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Assessing profitability factors in the Greek banking system: A multicriteria methodology

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Abstract

The increasing competition in the national and international banking markets, the changeover towards monetary union and the new technological innovations herald major changes in the banking environment, and challenge all banks to make timely preparations in order to enter into the new competitive monetary and financial environment. Therefore, it is interesting to investigate the effectiveness of Greek banks, as it is valued by the financial markets, i.e. the greater the efficacy the higher the competitiveness and vice versa. Taking into consideration the bank assets, we distinguish banks into small and large ones. Finding factors that make the differences in such effectiveness may explain the effective advantage of these two types of financial institutions and help us understand the 'financial intermediation' industry in Greece better. Based on their size, a classification of Greek banks, in a multivariate environment, according to the return and operation factors for the years 1990–1999 takes place. In order to investigate the differences of profitability and efficiency between small and large Greek banks, as well as the factors of profitability and operation related with the size of banks, a multicriteria methodology has been used. The results of this paper may help us determine the key success (or failure) factors of these two categories of Greek banks as well as the responsible banking decision-makers for future readjustments.

Keywords: Greek banks, profitability, efficiency, multicriteria decision aid

Introduction

With the deregulation of the banking system and the liberalization of capital flows between domestic and foreign residents, the Greek financial market has become much more attractive for institutional and private investors who seek to raise funds or invest part of their asset portfolio in drachma or foreign currency financial assets through financial institutions in Greece. The major changes in the Greek banking system, realized after 1992, include the interest-rate liberalization, the annulment of various credit rules, the release of capital movements, and the free entrance of banking institutions into the

European Union (Noulas, 1999). Nowadays, the Greek banking system is characterized by a high degree of concentration and competitiveness. Moreover, the changeover towards the monetary union and the new technological innovations herald major changes in the banking environment and challenge all banks to make timely preparations in order to enter into the new competitive monetary and financial environment.

Therefore, it is interesting to investigate the effectiveness of Greek banks. Taking into consideration the bank assets, we distinguish banks into small and large ones. The effectiveness is valued by the financial markets, i.e. the greater the efficacy the higher the competitiveness and vice versa. Finding factors that make the differences in such effectiveness may explain the effective advantage of these two types of financial institutions and help us to understand the 'financial intermediation' industry in Greece better.

The purpose of the present study is to measure the effectiveness of small and large Greek banks with the aid of the return on equity (ROE), return on assets (ROA), and net interest margin (MARG) ratios. Moreover, it measures the ratios of liquidity, risk, leverage, and capital adequacy of Greek banks to their sizes. The main objective of this study is the definition of efficiency, liquidity, risk, and capital adequacy of Greek banks depending on their financial statements. Based on their size, a classification of Greek banks, in a multivariate environment (multicriteria methodology), according to the return and operation factors for the years 1990–1999 takes place. The results of this paper may help us determine the key success (or failure) factors of these two categories of Greek banks, as well as the responsible banking decision-makers for future readjustments.

The paper is organized as follows: Section 2 presents a literature review of the Greek banking system and methodologies that have been applied to the Greek banks as well as to the world banking system up to the present. Section 3 underlines the methodologies employed and the sample data used in this study. Section 4 describes the empirical results obtained using the proposed multicriteria methodology and compares them with the results of logistic regression. Finally, in Section 5 the concluding remarks are discussed.

Literature review

The Greek banking system

The number of banks in Greece increased substantially during the second half of the nineteenth century (Gortsos, 1998). After considerable consolidation of the Greek banking sector in the late 1890s, several new banks were established during the first decade of the twentieth century. The 1920s was a period of major change in the structure of the Greek banking system. Although conditions did not favor the establishment of new banks, from the 1960s on, the internationalization of banking activities led to an increase in the number of foreign banks opening branch offices in Greece. This trend was reinforced by the association of Greece with the European Community in the 1970s, and then the membership of Greece in the European Community in 1981.

In 1982, and especially after 1987, the Greek financial system underwent a series of intense changes. Allocation inefficiencies, initiation of the process for financial integration within the European Union, and international trends towards globalization and deregulation, all contributed to the start of a program modernizing the Greek financial system and adapting it to internationally acceptable standards.

Nowadays, in its effort to prepare itself for the changeover to the Euro the Greek banking system will face some initial costs. Banks must follow a strategic plan and prepare themselves to enter the new competitive monetary and financial environment (Hardouvelis, 1997). This will have an impact on business, systems, and delivery. A radical change on the whole banking system is necessary in order to adopt the new currency and cooperate with other European banks (Vasiliou, 1993; Kloutsiniotis, 1996; Garganas, 1998; Karamouzis, 1998). It is obvious that during the last decade, there has been a restructuring of bank operations within all segments of the banking business. These major changes revealed the increasing competitiveness, the reformation of the banking groups, the mergers, and privatizations (Tolios, 1998). To examine the costs that will arise from this changeover and the benefits that will be produced, Kosmidou and Spathis (2000) estimated the change in the bank profits. This analysis showed that although during the period 2002–2007, banks will face a decrease in their profits in the short-term period, profits will rapidly show increases in the long-term. In view of the euro, banks will try to recover from the loss of revenues that will be caused following the introduction of the new currency by looking for new income resources. This loss and the imminent competition urge banks towards the purchase of small or medium-sized businesses aiming at a creative relationship with the customer-entrepreneur. Apart from loans and advisory consulting, this purchase includes investment banking, access to international financial markets, as well as alternative ways of capital movements through leasing, factoring, and venture capital. Zopounidis, Despotis and Stavropoulou (1995) dealt with the illustration of an ordinal utility model upon a sample of Greek commercial banks for the period 1989–1992, in order to evaluate their banking performance over multiple attributes. A multicriteria analysis approach was applied to measure the banking performance on the basis of financial ratios. An additive utility model was assessed to obtain the final ranking of a representative sample of Greek banks.

The liberalization and the profitability of the Greek commercial banks during the years 1989–1991 were examined by Alexakis, Thomadakis and Xanthakis (1995). The results suggest that the determinants of profitability of Greek commercial banks were highly different from those depicted in other countries during the periods of intense regulation in Greece. The cost structure and the scale economies in the Greek banking system during the years 1980–1989 were examined by Karafolas and Manatkas (1996). Variables such as size of assets, capital, labor, and technological progress were used. By exploiting the properties of the model, they were able to show whether technological progress has been the factor that affected the banking costs. Papaioannou and Ganzonas (1997) examined the development perspectives of non-financial products for the Greek banking system. Zopounidis, Doumpos and Georgiou (1997) evaluated the efficiency of the banking branches of the Bank of Greece with the aid of the multicriteria approach UTADIS. Three classification models were developed assigning the branches into three efficiency groups.

Hardy and Simigiannis (1998) examined the competitiveness and the effectiveness of the Greek banking system. They realized that during the 1990s few banks succeeded in attaining stable high levels of profitability. This was done especially through medium-sized banks that were not state-controlled and could keep high profitability. Moreover, banks perform full financial services through the creation of suitable companies.

Spathis and Kosmidou (1999) examined the competitiveness measured by Tobin's Q ratio between Greek small and large banks during the period 1990–1998. The evidence indicated that the competitiveness of Greek banks depends on their efficiency in asset/liability management, the current assets to loan ratio, and the size as measured by the total assets.

As far as the profitability and the efficiency of Greek banks are concerned, Noulas (1999) examined

the ROE and ROA ratios, the ratios of leverage and operating efficiency for 19 Greek banks for the period 1993–1998. According to the results, there are no significant differences in the return on equity and asset diachronically. Bank profitability was not better in 1998 than in 1993 or in 1994. The profitability of banks during the last two years (1997–1998) seems to increase, though, when compared to that of 1996. This year is representative, as few banks and especially the state-controlled ones, in their effort to improve their portfolios and to show reduced accounting profitability, have kept large amounts in the provisions account.

Staikouras and Steliaros (1999) examined the attributive profitability factors of 17 commercial Greek banks for the years 1991–1998. They used ROE and ROA ratios in relation to endogenous and exogenous variables. According to the results, the profitability of Greek banks is defined by the inflation rate, the proprietary régime, the ratio of reserve funds for borrowings to the total of granted debts, and the ratio of debts to the total assets. Hondrogiannis, Liolios and Papapetrou (1999) examined the competitive conditions of the Greek banking system for the period 1993–1995. The results indicate that bank revenues were earned under the conditions of monopolistic competition. This gradual elimination of exchange controls, the capital movement liberalization, the enactment of the Second Banking European Directive of the European Union, and the supervisory arrangements have been related to the competitive conditions of the Greek banking system.

The efficiency of the banking system

The efficiency of the banking system has been one of the major issues in the new monetary and financial environment. The efficiency and the competitiveness of financial institutions cannot easily be measured since their products and services are of intangible nature. Many researchers have attempted to measure productivity and efficiency of the banking industry using outputs, costs, efficiency, and performance.

The scale and scope economies of banking have been one of the issues related to the competitiveness and efficiency of banks studied extensively. Murray and White (1983), recognized the multi-product nature of financial intermediaries and used a translog cost function to evaluate the scale and scope economies of credit unions in Canada. They find that large multi-product credit unions are more cost-efficient than small single-product credit unions. Gilligann, Smirlock and Marshall (1984) also utilize the translog cost function to examine scale and scope economies in US banking firms. They find economies of scope but not economies of scale among US banks in their sample. Hunter, Timme and Yang (1990) analyze the US bank production using an intermediation approach and multi-cost production function. They find no evidence of cost complementary, i.e. no sub-additive cost functions.

In addition, there are variations of bank performance measurement. Revell (1980) uses interest margin as a performance measure for US commercial banks. He defines interest margin as the difference of interest income and expense divided by total assets. Arshadi and Lawrence (1987) measure bank performance using normal correlation analysis. Their multi-dimensional indexes include indexes of profitability, pricing of bank services, and loan market share. However, those measures of bank competitiveness are not the ones evaluated by the financial market. Size affects the efficiency of banks. Previous research, especially in the United States, indicates that scale economies appear in small banks and not in large ones (Short, 1979; Miller and Noulas, 1996). More recent research shows that the levels of size for the existence of scale economies are higher due to economic development and market liberalization (Miller and Noulas, 1997).

It has also been proved that in this new competitive environment, large banks will survive. Small banks could only survive if they specialized in a few of their activities (Peterson and Rajan, 1995; Hardy and Simigiannis, 1998). The efficiency and technical progress of German cooperative banks were examined by Lang and Welzel (1996). All banks enjoy productivity, which is higher in small banks according to this sample.

The technical efficiency of large banks was examined by Miller and Noulas (1996). Larger and more profitable banks have higher levels of technical efficiency. At the same time, larger banks are more likely to operate under decreasing returns of scale. The performance of the new US commercial banks was examined by DeYoung and Hasan (1998). The profit efficiency of the new banks improves rapidly during the first years of operation, but on average it takes about nine years to reach established bank levels. Small banks lend a larger proportion of their assets to small businesses than do large banks. In the USA, Jayaratne and Wolken (1999) found that the probability of a small firm having a line of credit from a bank does not decrease in the long run. This is done when there are few small banks in the area, although short-run disruptions may occur.

The present study uses ratios from financial statements (endogenous variables) to measure the performance of small and large banks. With the use of univariate and especially multicriteria techniques, this estimation approach gives us the probability of classifying a bank into the size category according to its relation with the parameter of efficiency and the various indices used.

Methodology

Sample and data

The application of the above methodology was realized in Greek banks. We have collected annual data from the financial statements of each bank separately for the period 1990–1999 (panel data). The sample includes 23 Greek banks. Foreign banks are excluded. Therefore, the data set includes data from 7 large and 16 small banks. The large banks include the Agricultural Bank of Greece, Alpha Credit Bank, National Bank of Greece, Commercial Bank of Greece, Ergobank, Ionian Bank of Greece, and National-Estate Bank of Greece. The small banks are Bank of Athens, Aspis Bank, Bank of Attica, General Bank of Greece, Credit Lyonnais, Dorian Bank, Egnatia Bank, ETBA, ETEBA, EFG EUROBANK, European and Popular Bank, Central Bank of Greece, Bank of Crete, Bank of Macedonia-Thrace, Bank of Piraeus, and Xiosbank. The classification of banks as small or large was based on the total assets. The average of the total assets for small banks is 289,330 m Greek drachma whereas for large ones it is 3,143,171 m Greek drachma (see Table 1). The number of observations is 181 in total. The number of observations for large banks is 61 and for small ones 120. There are no available data for the total of small banks as few of them were created after 1990. Our decision was based on the fact that all major changes within mergers and privatization will be effectuated within the Greek banking sector in the coming months.

Variables

The variables in this study involve ratios based on the financial statements of banks. The first objective of this paper is to test the differences between the effectiveness of small and large banks. In other

words, we investigate if small or large banks have better or weaker performance. We employ the t-test to see whether the efficiency ratios of small banks significantly differ from those of large ones. The second objective is to investigate the factors of efficiency and operation that are related to the size of banks. These factors inlcude the attributes of efficiency, liquidity, risk, leverage, and capital adequacy. The probability of classifying a bank based on its size is:

Probability (classification of bank i as small or large)

$= f$ (efficiency, liquidity, risk, leverage, capital adequacy)

The efficiency of small and large banks will be measured by their profitability, which includes the following:

ROE = The return on equity is the net profit after tax divided by the shareholders' equity and represents the earning performance of the bank based on the shareholders' stake.
ROA = The net profit divided by total assets represents the earning performance of the bank based on the total assets.
MARG = The net interest margin is the net interest income (Interest Income – Interest expense) divided by current assets. The net interest margin (MARG) of small and large banks indicates the rate of return on earning assets such as loans and other securities in generating net interest income. The higher net interest margin implies better performance.

For liquidity and risk, we will investigate the safety margin of technical insolvency that includes the following:

L/D = The ratio of loans to deposits
CA/TL = The ratio of current assets divided by total loans.

The loan to deposit ratio (L/D) shows the extent that the bank has lent its deposits. The higher L/D ratio results in a lower liquidity. In addition, it implies that banks use a lower level of debt financing than that of deposits.

The current assets to total loans ratio (CA/TL) reflects the liquidity and risk positions of the bank. The higher the CA/TL ratio means the larger proportion of short-term investments to total loans held by banks, resulting in a lower profitability and low risk of technical insolvency.

Regarding the leverage position of banks, the ratio of total assets to total equity (TA/TE) is employed to measure the extent of equity financing used in total assets investment. The higher TA/TE ratio means banks use relatively more debt financing and less equity. The ratio of total assets to total equity provides a useful picture of the capital adequacy of banks. The ratio TE/TA (total equity to total assets) is employed to measure the capital adequacy and define their solvency. It indicates the proportion of assets financed by the equity. The higher the ratio the less are the liabilities used by the bank. This results in reducing the risk. The relationship between size and efficiency estimated with the use of variables of different attributes is tested in this paper by multicriteria decision aid methods.

Methods

The methods used to define the ratios that affect the classification of a bank according to its size originate from the field of multicriteria decision aid. In particular, the UTADIS (UTilité's Additives

DIScriminatives) (Jacquet-Lagrèze, 1995; Zopounidis and Doumpos, 1999) and the M.H.DIS (Multi-Hierarchical DIScrimination) (Zopounidis and Doumpos, 2000) methods are employed to perform the classification of the banks. Both methods are well-suited to classification problems, leading to the development of additive utility functions that are used to score the banks and decide upon their classification, as large or small. The developed additive utility functions have the following general form:

$$U'(\underline{g}) = \sum_{i=1}^{m} x_i u_i'(g_i) \in [0, 1] \tag{1}$$

where $\underline{g} = \{g_1, g_2, \ldots, g_m\}$ is the set of the evaluation criteria (financial ratios), x_i is the weight of criterion g_i (the criteria weights x_i sum up to 1) and $u_i'(g_i)$ is the corresponding marginal utility function normalized between 0 and 1. The marginal utility functions provide a mechanism for decomposing the aggregate result (global utility) in terms of individual assessment to the criterion level. To avoid the estimation of both the criteria weights x_i and the marginal utility functions $u_i'(g_i)$, it is possible to use the transformation $u_i(g_i) = x_i u_i'(g_i)$. Since $u_i'(g_i)$ is normalized between 0 and 1, it is clear that $u_i(g_i)$ ranges in the interval $[0, x_i]$. In this way, the additive utility function is simplified to the following form:

$$U(\underline{g}) = \sum_{i=1}^{m} u_i(g_i) \in [0, 1] \tag{2}$$

The first major difference between the two methods is that UTADIS develops a single utility function that characterizes all banks in the sample, whereas M.H.DIS develops two functions $U_1(\underline{g})$ and $U_2(\underline{g})$, corresponding to the large and the small banks respectively. In that regard, the utility function of UTADIS provides an aggregate score $U(\underline{g_a})$ for each bank a along all financial ratios. This score provides the basis for deciding whether the bank can be considered as large or small. The classification rule in this case is the following (C_1 and C_2 denote the set of large and small banks respectively, while u_1 is a cut-off utility point defined on the global utility scale i.e., between 0 and 1):

$$\left.\begin{array}{ll} U(\underline{g_a}) \geqslant u_1 & \Rightarrow a \in C_1 \\ U(\underline{g_a}) < u_1 & \Rightarrow a \in C_2 \end{array}\right\} \tag{3}$$

On the other hand the two additive utility functions developed by M.H.DIS provide a measure of the similarity of each of the considered banks to the two groups, i.e., the large banks' group and the small banks' group, respectively. The classification decision for a specific bank a is taken using the following rule:

$$\left.\begin{array}{ll} U_1(\underline{g_a}) \geqslant U_2(\underline{g_a}) & \Rightarrow a \in C_1 \\ U_1(\underline{g_a}) < U_2(\underline{g_a}) & \Rightarrow a \in C_2 \end{array}\right\} \tag{4}$$

The estimation of the additive utility models in the UTADIS and the M.H.DIS methods is performed using mathematical programming techniques. In the case of the UTADIS method a linear programming formulation is employed to estimate the additive utility function and the utility threshold u_1, so that the sum of all violations of the classification rule (3) for all banks is minimized.

On the contrary, in the M.H.DIS method three mathematical programming formulations are employed to estimate the additive utility functions. Initially, a linear programming problem (LP1) is

solved to minimize the sum of all violations of the classification rule (4). Then, a mixed-integer programming (MIP) problem is solved to minimize the total number of misclassifications among the ones that occur after the solution of LP1, while retaining the correct classifications. Finally, a second linear programming problem is solved to maximize the clarity of the classification that is obtained after the solution of LP1 and MIP.

Detailed descriptions of the mathematical programming formulations that are employed in the two methods as well as details on their extension to the multi-group case can be found in the works of Zopounidis and Doumpos (1999, 2000).

Empirical results

Univariate tests

Table 1 presents the main variables of the banks. The average total assets of banks included in the sample comes up to 1,251,122 m Greek drachma. The average total assets for small banks is equal to 289,330 m Greek drachma while for large banks it is 3,143,171 m Greek drachma; it is, therefore, significantly higher for large ones.

As far as the equity is concerned, there is significant difference between small and large banks. The mean of equity for small banks is 31,449 m Greek drachma, while for large ones it comes up to 162,665 m Greek drachma. There is no significant difference between the means of total revenues. The mean of total revenues for small banks is 160,701 m Greek drachma, while for large ones is equal to 208,553 m Greek drachma. The fact that the means of total revenues of both banks are around the means of the total of banks, implies that both small and large banks have the ability to produce a similar income.

On the other hand, comparing the revenues to the asset or equity, we conclude that small banks are more efficient towards the creation of revenues. The net profits of the total of banks are on average 13,313 m Greek drachma. Moreover, there is a significant difference between the means of net profits of small and large banks. The mean of net profits for small banks is −536 m (losses), while for large

Table 1
Characteristics of Greek banks (means and t-tests)

	All Banks	Small Banks	Large Banks	t-test
Total Assets	1,251,122	289,330	3,143,171	−10.609***
Equity	75,671	31,449	162,665	−8.201***
Total Revenue	176,828	160,701	208,553	−0.399
Net Profit	13,313	−536	40,555	−6.243***

Notes: The amounts are reported in m Greek drachma
t-test: df = 179, (2-tailed)
*** significant at 1% level

ones it is 40,555 m (profits). This implies that, on average, large banks are more efficient than small ones. Comparing the above results with the variables of asset or equity, similar results are obtained.

Table 2 reports preliminary statistics and t-test of financial ratios for small and large banks. The ROE of small banks turns out to less (0.149) than that of large ones (0.197). The difference is not statistically significant. These conflicting profitability ratios resulted from higher operating expenses of small banks compared to large ones. Nevertheless, the ROE of small banks comes up to 6.470, indicating their vigor. This does not imply that the lower the ROE of small banks, the lower their leverage ratios are.

The ROA of small banks turns out to be less (0.008) than that of large ones (0.017). The ROA of large banks is on average twice that of small banks with a significant statistical difference. Large banks have a higher yield of total assets due to the existence of scale economies and reduced operating expenses.

The average net interest margin (MARG) of small banks is 0.051 while that of large banks is 0.030. This implies that on average small banks have a higher ability to make profits than large ones since they can generate a higher net interest income on their earning assets.

The L/D ratios of small and large banks are 2.082 and 0.485 respectively. This shows that small banks are relatively less liquid than large ones. This evidence seems to be consistent with the funding gap positions of small and large banks. The CA/TL ratios, which represent the proportion of short-term investment and total loans, are 1.164 and 0.962 for small and large banks respectively. The difference of CA/TL between small and large banks is not statistically significant. This implies that, on average, large banks have lent out more in long-lived assets. The TA/TE ratio of large banks (20.213) is quite higher than that of small banks (15.653). This means that large banks have a surprisingly smaller capital position than that of small banks. In other words, large banks maintain lower capital adequacy than small banks which means that, overall, large banks have a relatively higher bankruptcy risk. The TE/TA ratio of small banks is 0.117, while that of large ones comes up to 0.057. This implies that small banks have, on average, higher capital adequacy than large banks. Small banks finance their total assets with a bigger percentage of equity. This evidence indicates better capital structure and viability.

Table 2
Descriptive statistics and t-tests in the means of ratios for small and large Greek banks

	Small banks			Large banks			t-test
	Mean	Min	Max	Mean	Min	Max	
ROE	0.149	−1.934	6.470	0.197	−0.367	0.521	−0.437
ROA	0.008	−0.199	0.065	0.017	−0.012	0.069	−1.965*
MARG	0.051	0.000	0.620	0.030	0.000	0.062	2.069**
L/D	2.082	0.200	57.270	0.485	0.230	1.220	1.699*
CA/TL	1.164	0.220	6.960	0.962	0.400	1.190	1.910*
TA/TE	15.653	1.040	138.780	20.213	7.680	48.820	−1.691*
TE/TA	0.117	0.010	0.960	0.057	0.020	0.130	4.292***

Notes: t-test: df = 179, (2-tailed)
*** significant at 1% level, ** at 5% level, * at 10% level

Multicriteria analysis

The above results indicate that there are significant differences among the efficiency and the various indices of banks in relation to their size. Apart from these results, we examined the same indices in a multivariate environment with the use of multicriteria methods.

In applying the two multicriteria methods outlined in the previous section, a 10-fold cross-validation approach was employed. Cross-validation is a widely used approach to evaluate the generalizing and predictive performance of classification and regression models. In general, during a k-fold cross-validation a complete sample A consisting of n observations (banks), is randomly split into k mutually exclusive sub-samples (folds) $A_1, A_2, \ldots, A_k$ of approximately equal size d ($d \approx n/k$). The method under consideration is trained and tested k times: each time ($t = 1, 2, \ldots, k$) a model is developed on A, *excluding* A_t, and validated using the holdout sample A_t. Typically, the number of folds k ranges between 1 and 20. k can also be set equal to n (leave-one-out cross-validation), but several studies have shown that such a selection may lead to failure in estimating the generalizing performance of a classification model, while increasing the variance of the estimates (Kohavi, 1995; Shao, 1997; Brieman, 1996). On the other hand, if k is too small, the error estimate is pessimistically biased because of the difference in training set size between the full sample and the cross-validation analyses. In that case selecting a small number of folds leads to the use of inadequate samples for model development, since the number of observations in the reference set (training set) is quite limited. On the basis of these remarks, the most widely used value for the number of folds in cross-validation is 10 (10-fold cross-validation).

The application of the 10-fold cross-validation in this study leads to the development of 10 mutually exclusive sub-samples, each including 18 randomly selected banks. Therefore, in each of the 10 replications (folds), the reference set (training sample) consists of 162 banks, whereas the validation (holdout) sample consists of 18 banks. In each fold the UTADIS and the M.H.DIS methods are applied to the reference set to develop the additive utility classification models. These models are then tested on the validation sample to measure their classification accuracy.

On the basis of the above methodology, Table 3 summarizes some statistics on the robustness of the significance of each financial ratio in the discrimination between large and small banks according to

Table 3
Statistics on the weights of the financial ratios according to the UTADIS method (10-fold cross-validation results)

Ratios	Average	St. dev.	Coeff. of variation	Replications with weight >10%
MARG	6.35%	0.022	0.354	1
ROE	0.36%	0.001	0.299	0
L/D	64.09%	0.136	0.213	10
CA/TL	7.56%	0.041	0.541	1
TA/TE	8.90%	0.035	0.391	2
ROA	6.63%	0.043	0.652	3
TE/TA	6.10%	0.024	0.386	1

the models developed through UTADIS. The results clearly indicate one ratio as the major explanatory factor associated with the size of banks. This is the loans/deposits ratio (L/D), whose average weight along the 10 folds of the cross-validation experiment exceeds 60%. Moreover, the variability of the weight of this ratio is quite limited since the coefficient of variation is 0.213. That means that L/D contributes in differentiating the banks according to their size. From the remaining ratios, only five variables contribute significantly in the model classification. These are the total assets/total equity (TA/TE), the current assets/total loans (CA/TL), the return on assets (ROA), the net interest margin (MARG) and the total equity/total assets (TE/TA). These ratios have an average weight of more than 6%.

Similar results for the case of the M.H.DIS method are presented in Table 4. The results of the M.H.DIS method share some similarities with the ones of UTADIS. In particular, the L/D ratio is found to be once again a factor of major significance in discriminating between large and small banks. The explanatory power of this ratio is higher for the large banks, in which case its weight exceeds 37%. The ROA, TA/TE, and MARG ratios are also found significant in describing the large banks. The small banks are best described on the basis of the ROA ratio (higher ROA is associated with larger banks), while the L/D and TA/TE ratios are also found significant in this case.

On the basis of the above results, one can derive the conclusion that the L/D, ROA, and TA/TE ratios are the determinative factors for the classification of the banks as large or small.

Table 5 summarizes the average classification results for the 10-fold cross-validation experiment

Table 4
Statistics on the weights of the financial ratios according to the M.H.DIS method (10-fold cross-validation results)

Ratios	Average	St. dev.	Coeff. of variation	Replications with weight >10%
MARG	10.02%/9.67%	0.049/0.100	0.491/1.037	4/3
ROE	0.96%/1.14%	0.013/0.019	1.387/1.687	0/0
L/D	37.82%/24.63%	0.176/0.193	0.466/0.785	10/7
CA/TL	2.01%/2.36%	0.025/0.028	1.248/1.209	0/0
TA/TE	20.80%/16.69%	0.116/0.086	0.557/0.513	9/7
ROA	26.41%/44.82%	0.126/0.219	0.476/0.488	9/8
TE/TA	1.97%/0.7%	0.047/0.019	2.390/2.655	1/0

Note: All presented figures correspond to the pair of utility functions $U_1(g)$, $U_2(g)$

Table 5
Average (validation) classification results (10-fold cross-validation, %)

	UTADIS		M.H. DIS		Logistic regression	
	Large	Small	Large	Small	Large	Small
Large	86.89	13.11	80.11	19.89	71.54	28.46
Small	13.47	86.53	13.41	86.59	10.56	89.44
Overall accuracy	86.71		83.35		80.49	

obtained using the two multicriteria methods. For comparative purposes the results of logistic regression are also reported. The results presented in Table 5 involve the classification of the banks included in the validation samples formed during the 10-fold cross-validation experiment. The result in the training sets are not reported because both UTADIS and M.H.DIS have significantly more parameters to be estimated compared to the logistic regression, thus having an *a priori* data fitting superiority. On the contrary, the reported results for the validation samples provide an unbiased estimate of the generalizing ability of the considered models.

On the basis of the aforementioned remarks and the results of Table 5, the superiority of the two multicriteria methods becomes apparent compared to logistic regression. Although all methods have similar accuracies for the group of small banks, there are major differences with regard to the correct classification of the large banks. In this case UTADIS provides the higher accuracy (86.89%), followed by M.H.DIS (80.11%), while the accuracy of logistic regression is significantly lower at 71.54%. This is the same ordering of the methods when the overall classification accuracy is considered. It is also important to note that UTADIS provides a balanced error rate for both groups of banks (approximately 13% for both groups). On the other hand, the imbalance between the error rates across the two groups of banks for the other two methods is significantly higher, especially in the case of logistic regression.

Conclusions and future perspectives

The present study detects the endogenous factors of Greek banks that are induced from their financial statements and are related to their size, for the period 1990–1999. It classifies Greek banks into small and large ones, based on their total assets. In order to investigate the differences of profitability and efficiency between small and large Greek banks, as well as the factors of profitability and operation related with the size of banks, the multicriteria decision aid methodology has been used. More precisely, the M.H.DIS and the UTADIS methods have been used to identify the ratios that affect the classification of a bank according to its size. Seven financial ratios were selected for examination. These variables appeared to be important in previous research and constitute ratios derived from published financial statements. The variables selected by the above techniques are: the return on equity, the return on assets, the net interest margin, the ratio of loans to deposits, the current assets to total loans ratio, the total assets to total equity ratio, and the ratio of total equity to total assets. In applying the two multicriteria techniques, a 10-fold cross-validation approach was employed.

The evidence indicates that large banks are more efficient than small ones. Small Greek banks are characterized by high capital yield (ROE), high interest rate yield (MARG), high financial leverage (TA/TE), and high capital adequacy (TE/TA). Large Greek banks are characterized by high asset yield (ROA), and low capital and interest rate yield.

The UTADIS and M.H.DIS methods give an overall correct classification equal to 86.71% and 83.35% respectively, whereas the accuracy of logistic regression is 80.49%. The above results support the superiority of the two multicriteria methods compared to logistic regression.

Finally, the present study contributes to classify banks in the correct size in proportion to their differences in efficiency, liquidity, risk, leverage, and capital adequacy. Other endogenous and exogenous variables related to the size of a bank could be used in the future. These could be the proprietary régime, the existence of a banking group, the management, the number of stores, the interest-rate level, the inflation rate. The size of a bank is crucial. Both small and large banks have

advantages and disadvantages. Though small banks seem to be more efficient and vulnerable, large ones have lower operating costs due to the scale economies and their network. All of the above features could change due to new technology, new banking products, and especially the restructuring of bank operations that takes place through mergers and privatization. With advanced MCDA methods and a greater number of variables, it is possible to develop a more powerful analytical tool for the determination of the key success factors of these two categories of Greek banks.

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