

## The Efficiency of Cypriot Commercial Banks: A Comparison with Greece and the UK

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### Abstract

This study suggests that during the period 1995-2005, the average cost of Cypriot commercial banks is close to that of Greek banks, 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 banks, 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, thus allowing them more room to benefit from modernization.

**Keywords:** Cost efficiency, average cost, economies of scale, elasticities.

### 1. Introduction

In recent years, the banking industry in the European Union (EU), as well as in Cyprus, has witnessed important changes. With the rapid growth of banks and their expansion in cross-border activities, came a wave of mergers and acquisitions within and across, national borders. This process has led to the creation of large European banks, and has increased competition throughout the EU. During this period, bank assets have expanded rapidly not only for the largest banking groups, but also for the medium-sized and smaller institutions (ECB 2006).

A key turning point in the process was the year 1993 which brought about the coming-to-force of several key EU directives, which served to regulate the financial services industry. The introduction of the Euro on the 1<sup>st</sup> of January, 1999, which removed one of the last obstacles for the creation of a

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more competitive and integrated, banking market, was a second turning point in this process (ECB 2005).

The banking industry in Cyprus also witnessed fundamental changes, particularly since 1995. Bank assets have significantly increased throughout this period, both domestically and in other markets in Greece, and elsewhere (for instance Romania, Serbia, Australia and the UK). Banks have become more sophisticated in terms of the products offered, and due to the limited size of the domestic market have looked to expand their operations overseas. Still, the industry in Cyprus remains highly concentrated, compared to many other European countries, and there certainly appears to be room for increased competition in several segments of the market.

More recently, following the difficult years after the burst of the bubble in the stock market (which left the banks exposed to bad loans) banks announced record profits which in turn also spurred more rumours about takeovers and changes in the banking industry. An interesting question in this regard, is to how profitable banks are compared to institutions in other countries. This study attempts to address some important questions related to the efficiency of the Cypriot banking industry in comparison to other European countries. More specifically, it tries to shed some light on the following questions:

- How competitive is the banking sector in Cyprus in relation to the banking sectors in Greece and the UK?
- Do Cypriot banks operate at similar levels of cost compared to these countries?
- Can they benefit from expanding their activities either in domestic or foreign markets and take advantage of economies of scale?

To investigate the above issues, the efficiency of the banking sector in Cyprus is analysed in comparison with those of Greece and the UK for the period from 1995 to 2005. The choice of these countries is not arbitrary. On the one hand, Cyprus is very close to Greece mainly from the cultural perspective and as a result, many Cypriot firms (banks) consider Greece to be a natural destination for the expansion of their activities. On the other hand, the British banking system is one of the most profitable worldwide (Llewellyn, 2005). Thus, when comparing the Cypriot banking system to the British one, the latter offers a good benchmark for the evaluation of the standards and the quality of Cypriot commercial banks.

The rest of this paper is organized as follows: Section 2 gives a brief review of the related literature. The data and the empirical findings are discussed

in section 3. Section 4 discusses some policy implications and concludes. Finally, the Appendix describes the model.

## 2. Brief review of the literature

The assessment of efficiency and economies of scale of banks are two key issues in the literature. An assessment of the existence of economies of scale allows us to establish whether “bigger is better”, based on existing technology, while an examination of efficiency allows us to compare banks’ cost-effectiveness over time and across different banks. A more precise definition of the firm efficiency is warranted.

Efficiency refers to the ability of managers (given output and input prices) to use the appropriate portions of inputs (e.g. labour and deposits) effectively and allocate them in such a way that the cost is minimized and in turn the profit maximized. It is very common in the literature to model inefficiency instead of efficiency. According to Schmidt and Lovell (1979), a production process is inefficient if it fails to produce maximum output from a given input bundle and given input prices, or if it uses the wrong proportions of inputs to produce a certain output. Efficiency or inefficiency can be examined either from (maximum) profit or (minimum) cost perspective. In this study we adopt the latter approach.

From the European banking perspective, a number of studies offer a European cross-country comparison of bank efficiency (Casu and Girarbone 2006; Kumbhakar and Tsionas 2005; Bos and Schmiedel 2007 among others), using standard efficiency estimation methods. The way they compare the efficiency in various European banks is by defining a benchmark, the so-called “frontier”. The term frontier has the meaning of the “ideal” or the “best-practice” bank, i.e. the bank that operates in the most efficient way, at the lowest cost and/or maximum profit compared to other banks. All other banks are assessed relative to this frontier.

In general, most studies find that the overall economic efficiency of European banks, displays a clearly improving trend (Pastor *et al.* 1997; Lozano-Vivas *et al.* 2002; Brissimis *et al.* 2005; and Kumbhakar and Tsionas 2005), with the European integration having a positive effect on a bank’s cost and profit efficiency (Dietsch and Weill 1998; Cetorelli 2004; Casu and Girarbone 2006; and Balverde *et al.* 2007). The improving trend is mainly attributed to the performance of the most developed (in banking terms) countries like Germany, the UK, France, Spain and Denmark. The banking systems of Germany and the UK are typically found to be the most efficient (Casu and Molyneux 2003; and Bos and Kolari 2005). Nevertheless, large efficiency and cost differences exist among countries

(Staikouras and Koutsomanoli-Filippaki forthcoming), with Belgium, Greece and Italy being at the lowest efficiency level of the 15 EU countries (Bikker 2002).

In the literature there are also a number of studies which focus on economies of scale in the European banking system. This type of analysis allows us to assess at which point of the cost curve the bank operates, thus enabling us to judge whether it can benefit by expanding its operations. Generally, most of the studies concerning European banking industries suggest that European banks can take advantage of economies of scale (Altunbas and Molyneux 1996). However, they point to evidence that economies of scale are more pronounced for small to medium-sized banks (Altunbas *et al.* 2001; and Altunbas and Chakravarty 2001). As one would expect, economies of scale tend to disappear as the size of banks increases. This finding is confirmed by the data.

Levy-Garboua and Renard (1977) and Dietsch (1988 and 1993), confirm the above findings for the case of French banks, Bos *et al.* (2005) for the case of German banks, while Cossutta *et al.*, (1988), Baldini and Landi (1990) and Conigliani *et al.*, (1991), confirm the findings for the case of Italian banks. Similar inferences are drawn for the case of the Spanish (Fanjul and Maravall 1985; and Rodriguez *et al.* 1993), the Finnish (Kolari and Zardkoohi 1990), the Irish (McKillop and Glass 1992) and the British (Hardwick 1989, 1990; and Drake 1992) markets.

However, little work has been done so far concerning the banking sectors of smaller economies, such as Cyprus.<sup>1</sup> In this study, we assess the efficiency of the commercial banking sector in Cyprus and we compare it with the corresponding sectors in Greece and the UK. We follow a similar methodological approach to Pashardes *et al.* (2001) yet cover a more recent period.

### **3. Data and empirical findings**

#### **3.1. Variables used in the model and descriptive statistics**

This paper measures the economies of scale and efficiency of Cypriot, British and Greek banks. The sample which is analyzed includes data from

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<sup>1</sup> Notable exceptions are the studies of Pashardes *et al.* (2001), Soteriou and Zenios (1999 and 1999) and Zenios *et al.* (1999).

19 commercial banks and covers the period from 1995 to 2005.<sup>2</sup> The data were collected directly from the annual reports of banks and *DataStream*. DataStream delivers company accounts information and puts great emphasis on accuracy, quality and consistency. Since our study deals with markets of different accounting systems, the use of DataStream information helps to avoid the data inconsistency. All data have been denominated in sterling pounds in constant 2005 prices.

In Table 1, we briefly report some of the characteristics of the structure of the markets in our sample, including capacity indicators. Furthermore, since we are interested in the integration and the internationalization of the European banking industry, we will report the degree of foreign ownership of domestic banks.

TABLE 1  
*Capacity indicators and the participation of foreign banks (2004)*

	Number of Credit Institutions	Population per Credit Institution	Population per Employee	% of Participation of Foreign Banks
Cyprus	43 <sup>3</sup>	17,140	86	53,5
Greece	62	178,081	186	37,1
UK	413	145,337	117	42,4

*Note:* All figures were adjusted to include only commercial banks.

*Sources:* European Central Bank, Report on EU Banking Structure (October, 2005).

Cyprus has the lowest ratio of population per credit institution and population per employee. The extent of foreign ownership participation is also the highest, as a share, among the three countries.

Table 2 displays summary statistics for the average yearly wage paid to banking employees in each country, the average real interest rate paid by banks to deposit accounts and loan capital, and finally the average value of

<sup>2</sup> The data sample consists of 5 Cypriot, 7 Greek and 7 British commercial banks. The banking sector of Cyprus includes a large number of cooperative banks. These are not taken into consideration in estimation process, neither for Cyprus nor for the rest of the countries.

<sup>3</sup> This figure refers to domestic banks and international banking units operating in Cyprus. If we only take into account banks incorporated in Cyprus (11 in total), then the figures for population per credit institution and population per employee will be substantially higher. These ratios will nevertheless, still remain significantly below those of the UK and of Greece.

loans produced per employee. The average total earnings paid to employees are expressed in thousands of sterling pounds and include all expenses paid by banks (i.e. salaries and wages, social and medical insurance etc). We observe that the mean value of earnings is the lowest in Cyprus when compared to the UK and to Greece. The average real interest rate paid to deposits is similar across countries at around 2%. The average value of loans produced per employee however, is significantly higher for the UK banks. This finding suggests that profitability in the UK is expected to be significantly higher.

TABLE 2  
*Descriptive statistics (period 1995 – 2005)*

	Cyprus		UK		Greece	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Average Wage	21.87	4.33	29.57	4.62	22.68	3.45
Interest (%)	2.00	0.94	2.21	1.04	2.14	1.05
Loans	799.66	247.45	2638.70	2039.13	834.91	449.06

*Note:* 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) over time, since the averages do not mark changes over time. These figures show the average wage, the average interest paid and loans produced per employee respectively, for each country for the period from 1995 to 2005. Although the trend is common across the three countries, it becomes apparent that UK banks pay substantially higher wages throughout the period. Figure 2, shows that the average real interest rate declined, especially after 1999 to around 1%. As far as the value of loans (output) per employee is concerned, it is clear that UK banks produce more output compared to Cypriot and Greek commercial banks, with the latter two comparing significantly closely to each other throughout the sample period (Figure 3).

FIGURE 1

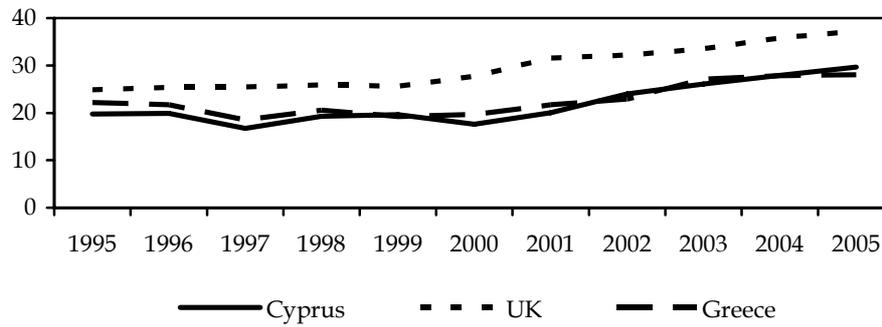
*Average wage (UK pound sterling, thousands)*

FIGURE 2

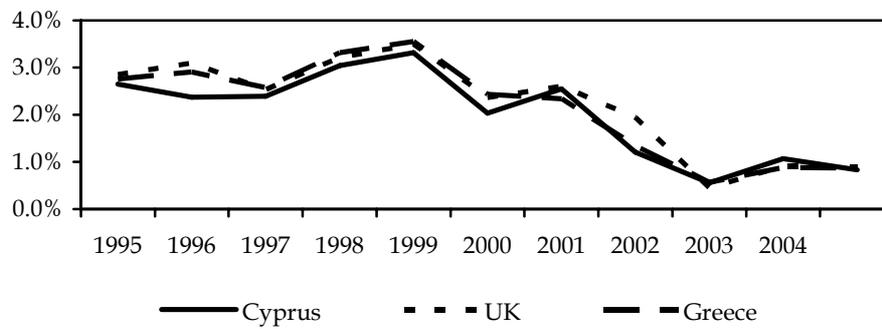
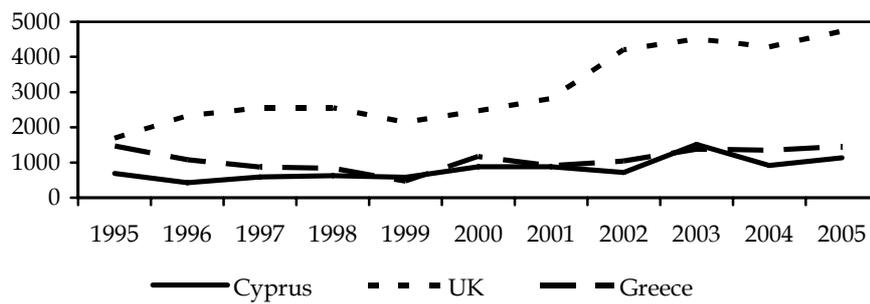
*Average interest paid (%)*

FIGURE 3

*Output per employee in constant prices (UK pound sterling, thousands)*

### 3.2. Empirical findings<sup>4</sup>

Although descriptive statistics offer some insights regarding the differences across the three countries, they cannot offer a complete picture of the interaction of all variables and how they determine the efficiency and profitability of banks in each country. For this reason we employ econometric methods which enable us to estimate the (in) efficiency taking into account all the relevant factors.<sup>5</sup> The model used, which jointly estimates the factors that may affect the (in) efficiency of banks, is easy to apply and provides clear results on the questions of interest.<sup>6</sup>

To estimate a measure of (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 only considers operating cost. The intermediation approach measures output by the value of accounts and considers both operating and interest costs. In this paper we follow the intermediation approach.<sup>7</sup>

The definition of a bank's inputs and output is a matter of ongoing debate. In the intermediation approach, a bank is assumed to use labour, capital and deposits to produce earning assets, for example, loans. Our model includes one output and two variable inputs. Although, banks make profits from other sources such as private banking, financial services, global investments, etc., we identify the value of the total customer loan as a measure of output. This however is warranted since it allows assessing the core profitability of banks which in turn depends crucially on lending. 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

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<sup>4</sup> It should be pointed out that the empirical findings depend on the sample chosen. Furthermore, the choice of banks might affect the estimations and the conclusion reached. Therefore, one should be careful in the interpretation of the findings and on the policy recommendations.

<sup>5</sup> More specifically, we use the Translog function adopting the cost minimisation approach. See Appendix A for more details.

<sup>6</sup> A brief description of the model is given in the Appendix A. For more details about the econometric specification we refer to the Economic Analysis Paper No.04-07 available from the Economics Research Centre website (University of Cyprus).

<sup>7</sup> Although Ferrier and Lovell (1990), adopt the production approach for studying the cost efficiency of banks, in this paper we follow the intermediation approach since it is not easy to find the actual number of loans outstanding.

(labour) and the interest bearing deposits and loan capital (deposits). A detailed description on the variables used is provided in the Appendix A.

Tables 3 and 4 show the share of inputs in cost and report the elasticities estimated using the model.

TABLE 3

*Share of labour and deposits in cost*

Country	Labour	Deposits
Cyprus	0.295	0.705
UK	0.259	0.741
Greece	0.308	0.692

First as seen from the cost shares (Table 3), interest costs account for the greater share of total costs. The interest paid to deposit accounts and loan capital has a greater effect on cost than the total wages. Wages account for 29.5% of the total cost of Cypriot banks, 25.9% for British banks and 30.7% for Greek banks. Interest paid on deposit accounts and loan capital, account for 70.5%, 74.1% and 69.3% of the total cost of Cypriot, British and Greek banks respectively. Overall, these figures, which represent the shares of the two inputs in total costs, appear to be very similar across the three countries (approximately 7/10 of the total cost goes to interest paid and 3/10 to wages).

TABLE 4

*Cost elasticities*

Country	Loans ( $\epsilon$ )	Capital (k)	T	D <sub>GREEK</sub>	D <sub>UK</sub>
Cyprus	0.903	0.129	0.016	-	-
UK	0.864	0.089	0.012	-	-1.685
Greece	0.928	0.132	-0.068	-0.111	-

Elasticities measure the ratio of the incremental percentage change in one variable with respect to an incremental percentage change in another variable. In other words, elasticity measures the percentage change of cost to a percentage change in one of the variables of the model. For example, elasticity of 0.65 means that an increase by 1%, say in output, provokes an increase of 0.65% in costs. More specifically, we report the elasticity of total cost with respect to loans ( $\epsilon$ ), the elasticity of total cost with respect to the

fixed factor capital ( $k$ ), the technological change ( $T$ ) and the difference in average cost among Cypriot, British and Greek banks ( $D_{UK}$  and  $D_{GREEK}$ ).<sup>8</sup>

Here we observe that a 1% increase in output (i.e. loans) leads to 0.903%, 0.864% and 0.928% increase in the cost for the Cypriot, the UK and the Greek banks respectively. In all cases the cost increases by less than the increase in output, thus highlighting the fact that banks in all countries have potential economies of scale to reap. We shall refer to this in the following paragraphs.

In addition to the above information, Table 4 reports the shadow price of capital ( $k$ ). The shadow price denotes the increase or reduction in costs when the company decides to add an extra unit of capital (i.e. premises, computer equipment, etc.). The shadow price of capital is positive for all countries in our sample (i.e. 0.129 for Cyprus, 0.083 for the UK and 0.132 for Greece). This implies that investing in premises and equipment adversely impacts the earnings of the banks in our sample (i.e. the return on this kind of investment is lower than the actual cost).

From the results of Table 4, and more specifically from  $\varepsilon$ , we are able to assess the real impact of loans on the cost of production. This can be done by calculating the economies of scale (Table 5). If costs increase proportionately to the change in the output (in this case loans), it can be inferred that no economies of scale exist ( $1/\varepsilon = 1$ ); if costs increase by a greater amount, there are diseconomies of scale ( $1/\varepsilon < 1$ ); if costs increase by a lesser amount, there are positive economies of scale ( $1/\varepsilon > 1$ ). More specific to our study, economies of scale provide information on the likely cost savings which may result when a bank increases its output, while keeping the output mix constant.

TABLE 5  
*Economies of scale*

	Cyprus	UK	Greece
Output	1.11	1.16	1.08

<sup>8</sup> This is also known as the shadow price of capital. Shadow price represents the true economic price of an activity.

From the results in Table 5, it is interesting to note that the commercial banks in all countries can take advantage of the positive economies of scale. Generally speaking, these results suggest that banks in the three markets can increase profits or reduce their costs via output expansion, i.e. expanding loans. However, Cypriot banks have the second largest ones (following UK banks). This shows that there are potential economies of scale in the Cypriot banking sector that have not yet been exploited. This may be one of the reasons why Cypriot banks are very popular when it comes to take-over deals or mergers with foreign banks, in particular from Greece. In addition, the large economies of scale in the UK may be attributed to the many small/medium sized banks which are capable of expanding their activities and reaping potential economies of scale.

### 3.3. Technical change

Technological change (T) is calculated in relation to the cost. Any cost saving which is not explained by change in any of the variables in the model is assumed to come from exogenous technological change. This is captured by means of a trend variable in the model. If T, in Table 4, is smaller than zero, then a country's banking industry experiences technological progress. The negative value indicates that the cost can be reduced as a result of improved technology. In our study, the 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 in the case 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).

The fact that Greek banks appear to achieve higher technological progress over the period 1995-2005, as compared to Cypriot and UK commercial banks, may be due to the low level of banking services which the Greek banks incurred at the beginning of this period. It may also be due to the ongoing extensive changes in the structure of the Greek banking industry. During the period under investigation, Greek banks made a great effort in improving their management and customer services and built an advanced electronic network. These changes, as well as other (institutional) changes in the Greek banking sector, appear to have had a positive impact on the overall cost structure of the Greek banking industry.

### 3.4. Efficiency

From the results obtained for the difference in average cost ( $D_{\text{GREEK}}$  and  $D_{\text{UK}}$ ) shown in Table 4, we infer that on average, UK banks are more

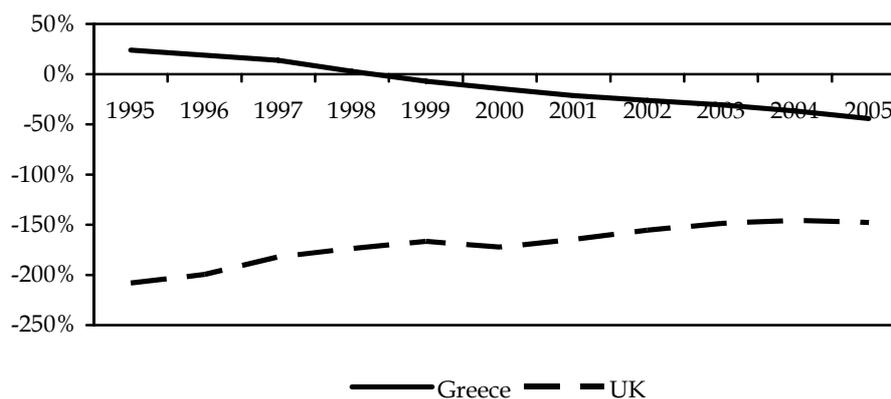
efficient than Cypriot ones. Their cost growth is on average 1.69 times lower than that of Cypriot banks. This finding suggests that Cypriot banks can narrow this gap by improving their efficiency (either by improving the productivity of their labour force, or by improving the way they handle their deposits). There appears however, to be no significant difference between Cypriot and Greek banks.

Figure 4 plots the percentage difference in cost growth 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 as the Greek banks, despite the fact that the latter appear to gradually gain a very small advantage in recent years. Again, this suggests that the reform of the Greek banking industry has had a positive effect on average costs. This development was not only beneficial for the Greek banks but also for the Cypriot banks which managed to expand in Greece over recent years. In contrast, the Cypriot banks appear to have a substantially higher average percentage cost than the UK banks. This gap is however narrowing over time, thus suggesting that Cypriot banks are improving faster than UK banks in terms of efficiency.

In addition to the above, there are however some institutional differences among those countries which may explain a part of the differences in efficiency. For instance, the degree of unionization in Cyprus is very high compared to other countries. On the one hand, unions tend to increase wages, employment and productivity; on the other hand they impose constraints, since in many cases, they restrict the options of management to conduct operations (e.g. outsourcing of services, etc.).

FIGURE 4

*Estimated percentage difference in cost growth relative to Cyprus*



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

- i. **Economies of Scale:** Typically, a company (bank) that can benefit from economies of scale can lower the average cost per unit through increased production, since its fixed costs are shared over an increased number of goods (loans). Based on the results presented here (Table 5), Cypriot banks appear to be benefiting from positive economies of scale, as the average cost decreases with the level of output. Generally, the findings suggest that cost advantages achieved through a larger bank size could be an important factor in generating economic gains.
- ii. **Productivity:** Higher productivity means lower cost per unit of work produced, due to the additional working ability of a firm's employees because the employees of a firm can do more. Hence, 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, as a result of the relaxation of credit restrictions.<sup>9</sup>

#### **4. Conclusions**

In this study we assess the efficiency of the commercial banking sector in Cyprus and we compare it with the corresponding sectors in Greece and in the UK.

The empirical results suggest that Cypriot banks appear to be benefiting through expansion, since they can reap potential economies of scale. Cypriot banks have realized more gains through expansion, whereas Greek banks 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 realize substantial economies of scale (slightly above those of Cypriot banks) and have a similar technological progress to the Cypriot

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<sup>9</sup> Other market or specific bank 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 (but lower than 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

These results provide groundwork for making a set of useful policy conclusions:

- The policy of the Cypriot banks to expand is fully justified in the sense that it enables them to increase their efficiency (reduce average cost), by exploiting economies of scale. In particular, this has been 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 moves ahead with the reform and modernisation of its banking sector, the ability of the Cypriot banks to absorb the market share from the Greek banks will be reduced. This however will still allow the Cypriot banks operating in Greece to benefit from the expansion and modernization 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. to lower the labour and capital cost per unit of output (loans). This does not imply lowering the wage level. After all, the mean wage paid by UK banks is higher than that paid by Cypriot banks, with the output produced per unit of labour cost, remaining below that of that of UK banks. This further implies that the Cypriot banks can make substantial progress by improving the productivity of their labour force and/or by improving the handling of their deposits.
- The differences in efficiencies, which we have uncovered, may be explained by structural factors, for example labour market rigidities. To facilitate the expansion of the sector further, policy makers must consider a way to alleviate these constraints and impediments.

In interpreting the results reported in this paper, one should bear in mind the difficulties encountered in performing comparisons of efficiency between banks on the grounds of empirical observation. Most importantly the lack of a full-proof method to correctly measure the level of output presents a hindrance. Banks around the world specialize in different activities, hence their output is non homogeneous. Therefore, the use of loans as output, as conducted 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 incorporate within the

econometric specification. Omitting important factors from the model can affect the results 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 as precise measures of cost efficiency. At the same time, the cautious remarks above can be seen as a challenge for further research on improving the empirical estimates.

### **Acknowledgements**

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## **Appendix**

### **A1: Data description**

Our model includes one variable for output and two for inputs. As output we identify the value of the total customer loans. The variable inputs are the number of employees (labour), the interest bearing deposits and loan capital (deposits).

Input prices are calculated as follows: The first input price is the average wage paid to employees, while the second is the average interest paid by the bank to deposit accounts (and to loan capital). Capital ( $K$ ) is approximated by fixed assets and is considered to be constant for the short period it is being studied in. It represents the wealth of the bank. As output, we use the value of total consumer loans. To measure the cost incurred by banks, we use the total wage bill and the interest paid to deposits.

To model cost inefficiency, we include dummy variables in the model ( $D_{\text{Greek}}$  and  $D_{\text{UK}}$ ) which can potentially account for the inefficiency of banks in Cyprus, Greece and the UK. According to the specification of our model, the estimated coefficients can provide information which allows us to measure the inefficiency gap between the foreign and Cypriot commercial banks. Similarly, we introduce variables for each country that control the differences in the levels of the two inputs and output.

Finally, an additional variable ( $T$ ) is included in the model to take into account any external factors that have positively or negatively affected the total cost of a bank during the time period of our study. These factors can be technological improvements or macroeconomic factors that affect the activities of the institutions

but that are not under their control. Nevertheless, the most important conclusions can be drawn through the elasticities.<sup>10</sup>

### A2: Translog function

To study how Cypriot commercial banks compare to commercial banks in Greece and the UK in terms of efficiency, a translog function is estimated adopting the cost minimization approach.

$$C = f(w_1, w_2, Y, K) \quad (1)$$

The cost function depends on the prices of inputs (labour -  $w_1$  and deposits -  $w_2$ ) as well as on the output (loans -  $Y$ ) and capital (fixed assets -  $K$ ).

It is important to note that we gain estimation efficiency by including equations for the input cost share. The cost share of input  $j$  is given by  $S_j$  and is derived using Shephard's lemma. The equations for the cost share add information without adding parameters to the regression. The cost shares are  $S_j = \partial \ln(c) / \partial \ln(w_j)$  where  $j=1,2$  and  $\sum S_j = 1$ .

Translog function jointly estimates all the factors included in the model that may affect efficiency of the banks. By using equation (1) with its associate cost shares we create a system of equations which is estimated using the Iteratively Seemingly Unrelated Regressions (ISUR) estimation method. ISUR estimation method is employed in order to avoid the problems of correlated error terms. It should also be noted that due to linear homogeneity of the cost function and symmetry of the model some additional restrictions should be imposed prior the estimation. For more details we may refer to Mamuneas and Savva (2007).

Although the translog function is easy to estimate, its parameters are not easy to interpret. A more intuitive way to assess the differences (if any) in the banking industries between Cyprus, Greece and the UK is by calculating the elasticity of cost with respect to various inputs and the output of the model.

More specifically we calculate,  $\varepsilon = \partial \ln C / \partial \ln Y$ ,  $k = \partial \ln C / \partial \ln K$ ,  $T = \partial \ln C / \partial \ln T$ ,  $D_{Gr} = \partial \ln C / \partial \ln Greek$  and  $D_{UK} = \partial \ln C / \partial \ln UK$  and obtain an estimate for each observation which corresponds to a specific year and bank<sup>11</sup>. Thereafter we average only the observations that concern a specific country in order to obtain the values of  $\varepsilon$ ,  $k$ ,  $T$ ,  $D_{Greek}$  and  $D_{UK}$ .

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<sup>10</sup> We refer to this in subsection 3.2.

<sup>11</sup> The total number of observations is 209 (i.e. the number of banks (19) times the number of years (11)).

## References

- Altunbas, Y. and Chakravarty, S. P. (2001) 'Frontier cost functions and bank efficiency', *Economics Letters* 72: 233-240.
- Altunbas, Y., Evans, L. and Molyneux, P. (2001) 'Bank ownership and efficiency', *Journal of Money, Credit and Banking* 33: 926-954.
- Altunbas, Y. and Molyneux, P. (1996) 'Economies of scale and scope in European banking', *Applied Financial Economics* 6: 367-375.
- Baldini, D. and Landi, A. (1990) 'Economie di scala e complementarieta di costa nell inustria bancaria Italiana', *L Industrial* 1: 25-45.
- Bikker, J. A. (2002) 'Efficiency and cost differences across countries in a unified European banking market', *Credit and Capital* 35: 344-380.
- Bos, J.W.B and Kolari, J. (2005) 'Large bank efficiency in Europe and the United States: Are the economic motivations for geographic expansion in financial services?' *Journal of Business* 78 (4): 1555-1592.
- Bos, J.W.B., Heid, F., Koetter, M., Kolari J. and Kool C. J. M. (2005) 'Inefficient of just different? Effects of heterogeneity on bank efficiency scores', *Deutsche Bundesbank Banking Supervision Discussion Papers*, 15.
- Bos, J.W.B and Schmiedel, H. (2007) 'Is there a single frontier in a single European banking market?', *Journal of Banking and Finance* 31 (7): 2081-2102.
- Brissimis, S., Matthaïos D. and Tsionas E. (2006) 'Technical and allocative efficiency in European banking', *Bank of Greece, Working Paper Series No. 46*.
- Casu, B. and Molyneux P. (2006) 'Bank competition, concentration and efficiency in the single European market', *The Manchester School*, 74 (4): 441-468.
- Casu, B. and Molyneux P. (2003) 'A comparative study of efficiency in European banking', *Applied Economics* 35: 1865-1876.
- Cetorelli, N. (2004) 'Bank concentration and competition in Europe', *Journal of Money, Credit and Banking*, 36 (2): 563-584.
- Conigliani, C., De Bonis, R., Motta, G. and Parigi, G. (1991) 'Economie di scala e di diversificazione nel sistema bancario', *Banca d Italia, Temi di discussione* 150.
- Cossutta, D., Di Battista, M. L., Giannini, C. and Urga, G. (1988) 'Processo Produttivo e Struttura dei Costi nell Industria Bancaria Italiana', in F. Cesarini *et al.* (eds) *Banca e Mercato*, Il Mulino Bologna.
- Dietsch, M. (1988) 'Economies d' échelle et économies d'envergure dans les banques de depots Francaises', Mimeo, *Institute d' Études Politiques de Strasbourg*.

Dietsch, M. (1993) 'Economies of scale and scope in French commercial banking industry', *The Journal of Productivity Analysis* 4: 35-50.

Dietsch, M. and Weill L. (1998) 'Banking efficiency and European integration: Productivity, cost and profit approaches', *Paper presented at the SUERF Conference The Euro: Challenge and Opportunity for Financial Markets*, 15-17 November, Frankfurt.

Drake, L. (1992) 'Economies of scale and scope in UK building societies: An application of the translog multiproduct cost function', *Applied Financial Economics*, 2: 211-219.

European Central Bank (2005). EU Banking Structures. *ECB*, October 2005.

European Central Bank (2006). EU Banking Structures. *ECB*, October 2006.

Fanjul, O. and Maravall, F. (1985) 'L a eficiencia del sistema bancario Espanol', *Alianza Universidad, Madrid*.

Ferrier, G. D. and Lovell, C.A.K. (1990). 'Measuring cost efficiency in banking: Econometric and linear programming evidence', *Journal of Econometrics*, 46: 229-245.

Hardwick, P. (1989) 'Economies of scale in building societies', *Applied Economics*, 21: 1291- 304.

Hardwick, P. (1990) 'Multi-product cost attributes: A study of UK building societies', *Oxford Economics Papers*, 42: 446- 61.

Kolari, J. and Zardkoohi, A. (1987) 'Bank cost, structure and performance', *Massachusetts-Toronto, Lexington Books*.

Kumbhakar, S. C. and Tsionas, E. G. (2005) Measuring technical and allocative inefficiency in the translog cost system: A bayesian approach', *Journal of Econometrics* 126: 355-384.

Llewellyn, D. (2005) 'Competition and profitability in European banking: Why are British banks so profitable?', *Economic Notes by Banca Monte dei Paschi di Siena Spa*, 34 (no. 3-2005): 279-311.

Levy-Garboua, V. and Renard F. (1977) 'Structure et rentabilité des banques', *Banque Sept./Oct*.

Lozano-Vivas, A., Pastor, J. T. and Pastor, J. M. (2002) 'An efficiency comparison of European banking systems. Operating under different environmental conditions', *Journal of Productivity Analysis* 18: 59-77.

Mamuneas T. and Savva, C. S. (2007) 'The Efficiency of Cypriot Commercial Banks: Comparison with Greece and the UK', *Economic Analysis Paper No 04-07*, Economics Research Centre, University of Cyprus.

McKillop, D.G. and Glass, J.C. (1992) 'Building societies as producers of mortgage and nonmortgage products', *Queens University of Belfast, Working Paper Series*, AF192 No. 3.

Pashardes P., Ioulianos G. and Lois N. (2003) 'Productivity of Cypriot Banking Sector. Comparison with Coops and British Banks', *Economic Policy Paper No 03-03*, Economics Research Centre, University of Cyprus – In Greek.

Pastor, J. M., Pérez, F. and Quesada, J. (1997) 'Efficiency analysis in banking firms: An international comparison', *European Journal of Operational Research*, 98: 395-407.

Rodriguez, J. R. O., Alvarex, A. A. and Gomez, P. P. (1993) 'Scale and scope economies in banking: A study of savings banks in Spain', *Universidad De La Laguna, Tenerife, Spain*.

Schmidt, P. and Lovell, C.A.K. (1979) 'Estimating technical and allocative inefficiency relative to stochastic production and cost frontiers', *Journal of Econometrics* 9: 343-366.

Soteriou, A.C. and Zenios S.A. (1999) 'Using DEA for costing bank products', *European Journal of Operational Research*, 114: 234-248.

Soteriou, A.C. and Zenios S.A. (1999) 'Quality, profitability and efficiency in the provision of banking services', *Management Science* 45: 1221-1238.

Staikouras, C. and Koutsomanoli-Filippaki A. (forthcoming) 'Competition and Concentration in the New European Banking Landscape' *European Financial Management*.

Valverde, S., Humphrey D. B. and Lopez del Paso, R. (2007) 'Do cross-country differences in bank efficiency support a policy of "national champions"?' , 31 (7): 2173-2188.

Zenios, C. V., Zenios S. A., Agathocleous K. and Soteriou A. (1999) 'Benchmarks of the efficiency of bank branches', *Interfaces*, 29 (3): 37-51.