstand negative shocks and contributes to the stability of the financial system (Brissimis et. al., 2006). Therefore, evaluation of the efficiency and productivity growth of banking sector can provide clues about the development prospects of an economy and useful information to policy makers.

Furthermore, following accession to the EU, the efficiency and productivity growth of the banking sector in Cyprus is raising important questions about the ability of Cypriot banks to compete with those of other EU countries in a single currency area. More specifically, is the banking sector in Cyprus efficient enough to withstand competition from the banking sectors in other EU countries? Can Cypriot banks improve by achieving higher rates of technical productivity growth or by expanding, autonomously or through mergers?

To investigate the above issues, we estimate the efficiency (average cost) and technical productivity growth of the banking sector in Cyprus for the period from 1995 to 2005, in comparison to the corresponding figures in Greece and the UK. The choice of Greece as a benchmark to assess Cypriot banks reflects the very close cultural links between the two countries. Whereas, the use of UK banks as benchmark reflects the generally held view that the UK banking system is one of the best and most profitable worldwide (Llewellyn, 2005).

The structure of this paper is as follows. Section 2, provides a brief review of the literature which is presented with emphasis on the methodology used by various studies to investigate empirically the efficiency and productivity growth of the banking sector. Section 3 provides background information on the Cypriot, Greek and UK banking sectors through simple descriptive statistics. Section 4 describes the specification of the model used for the empirical analysis and section 5 presents the empirical results obtained from the estimation of this model. Section 6 summarises and concludes the paper.

2. LITERATURE REVIEW

The efficiency and economies of scale of banks are two key issues in the banking literature. They can provide important insights to policy makers, especially on regulatory issues. In order to proceed with our research, we need to define the various forms of efficiency. On the one hand we have the technical efficiency and on the other the allocative efficiency. These are the two most commonly used terms in the relevant literature. According to Schmidt and Lovell (1979), a production process is technically inefficient if it fails to produce maximum output from a given input bundle. On the other hand, a production process is allocatively inefficient when, given input prices; it uses the wrong proportions of inputs to produce a certain output. However, the empirical estimation of both technical and allocative efficiency at the same time is rather a difficult task[1]. Therefore, we restrict our analysis to the relative efficiency which enables us to compare banks' cost-effectiveness over time. In addition, economies of scale enable us to assess statistically the potentials of each market.

The research into efficiency serves the purpose of estimating the so-called "efficient frontier" and analysing deviations from such frontier corresponding to the loss of efficiency[2]. The methods are distinguished on the basis of the procedures applied to produce the frontier, and the assumptions made, for example, in relation to the distribution of the inefficiency term. The creation of the "efficient frontier" serves the purpose of distinguishing well performing (efficiently operating) production units from the group of poor performers. In the literature two major concepts are frequently used in generating this frontier: non-parametric and parametric approaches. The non-parametric methods first proposed by Farrell (1957) select efficient production units in order to create the "efficient production frontier" (known as DEA – Data Envelopment Analysis). This method offers the advantage of simple application and restrictive assumptions are not required in advance with regard to the functional form. Its main disadvantage lies in the fact that this technique is unable to decompose the deviations of certain banks from the efficient production frontier into components: inefficiency and random error parts. The deviation as a whole is considered as inefficiency, irrespective of whether it derives from inefficient operation or exogenous effects independent of management. An additional problem is that the method disregards

[1] See Kumbhakar and Wang (2006).

[2] This part is based on the description of Hollo and Nagy (2006).

prices. The procedure rather focuses on measuring technological efficiency, based on technological and not economic optimisation.

Parametric methods are considered to be more sophisticated compared to non-parametric techniques, whereby the estimation of efficiency is based on economic optimisation, given the underlying assumption of a stochastic optimal frontier. Parametric methods are capable of incorporating both input allocative and technical efficiencies. The two most frequently used parametric techniques are the Stochastic Frontier Approach (SFA) and the Distribution Free Approach (DFA). The SFA was independently developed by Aigner et al. (1977) and Meeusen and van den Broeck (1977). While the non-parametric DFA method regards all deviations (including errors and imperfections) from the frontier to constitute a loss of efficiency, the SFA attempts to decompose such differences into inefficiency and noise by making explicit assumptions about the inefficiency component's distribution. Thus, the procedure only analyses differences in efficiency measured in relation to the optimal frontier which – with an unbiased estimate – are independent of exogenous shocks that are beyond the control of the bank's management. The necessity of prior distributional assumptions regarding the inefficiency component represents the main shortcoming of the SFA.

Schmidt and Lovell (1979) make use of a stochastic production frontier in which each firm is bounded above by a frontier that is stochastic in the sense that its placement is allowed to vary randomly across firms. This way each firm is allowed to be technically inefficient compared to its own frontier. Interfirm variation should capture any exogenous variation which is not under the control of the firm. According to Schmidt and Lovell (1979) the disturbance term of this specification is made of two terms: a random error which is a symmetric, normal component; and a one-sided component capturing randomness under the control of the firm, i.e. inefficiency. When searching for inefficiency, one can do this using two ways: either check how efficient the firm is in profit maximization or how efficient it is in cost minimization. The authors use cost minimization efficiency - which is the most commonly used method - and state that if the firm operates beneath its stochastic production frontier then it is technically inefficient, whereas it is allocatively inefficient if it operates off its least cost expansion path. The functional form used by Schmidt and Lovell is a Cobb-Douglas production

function and they derive the exact relationship between allocative inefficiency and cost of allocative inefficiency.

Greene (1980) used a translog cost function to model technical and allocative inefficiency. He defined allocative inefficiency as the departure of the actual cost shares from the optimum share, failing, in such a context, to derive the relationship between allocative inefficiency and cost increases from such inefficiency (this is also known as the Greene problem). As a result he assumed independence between the two. This was not accepted by many who tried to find some form of relationship. Kumbhakar (1991) provided a theoretically consistent linkage between allocative inefficiency and cost therefrom, but not an exact relationship.

Building on his previous work and following the definition of allocative inefficiency in Schmidt and Lovell (1979), Kumbhakar (1997), in an important contribution used a translog cost function and established an exact relationship between allocative inefficiency in the cost share equations and in the cost function. Empirical estimation of this model has been restricted to panel datasets in which technical and allocative inefficiency are either assumed to be fixed parameters or functions of the data and unknown parameters (Maietta, 2002). A notable application of such a model in banking is the one of Kumbhakar and Tsionas (2005). They estimate a panel data on U.S. commercial banks and they show that the inclusion of allocative inefficiency in the model produces some notable differences from simple models of technical efficiency, since failure of banks to efficiently allocate their inputs leads to further increases in costs. However, the estimation of both technical and allocative inefficiency remains a difficult task and the results are rather questionable.

Although, it would be ideal to estimate both technical and allocative inefficiency, due to the difficulties in estimation, we adopt the translog framework approach and compare the relative (in)efficiency of banking sector in Cyprus with the efficiency of banking sectors in Greece and UK.

3. DATA

A sample of 19 commercial banks has been employed. It covers the period from 1995 to 2005[3]. The data on inputs and outputs were collected from the financial institutes, their annual reports, and DataStream. DataStream delivers company accounts information and it gives great emphasis on accuracy, quality and consistency. Since our study deals with markets which have different accounting systems, using DataStream helps to avoid the problem of inconsistency. Furthermore, to avoid exchange rate variation we denominated all figures to sterling pounds.

Table 1 displays summary statistics for the yearly average wage given to employees of the banking institutions in each country, the average interest rate paid by banks to deposit accounts and loan capital and finally the average value of loans produced per employee. Average wage paid to employees by the banking institutes is expressed in thousand sterling pounds and includes all the expenses paid by banks (i.e. salaries and wages, social and medical insurance etc.). We observe that the mean value of average wage is higher for the UK followed by Greece. The value of the average interest rate paid is higher for the Greek banks probably due to the high inflation rates experienced by the Greek economy during the first half of our sample period. Finally, the average value of loans produced per employee is higher for the UK banks.

Table 1: Descriptive Statistics*

	Cyprus		UK		Greece	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Wage	21.87	4.33	29.57	4.62	22.68	3.45
Interest	0.046	0.007	0.049	0.011	0.066	0.032
Loans	799.66	247.45	2638.70	2039.13	834.91	449.06

**Average Wage and Loans are expressed in thousands of sterling pounds while Interest is expressed in percentage.*

A better intuition is gained by plotting inputs and output (Figures 1 -3). These figures show the average wage, average interest paid and loans produced per employee respectively, for each country for the period from 1995 to 2005. More specifically,

[3] The data sample consists of 5 Cypriot, 7 Greek and 7 UK commercial banks.

Figure 1 shows that the average wage in UK banks is substantially higher. The average wage in Cyprus and Greece is moving at the same levels. Figure 2, shows that the average interest paid in Greece is much higher at the beginning of the sample period (1995), gradually dropped and reached the levels of the UK and Cyprus (2001-2002) and became lower for the remaining periods (2003-2005). This fact is attributed to the convergence of the Greek economy to the Maastricht criteria. As far as the value of loans (output) per employee is concerned, in Figure 3, we observe a similar behaviour to that of Figure 1. UK banks produce more output compared to Cypriot and Greek commercial banks, with the latter two being very close to each other throughout the sample period

Figure 1: Average Wage (UK thousand sterlings)

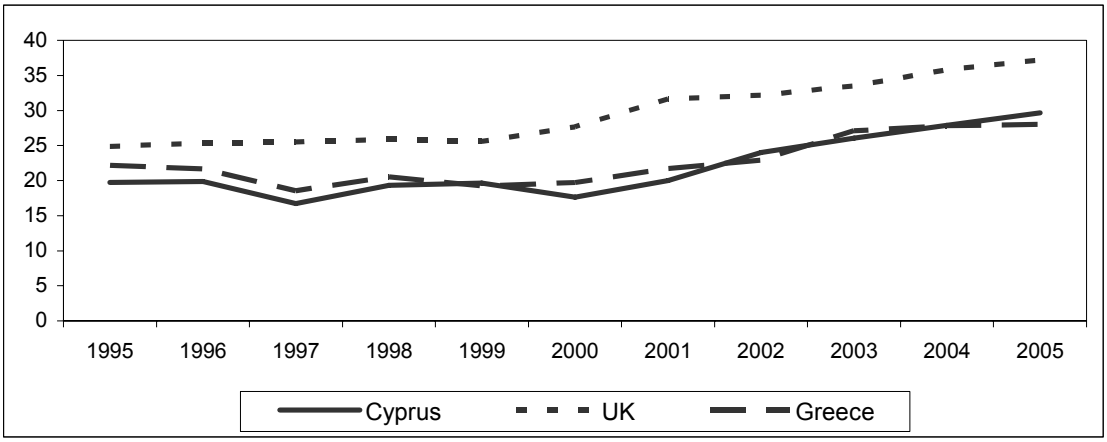


Figure 2: Average Interest Paid (%)

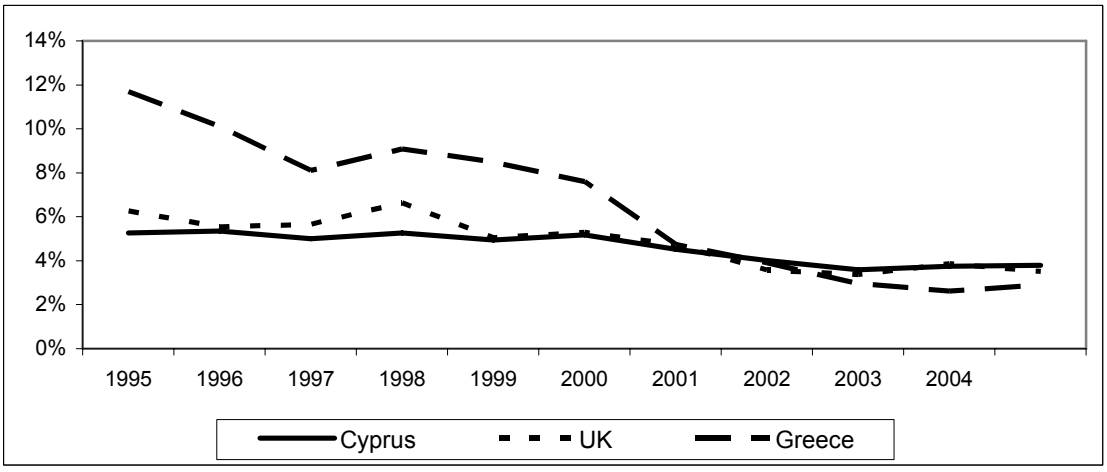
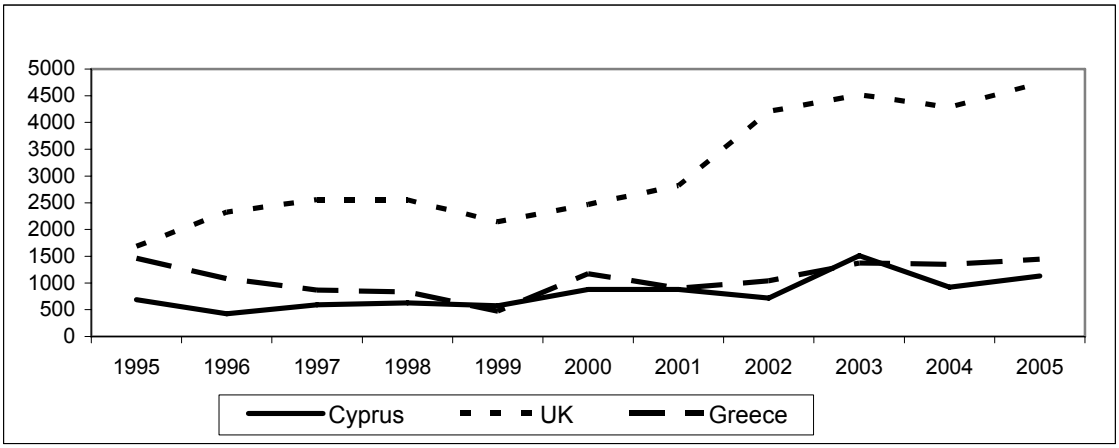


Figure 3: Output per Employee in Constant Prices (UK thousand sterling)



4. EMPIRICAL SPECIFICATION

To estimate a measure of technical (in)efficiency a theoretically consistent model must be specified. There are two common approaches in the literature: the production and intermediation approach. The production approach measures output by the number of accounts and considers only operating cost. The intermediation approach measures output by the value of accounts and considers both operating and interest costs. Although, according to Ferrier and Lovell (1979), the production approach should be the one used for studying the cost efficiency of banks, here we follow the intermediation approach since it was not easy to find the actual number of loans outstanding.

Our model includes one output and two variable inputs. As output we identify the value of the total customer loans[4]. To express the output series in constant prices we deflate it by the GDP deflator (2005=100). The variable inputs are the number of employees (labour) and the interest bearing deposits and loan capital (deposits).

Input prices are calculated as follows: the first input price is the average wage given to employees of the banking institution while the second one is the average interest paid by the bank to deposit accounts and loan capital. Capital (K) which is approximated by fixed assets is considered as constant in the short-time period we are looking at and represents the wealth of the banking institute.

[4] The definition of a bank's inputs and outputs is a matter of ongoing debate. In the intermediation approach, a bank is assumed to use labour, capital, and deposits to produce earning assets (such as loans).

We compare the cost inefficiency of the Cypriot with UK and Greek banks using dummy variables. According to the specifications of our model, the coefficient of these dummy variables will give the relative technical inefficiency between the Cypriot and the commercial banks of Greece and UK. Similarly, we introduce dummy variables to capture the percentage differences in the levels of two inputs (capital and labour) and the level of output.

Finally, a trend variable is included in the model to capture external factors that have affected positively or negatively the total cost of a bank during the time period of our study. These factors can be technological improvements, market power and/or macroeconomic factors that affect the activities of the banking sector but are not under its control.

To study how Cypriot commercial banks compare to commercial banks in Greece and the UK in terms of efficiency we use the translog cost function adopting the cost minimisation approach. The model is easy to use and gives clear results on efficiency differences as well as on how the cost of production is related to these inefficiencies. The translog cost function with its associate share functions specific to this study are given as follows:

$$
\begin{aligned}
\ln C = {} & \alpha_o + \alpha_1 \ln w_1 + \alpha_1^{Gr} * Greek * \ln w_1 + \alpha_1^{B} * UK * \ln w_1 \\
& + \alpha_2 \ln w_2 + \alpha_2^{Gr} * Greek * \ln w_2 + \alpha_2^{B} * UK * \ln w_2 \\
& + \frac{1}{2}(\alpha_{11} \ln w_1 \ln w_1 + \alpha_{12} \ln w_1 \ln w_2 + \alpha_{21} \ln w_2 \ln w_1 + \alpha_{22} \ln w_2 \ln w_2) \\
& + \alpha_y \ln Y + \alpha_y^{Gr} * Greek * \ln Y + \alpha_y^{B} * UK * \ln Y \\
& + \frac{1}{2}\alpha_{yy} \ln Y \ln Y + \alpha_k \ln K + \frac{1}{2}\alpha_{kk} \ln K \ln K + \alpha_{yk} \ln Y \ln K \\
& + \alpha_{1y} \ln w_1 \ln Y + \alpha_{2y} \ln w_2 \ln Y + \alpha_{1k} \ln w_1 \ln K + \alpha_{2k} \ln w_2 \ln K \\
& + \alpha_0^{Gr} Greek + \alpha_0^{B} UK + \alpha_{yt} \ln Y * T \\
& + \alpha_t T + \alpha_{tG} Greek * T + \alpha_{tB} UK * T + \alpha_{1t} \ln w_1 * T + \alpha_{2t} \ln w_2 * T + \frac{1}{2}\alpha_{tt} * T^2
\end{aligned}
\qquad (1)
$$

where w_1 and w_2 are the prices of inputs and Y the output (K represents the quasi fixed capital). Coefficients α_0^{Gr} and α_0^B (multiplied with dummy variables Greek and UK) give the relative technical inefficiency between the Cypriot commercial banks and the commercial banks in Greece and the UK[5]. Variable *T* is used to take into account any external factors that have affected positively or negatively the total cost during the time period of our study. These factors can be technological improvements or macroeconomic factors that affect the activities of the institutions but are not under their control. Coefficients α_t, α_{tG} and α_{tB} capture these effects for Cypriot, Greek and UK banks respectively while α_{tt} determines the growth rate of the technological progress.

However, the translog model parameters are not easy to interpret. A more intuitive way to assess the differences (if any) in the banking industries among Cyprus, Greece and the UK is by calculating the elasticity of cost with respect to various inputs and the output of the model. We return to this in the next section.

The parameters of (1) are estimated from the cost shares

$$S_1 = \alpha_1 + \alpha_1^{Gr} * Greek + \alpha_1^B * UK + \alpha_{11} \ln w_1 + \frac{1}{2}\alpha_{12} \ln w_2 + \frac{1}{2}\alpha_{21} \ln w_2 + \alpha_{1y} \ln Y + \alpha_{1k} \ln K + a_{1t} T \qquad (2)$$

$$S_2 = \alpha_2 + \alpha_2^{Gr} * Greek + \alpha_2^B * UK + \frac{1}{2}\alpha_{12} \ln w_1 + \frac{1}{2}\alpha_{21} \ln w_1 + \alpha_{22} \ln w_2 + \alpha_{2y} \ln Y + \alpha_{2k} \ln K + a_{2t} T \qquad (3)$$

where S_i are the cost shares. It should be noted that due to the adding-up criterion ($\sum S_i = 1$). Due to linear homogeneity of the cost function and symmetry of the model the following restrictions are set:

$$\alpha_1 + \alpha_2 = 1,\ \alpha_1^{Gr} + \alpha_2^{Gr} = 0,\ \alpha_1^B + \alpha_2^B = 0,\ \alpha_{11} + \alpha_{12} = 0,$$
$$\alpha_{11} + \alpha_{21} = 0,\ \alpha_{1y} + \alpha_{2y} = 0,\ \alpha_{1k} + \alpha_{2k} = 0,\ \alpha_{1t} + \alpha_{2t} = 0$$
$$\alpha_{11} = \alpha_{22}$$

[5] Cyprus is used as the reference country. Therefore, coefficients α_0^{Gr} and α_0^B are compared to α_0.

5. RESULTS

5.1 Parameter estimates

The translog cost function (equation 1) and cost shares (equations 2 and 3) are estimated using Iterative Seemingly Unrelated Regressions (ISUR). Complete parameter estimates of each model are provided in Table 2.

Table 2. Estimation Results

Parameter	Estimation	Standard Errors
α_0	9,409	1,465
α_1	0,968	0,053
α^{GR}_1	0,079	0,010
α^{B}_1	0,041	0,017
α_{11}	0,185	0,008
α_y	-0,731	0,263
α^{GR}_y	-0,098	0,039
α^{B}_y	-0,534	0,103
α_{yy}	0,223	0,039
α_k	0,541	0,171
α_{kk}	0,140	0,043
α_{1y}	-0,043	0,007
α_{1k}	0,020	0,006
α_{yk}	-0,132	0,039
α_t	0,319	0,059
α_{tG}	-0,060	0,014
α_{tB}	0,101	0,024
α_{1t}	-0,009	0,002
α_{yt}	-0,022	0,004
α_{tt}	-0,002	0,003
α^{GR}_0	1,826	0,517
α^{B}_0	7,550	1,577
System R square: 0.9910		

Most of the estimated coefficients given in Table 2 have a sign as, normally, expected[6]. The coefficients of the two inputs have positive signs, showing that the cost of an institution increases when higher wages and higher interest are paid. The share of the two inputs in cost (S1 and S2) is given in Table 3. As shown in this table, the interest paid to deposit accounts and loan capital has a greater effect on cost than the total wages. For instance, an increase in wages (say by 1%) leads to a 29.5%

[6] In addition to the estimated coefficients we have also performed likelihood ratio tests for the joint significane of α^{GR}_1 *and* α^{B}_y, α^{GR}_y *and* α^{B}_y, α_{tG} *and* α_{tB}, α_{0G} *and* α_{0B}, as well as for the hypothesis of constant returns to scale. Results confirmed the adequacy of our specificaton.

increase in total cost for Cypriot, 25.9% for UK and 30.8% for Greek banks. An increase in interest rates by 1% leads to 70.5%, 74.1% and 69.2% increase in total cost for Cypriot, UK and Greek banks respectively. These figures represent the shares of the two inputs in total costs and they appear to be very similar for Cypriot and Greek commercial banks (approximately 7/10 of the total cost goes to interests paid and 3/10 to wages).

5.2 Elasticities

Furthermore, in Table 3 we report the elasticity of total cost with respect to the output when prices are held constant ($\varepsilon = \frac{\partial \ln C}{\partial \ln Y}$), the shadow price of capital[7] ($k = \frac{\partial \ln C}{\partial \ln K}$), the technological progress or regression ($T^* = -\frac{\partial \ln C}{\partial T}$) and the percentage difference in average cost ($D_{Greek(UK)} = \frac{\partial \ln C}{\partial Greek(UK)}$)[8].

Table 3. Elasticities

	Cost shares						
	Labour	Capital	ε	k	T	DGREEK	DUK
Panel A: Cyprus							
Cost	0,295	0,705	0,903	0,129	0,016	-	-
Labour	-0,078	0,078	0,757	0,197	-0,013	-	-
Deposit	0,033	-0,033	0,964	0,100	0,029	-	-
Panel B: UK							
Cost	0,259	0,741	0,864	0,089	0,012	-	-1,685
Labour	-0,026	0,026	0,697	0,167	-0,022	-	-1,527
Deposit	0,009	-0,009	0,922	0,062	0,024	-	-1,740
Panel C: Greece							
Cost	0,308	0,692	0,928	0,132	-0,068	-0,111	-
Labour	-0,091	0,091	0,788	0,198	-0,097	0,147	-
Deposit	0,040	-0,040	0,990	0,103	-0,055	-0,225	-

[7] Shadow price represents the true economic price of an activity: the opportunity cost. Shadow prices can be calculated for those goods and services that do not have a market price, perhaps because they are set as fixed or quasi fixed.

[8] In Table 3 and 4 we do not report the standard errors due to the complexity of their estimation.

More specifically,

$$\varepsilon = \frac{\partial \ln C}{\partial \ln Y} = a_y + a_y^{Gr} * Greek + a_y^B * UK + a_{yy} \ln Y + a_{yk} \ln K + a_{1y} \ln w_1 + a_{2y} \ln w_2 + a_{yt} * T \quad (4)$$

$$k = \frac{\partial \ln C}{\partial \ln K} = a_k + a_{kk} \ln K + a_{yk} \ln Y + a_{1k} \ln w_1 + a_{2k} \ln w_2 \quad (5)$$

$$T = \frac{\partial \ln C}{\partial T} = a_t + a_t^{Gr} Greek + a_t^B UK + 2a_{tt} T + a_{yt} \ln Y + a_{1t} \ln w_1 + a_{2t} \ln w_2 \quad (6)$$

$$D_{Greek} = \frac{\partial \ln C}{\partial Greek} = \alpha_1^{Gr} * \ln w_1 + \alpha_2^{Gr} * \ln w_2 + \alpha_y^{Gr} * \ln Y + a_0^{Gr} + a_t^{Gr} * T \quad (7a)$$

$$D_{BRIT} = \frac{\partial \ln C}{\partial UK} = \alpha_1^B * \ln w_1 + \alpha_2^B * \ln w_2 + \alpha_y^B * \ln Y + a_0^B + a_t^B * T \quad (7b)$$

For the translog cost function we directly compute the own (ε_{ii}) and cross-price elasticities (ε_{ij}). These elasticities are calculated as follows:

$$\varepsilon_{ij} = \frac{a_{ij} + S_i S_j}{S_i}, \qquad i,j = 1,2,\ldots..,n \quad but\ i \neq j \quad (8)$$

$$\varepsilon_{ii} = \frac{a_{ii} + S_i^2 - S_i}{S_i} \qquad i = 1,2,\ldots..,n \quad (9)$$

All own-price elasticities are negative in accordance with theory. Moreover, since own-price elasticities are less than one in absolute value, all input demands are price-inelastic. Elasticity of output (*ε*) shows that an increase in output has a greater impact on cost of deposits than that of labour.

Furthermore, from the results of Table 3, and more specifically from *ε*, we are able to calculate the economies of scale (Table 4). Economies of scale inform us of the cost savings/dissavings when a bank increases its output, while keeping the output mix constant. There are increasing returns to scale if $\frac{1}{\varepsilon} > 1$, constant returns to scale if $\frac{1}{\varepsilon} = 1$, and decreasing returns to scale if $\frac{1}{\varepsilon} < 1$.

Table 4. Economies of Scale

	Cyprus	UK	Greece
Output	1.11	1.16	1.08

From the results in Table 4, it is interesting to note that the commercial banks in all countries have relatively large economies of scale. Generally speaking, these results suggest that banks in these 3 markets can increase their profits or reduce their costs via output expansion. Cypriot banks have the second largest ones (following UK banks), showing that there are economies of scale in the Cypriot banking sector that have not been exploited yet. This might be one of the reasons why Cypriot banks are very popular for take-over deals or mergers with foreign banks (in particular from Greece).

Returning to the results of Table 3, we observe that the shadow price of capital is positive for all countries. In other words investing in premises and equipments adversely impact earnings of the banks in our sample (i.e. the return on this kind of investments is lower that the actual cost). Therefore, banks can benefit from reduction in buildings and equipment.

Finally from the results obtained for the percentage difference in average cost (D_{GREEK} and D_{UK}) shown in Table 3 we infer that, on average, the UK banks are more efficient than the Cypriot ones. From the particular results of labour and deposits we can see that UK banks are more efficient than Cypriot banks, not only in labour but also in deposits. Greek banks are more or less equally efficient as the Cypriot banks, with a small edge in their favour in the case of deposits.

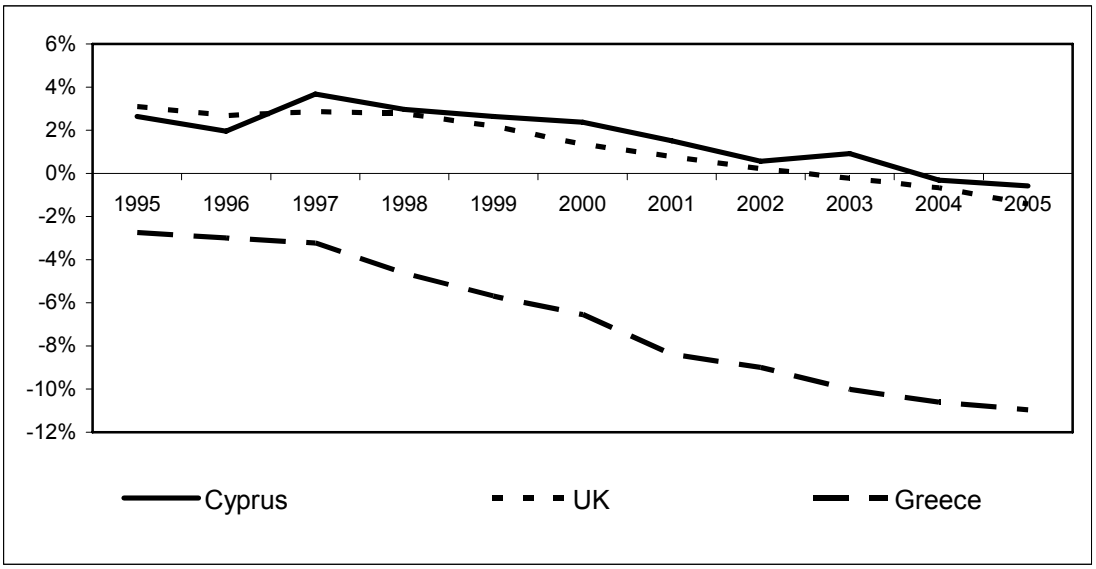
5.3 Technical change

Technological change (T) is calculated in relation to the cost. If T is smaller than zero then country's banking industry experiences technological progress. The negative value indicates that the cost reduces due to the improved technology. In our study, Greek banking industry exhibits a rate of technical change of 0.068 (i.e. holding output constant, there is a decrease in total cost at a rate of 6.8% per annum). The opposite holds for the cases of Cyprus and the UK (i.e. holding output constant, an increase in total cost at a rate of 1.6% and 1.2% per annum respectively is observed). Moreover, the technological change can be decomposed according to the contribution of labour

and deposits. The value attributed to labour is negative for all countries in our sample, indicating that there is progressive technology in labour (savings in labour). However the value for deposits is negative only for Greece indicating that the regressive technology in Cyprus and the UK is attributed to the inefficiency in the way they handle their deposits. In other words in Cyprus and the UK the cost of maintenance and monitoring of the deposits increases over time in contrast with Greece where this cost reduces over time.

In addition to the above, using the estimates of our model, we are able to evaluate the technological progress/regression of the banking industries in three countries during the last decade. Figure 4, depicts the differences in the technological change in each country.

Figure 4: Technological Change (% change in Cost)

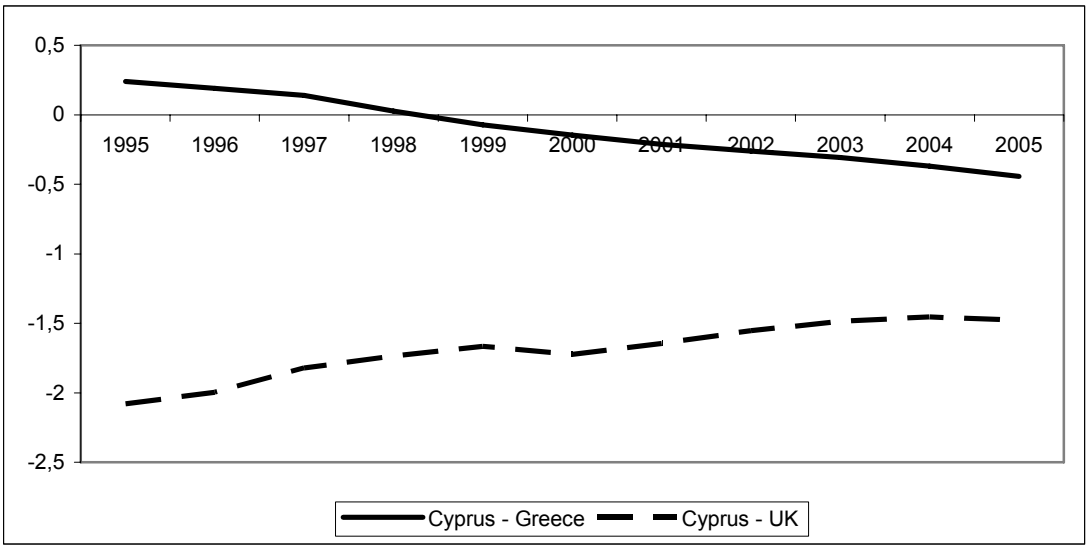


As regards technological progress achieved over the period 1995-2005 (Figure 4) Cypriot and UK commercial banks are at the same level, whereas Greek banks appear to have been more successful in this respect. This may be due to the low level at which the Greek banks were at the beginning of this period and the ongoing extensive changes in the structure of the Greek banking industry. During the period under investigation Greek banks have made a great effort in improving their capital equipment and customer services and building advanced electronic networks. These, and other (institutional) changes in the Greek banking sector appear to have had a positive impact on the overall technological progress of the Greek banking industry.

5.4 Efficiency

Figure 5 shows the percentage difference in the average (logarithmic) cost between Cypriot banks and those in Greece and the UK over the period 1995-2005. As we can see, on average, the Cypriot banks are at the same level of efficiency with the Greek banks, albeit the latter appear to gradually gain a very small advantage in recent years. Again, this suggests that the reform of the Green banking industry has had a positive effect on the average cost, a development benefiting not only the Greek banks but also the Cypriot ones which expanded in Greece during the recent years. In contrast, the Cypriot banks appear to have substantially higher average percentage cost than the UK banks. However, this gap is narrowing over time, suggesting that Cypriot banks are improving in terms of efficiency faster than the UK ones.

Figure 5: Estimated Difference in Average Log Cost (times)



According to our results there are two reasons why the Cypriot banks are improving their efficiency over time:

i. Economies of Scale: based on the results of the economies of scale (Table 3), Cypriot banks appear to be benefiting from positive economies of scale, the average cost decreases with the level of output.

ii. Productivity: the quality of a bank's staff might influence average cost. Indeed, in Figure 3 we observe that the output per employee of Cypriot (and Greek) banks is substantially lower than that of UK banks.

Other possible reasons why the Cypriot banks improve their competitiveness over time are endogenous factors such as a good management and exogenous factors (not under the control of the banks themselves) like the increased demand for loans by households, following the relaxation of credit restrictions.[9]

6. CONCLUSIONS

In this study we estimate the efficiency of the commercial banking sector in Cyprus by comparison with the corresponding sectors in Greece and the UK. For this purpose we use a sample of 19 commercial banks, covering the period from 1995 to 2005, to estimate the parameters of a translog cost function. Efficiency and productivity differences between the banks in the three countries are captured through dummy and trend variables.

The empirical results suggest that Cypriot banks appear to be benefiting from their expansion, in the sense that they realise substantial economies of scale. They are not doing so well, however, in terms of technological progress. The Cypriot banks realise more gains from expansion, whereas the Greek banks do so from technological progress. The result is that, on average, the two banking sectors appear to operate at a comparable efficiency level. The UK banks also realise substantial economies of scale (slightly above those of Cypriot banks) and have similar technological progress as the Cypriot banks (but below the Greek ones). Overall, the UK banks have the lower average costs, as they are the most efficient in the use of labour and in the handling of deposits

The main conclusions emerging from our analysis are as follows:

- The policy of the Cypriot banks to expand is fully justified in the sense that it enabled them to increase their efficiency (reduce average cost) by exploiting economies of scale. This has been particularly the case vis-à-vis the expansion in Greece in the 1990s, when the Cypriot commercial banks were more efficient than the Greek ones. As Greece is completing the reform and modernisation of its banking sector, the ability of the Cypriot banks to absorb market share form Greek

[9] Other market of bank specific factors can also affect performance and average costs, including market structure for the output and inputs, taxation, GDP growth rate, fiscal policies, demographics etc.

banks is reduced, albeit the Cypriot banks operating in Greece still benefit from the expansion and modernisation of the Greek banking sector at large.

- The Cypriot banks can make further progress and improve their competitiveness by increasing their input efficiency, i.e. lower the labour and capital cost per unit of output (loans). This does not mean lowering the wage level. After all, the mean wage paid by UK banks is around 1.3 times higher than that paid by Cypriot banks, yet the output produced per unit of labour cost is around 1.5 times below that of UK banks. This means that the Cypriot banks can make substantial progress by improving the productivity of their labour force.

- The same conclusions can be drawn about the handling of deposits where the cost of Cypriot banks is around 1.7 times higher than that of the UK.

Nevertheless, in interpreting the results reported in this paper one should bear in mind the difficulties in performing comparisons of efficiency between banks on the bases of empirical observation, most importantly the lack of a full-proof method to measure correctly the level of output. Banks around the world specialise in different activities, hence their output is not homogeneous. Therefore, the use of loans as output, as we do in this study, can affect the results if the share of loans in banking activities differs between the commercial banks in Cyprus, Greece and the UK. In addition, banks operating under different institutional environments may be affected by various, sometimes unobserved, factors that are not possible to include in the econometric specification. Ommiting important factors from the model can affect the intercept (and the dummy coefficients) modifying it (them) on which cost comparisons are based.

With this note of caution, one should interpret the empirical findings reported in this paper more as indicative of direction rather than precise measures of cost efficiency. At the same time, the cautious remarks above can be seen as a challenge for further research to improve on the empirical estimates.

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