Bank Specific, Industry Specific and Macroeconomic Determinants of Bank Efficiency in Euro Area

Ehsan Rajabi[1] | *Agricultural Planning, Economic and Rural Development Research Institute (APERDRI), Tehran, Iran*
Reza Sherafatian-Jahromi[2] | *Universiti Putra Malaysia, Serdang, Selangor, Malaysia*

Abstract

This study analyses the cost and profit efficiency of the banking sector in all 17-Euro area Member States during the period from 1999 until 2012. The two-stage approach, the generalized method of moment (GMM) regression model is used to regress the efficiency level obtained from the first stage on factors that could influence the efficiency score. Therefore, the efficiency score measures that derived from the DEA estimations are used as the dependent variable and then regressed upon environmental variables. The result suggests that the cost and profit efficiency of 126 listed bank is found to be on average negatively related to population density, banking activity, loan management activity, and profitability while economic condition, financial deeping rate, and bank network extension have a positive influence on cost and profit efficiency. Overall, our results demonstrate that environmental variables contribute significantly to the difference in efficiency scores between the Member States.

Keywords

Efficiency, Euro area, generalized method of moment (GMM), environmental variables, banking characteristics

JEL code

G21, D61, L16

INTRODUCTION

The Eurozone, which is composed of the seventeen European countries that have joined together to form a common monetary union, represents more than 15% of global Gross Domestic Production (GDP) and 20% of world exports (European Commission, 2015). The European Central Bank (ECB) is the sixth of the seven institutions of the European Union (EU) as listed in the Treaty on European Union (TEU). It is the central bank for the Eurozone, one of the world's most important central banks, to administrate the monetary policy of the 17 EU Member States that constitute the Eurozone. In 1957, the European

[1] Assistant Professor, Department of Agriculture and Food Policy, Agriculture Planning, Economic and Rural Development Research Institute (APERDRI), Ministry of Jihad-e Agriculture, Tehran, Iran. Corresponding author: e-mail: rajabi.ehsan63@gmail.com.
[2] Department of Economics, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia. E-mail: rezasherafatian@yahoo.com.

Union was founded. From 1957 to 1999, economic integration has progressed as follows by Treaty of Rome (1957), the snake (1970s), European Monetary System (1979), the Single European Act (1986), Maastricht Treaty (1991), and Stability & Growth Pact (1997) and, finally, in 1999 the Euro is launched among 11 members of EU. Greece, Slovenia, Cyprus and Malta, Slovakia and Estonia have been joined Euro area from 2001 to 2011.

The economic impacts of this zone are resounding worldwide nations. Thus, both the success and failures of the European Central Bank policies will affect not only country members of the Eurozone, but also the global economy in general. The formation of the ECB and its currency, the Euro, has presented greater success to the euro Member States. Its long-term efficiency, productivity, and stability will base on the efficacy of the ECB policies in addressing some critical obstacles to its success.

The European banking markets, especially banks, in their function as financial intermediaries, contribute to economic activity in a number of ways. In this case, the banking systems in developing countries have undertook major reforms in order to create effective banking institutions with a high level of soundness and capable of facilitating economic growth (Andries, Apetri, Cocris, 2012). Furthermore, banking sector has undergone significant transformation worldwide in its operational environment during the last two decades. Both environmental and internal factors have influenced its structure, efficiency, and performance in banking industry, and effective banking system is better able to withstand negative shocks and contribute to the stability of the financial sector (Brissimis, Delis, Tsionas, 2010). Therefore, the efficiency of the banking system becomes an important issue to the academic world, the banking system decision-makers, and regulatory bodies.

Moreover, the banking sector is considered by any economy as a key sector for the smooth operating of its domestic economic system, so the development of the new banking status is an issue of major concern. When competition increases between banks or between banks and other financial institutions, internally and internationally, bankers and policy makers are to determine whether banks are managed efficiently and productively, and, if not, to take remedial action.

In other respect, analysing the efficiency level of banks is of interest from a policy perspective because if banks are becoming more efficient then, one would expect better performance, enhanced profitability, greater amounts of funds channelled through the system, competitive prices, and service quality for consumers, as well as increased safety and soundness (Casu, Girardone, Molyneux, 2004). In addition, looking at efficiency differences across countries may help to identify the achievement or perhaps of policy notations or, additionally, may highlight a variety of strategies carried out through banking systems. The information acquired about the evaluation of the bank's performance is known to improve its overall efficiency of operations and, in turn, it may improve its competitive frontier.

The banking industry exposes a multitude of new developments and challenges. Deregulation, liberalization, information technology, and the entry of new types of competitors have contributed to internationalization of the existing capital markets and to the developments of new markets of sophisticated financial instruments. The banking scenery changes even more radically in Europe, where the introduction of the single currency (Euro) in 1999 has removed institutional obstacles for banks to operate in other EU countries.

This changing banking environment concentrates on competitive conditions in the Eurozone and on the viability of its – until recently – sheltered banks. After all, for long, domestic banks have enjoyed comparative advantages on the domestic markets for bonds and equity in the field of underwriting and trading activities based on the existence of national currencies. Nowadays, especially after the constitution of the Euro, the efficiency of the euro area banks will become more and more crucial in the light of the current and expected increase in competition. Less efficient banks run the risk to be driven from the market. Efficiency can also be a decisive element in the game of mergers and take-overs, where inefficient banks are an easy and sought-after target.

Furthermore, in order to response a major concern of investors and policy makers how is the health performance of EU-17's banks, this paper seeks to discover the level and spread of bank efficiency in the Eurozone. In particular, it targets on differences across countries explained by environmental condition like various macroeconomic conditions, various banking specification, bank specific characteristics, and other sources over time. Therefore, this study attempts to determine the influencing factors of bank efficiency level in the Eurozone.

Our study contributes to the literature as follows. First, the literature is a treasure of country studies on efficiency in the banking industry. Studies on international comparison of efficiency are rare. Actually, such an international comparison is really a heroic attempt, as the differences in banking behaviour and economic and institutional conditions (in terms of institutions, supervisory rules, government interference, customer preferences and level of development) between countries are huge. As activities of banks diverge strongly and as part of these activities are truly challenging, it is actually for just one country quite a task to capture bank behaviour by one model. Moreover, international comparisons are easily distorted by national differences in macroeconomic condition, banking sector specification categories, as shown in this study. In other words, it can easily be confirmed that single-country studies are entirely unsuitable for international comparisons and provide misleading results.

Moreover, our study contributes to the literature by providing estimations of both cost and profit efficiency of banks based on nonparametric frontier analysis for all the euro area Member States; also, it compares efficiencies scores derived from Member States. Although, most of the studies of banking efficiency in the European countries are based on one-year analyses, and one year is not sufficient to observe the efficiency level. Hence, this study will evaluate the efficiency level for fourteen years. In addition, the sample of this study will include most significant banks (85 percent of total banking assets in the euro area) that operate in all seventeen Member States.

The rest of this paper is structured as follows: The literatures are reviewed in section two, followed by model specification in the third section. The sources of data are represented in section four. In section five, the empirical results and discussion are presented, followed by the conclusion and policy implications in the last section.

1 LITERATURES REVIEW

The literature on bank efficiency has a long tradition and has accumulated a significant amount of researches with various results, scopes, and methodologies. As an example, we can refer to Berger and Humphrey (1997), and Berger et al. (1999). In the United States, Berger and Humphrey (1991) published a report based on bank performance. In this report, it was stated that banks could improve their performance in terms of efficiency and productivity by using economies of scale, or economies of scope. Moreover, some studies looked at the conceptual background of the banks (Lovell, 1993) and the risks associated with their performance (e.g. Paradi and Zhu, 2013; Casu, Ferrari, Zhao, 2013; Berg, Førsund, Jansen, 1992; Berger and DeYoung, 1997; McAllister and McManus, 1993; Mester, 1996). It is also notable that the common point among these studies is that they ranked foreign banks less efficient compared to the local ones (DeYoung and Nolle, 1996; Edward Chang, Hasan, Hunter, 1998; Hasan and Hunter, 1996; Mahajan, Rangan, Zardkoohi, 1996; Peek, Rosengren, Kasirye, 1999).

One thing that remains the same though is the number of the cross-country comparative researches. They mostly concentrated on the European market. Studies show that changes in the sample size, production specifications, and assessment techniques lead to different results (Bos and Schmiedel, 2007). Notwithstanding their gap, some experimental results are valuable. Some of the studies done in the EU were in alliance with those done in the U.S.; both possessed cost efficiency levels of 70 to 80 percent, and the profit was around 50 to 60 percent. However, some countries were more efficient; for instance

Spain, and Belgium, showed greater degrees of efficiency compared to Germany, Austria, and the United Kingdom (Pastor, Perez, Quesada, 1997).

Some studies tried to do cross-country studies. For instance, Sheldon (1999) conducted a study on 1 783 banks in the EU using data from 1993 to 1997. By applying the Data Envelopment Analysis, Sheldon realized that usually larger banks showed better performance compared to smaller ones. It was also shown that specialized banks as well as retail banks were also more profit and cost efficient. On the other hand, smaller banks and wholesale banks showed lower efficiency levels. The efficiency on average was quite low at less than 46%. The profit efficiency of the banks was slightly better at 65%. In his study, Sheldon showed that banks from Denmark, Sweden, and France had the higher profit levels and the ones in Portugal, Greece, Spain, and U.K had the lowest profits.

Being concerned with a similar notion, Altunbas et al. (2001) concentrates on the German banking market in the period between the years 1989 to 1996. They discern between public savings banks, private commercial banks, and mutual cooperative banks. As a result of this comparison between the private commercial banks and others banks including the public ones they realized that private banks were more inefficient in terms of cost and profit.

In another study done in Germany, Bos et al. (2005) looked at the accounting factors that lead to differences in bank efficiency. It was also shown that banks from different regions have different performance. The size of the banks, their type, as well as their geographic origin was also found to be influential factors in the efficiency of the banks. However, they realized a huge difference between the results they obtained by the method employed for controlling the heterogeneity. That is how they arrive at the benchmarking paradox and elaborate on it: "we take part in a benchmarking activity to evaluate and measure the differences in performances; however, to do so, a general benchmark has to be assumed".

It can be said that such paradox is quite clear in the case of cross-country studies. The reason is that in such studies a common efficient frontier is often used as the basis of comparison. This can lead to wrong results as some countries have access to technologies that are absent in others. However, it is not possible to compare the efficiency outcomes across borders in cases where the frontier has been employed in every country in the sample and every banking institution's performance is weighed up against the bank which has the best-practice within that country. Recent studies tried to stay away from the bias estimation in cross-country bank efficiency comparisons by combining country-specific environmental variable (Barth, Lin, Seade, Song, 2013; Chaffai, Dietsch, Vivas, 2001; Dietsch and Vivas, 2000; Vivas, Pastor, Hasan, 2001; Vivas, Pastor, Pastor, 2002).

As an example, we can refer to Dietsch and Vivas (2000) who were more focused on the theory that the employment of a frontier benchmark can lead to misleading result. The reason for these misleading efficiency outcomes of companies from different nations is that these approaches often fail to control the cross-country economic conditions, demographic, and regulatory differences which are beyond a company's control. Therefore, using common frontier can lead to results that indicate a bank to be inefficient while it is regarded as efficient in comparison to the average performance of the banks operating within the national market.

In addition, in another study Vivas et al. (2001) make a test where they replicate every banking market's performance if the average banks chose to function in any other nation. That is how they realized that it would be good for some banks to operate in another country since their performance in another country was quite higher and better in comparison to their performance in their original country.

At the end, Bos and Kolari (2005) make a better quality comparison by weighing up small and large independent US and European banks. As for the none-common frontier sets of rules and regulations, they keep the profit and cost frontier the same in both the US and Europe and operate on that basis. Although, they found evidence in favour of a single profit frontier, they declined the single cost frontier.

As explained above, the initiatives cannot solve the problem of cross-border efficiency comparison of banks with different level and type of technologies in different nations. This study tries to use the single-frontier method to increase the level of the published researches in the literature, to forecast the common efficiency variables across the countries and to consider their specified environment circumstances to account for the main technologies in the EU financial industry.

In view of the literature discussed, we can say that empirical studies in banking efficiency have been conducted extensively (for example USA, Germany, and Spain) with financial variable and monetary policy but that few studies have been done to investigate banking efficiency in European countries, especially for all the euro area countries with these financial integration and monetary policy variables. Therefore, more empirical work is needed on the banking efficiency in the euro area Member States.

2 MODEL SPECIFICATION

To investigate the influence of different factors of environmental condition two-step procedure was employed; the data envelopment analysis (DEA), and GMM estimators. Therefore, in following section, we select inputs, outputs, and DEA approach.

There is a continuous discussion in the banking literature concerning the most appropriate interpretation of outputs and inputs. According to Bergendahl (1998): "There have been almost as many assumptions of inputs and outputs as there have been applications of DEA" (p. 235). Berger and Humphrey (1997) identified two major approaches including production approach and intermediation approach for selecting inputs and outputs; production approach and intermediation approaches. According to Berger and Humphrey (1997), neither intermediation approach nor production approaches are perfect because they cannot perform financial institutions' dual role as being financial intermediaries and provider of document or transactions processing services.

In some studies, earning assets is used as an output. This is consistent with asset approach proposed by Sealey and Lindley (1977) while deposits are considered as an additional output, by other researchers, which is related to an approach known as value-added approach. Recently, a different modified version of the intermediation approach is adopted (see Avkiran, 1999; Chu and Lim, 1998; Das and Ghosh, 2006; Drake, Hall, Simper, 2006; Sturm and Williams, 2004). This is known as profit oriented or operation approach that considers revenue components such as interest income, non-interest income as outputs and cost components such as personal expenses, interest expenses as inputs. According to Drake et al. (2006), based on input oriented DEA relative efficiency analysis, the more efficient units will be better at maximizing profit through minimizing different costs incurred in making different revenue flow. They also indicated that, this approach could be more suitable for taking the variety of strategic responses by financial companies in confronting dynamic changes in environmental and competitive situations.

To estimate cost and profit efficiency score, the present study focused on intermediation approach to construct the DEA frontier. Under the intermediation approach (following Berger and Humphrey, 1992), we assume deposits (X_1): demand, savings, and time deposits, Labor (X_2): staff of bank together with management expertise required for providing bank services ,physical capital (X_3): offices, branches, and computer hardware as inputs and loans (Y_1): is total amount of loans concerning each banking firm, investment (Y_2) total securities, equity investments and other investments as outputs.

Price of borrowed funds (w_1) was used as interest expenses over the sum of deposits price of labor (w_2) calculated by personnel expenses to the employees' number as the unit price of labor. Price of physical capital (w_3) was measured by non-interest expenses over fixed assets. Price of loan (p_1) was calculated by interest income on loans over total loan. Price of investment (p_2) was measured by total non-interest operating income plus other interest income over other earning assets.

As already recorded, if economic objective functions are reasonable and if reliable price information is available, however, DEA can be used to identify cost efficiency (Cooper et al., 2000). Since we assume

indeed that banks minimize cost in the euro area, we consider in this study input-oriented efficiency with variable return to scale. The minimum cost is obtained by solving the DEA linear programing problem.

$$min \sum_{i=1}^{n} w_{io} x_i, \tag{1}$$

$$\text{subject to: } \sum_{i=1}^{n} x_{ij} \lambda_j \leq x_i \quad (i = 1, 2, \ldots, n), \tag{2}$$

$$\sum_{i=1}^{n} y_{rj} \lambda_j \geq y_{r0} \quad (r = 1, 2, \ldots, m), \tag{3}$$

$$\sum_{j=1}^{n} \lambda_j = 1, \tag{4}$$

$$\lambda_j \geq 0 \quad (j = 1, 2, \ldots, N), \tag{5}$$

where $j = 1, \ldots, N$ are the number of banks, $i = 1, \ldots, n$ are input volumes used by bank j, $r = 1, 2, \ldots, m$ measures the volume of output r and w_{io} is the unit cost of the input i of bank DMU_o which is the benchmark projection that can be different from one bank to another. Although, the objective is to choose the x_i and λ_j values to minimize the total cost of satisfying the output constraints. The w_{io} in the objective represent unit costs. The minimization problem is calculated for each bank of and each year in the sample, thus identifying for each a benchmark combination of inputs and cost.

Every DEA model assumes a returns-to-scale characteristics that is represented by the ranges of the sum of the intensity vector λ, i.e., $L \leq \lambda_1 + \lambda_2 + \ldots + \lambda_n \leq U$. Here, we compute variable returns to scale and use $L = U = 1$. We consider convex hull representation. Our model allows substitutions in inputs. Based on an optimal solution (x^*, λ^*) of the above problem, the cost efficiency of DMU_o is defined as:

$$CE_o = \frac{C_{min}}{C_o} = \frac{\sum_{i=1}^{n} w_{io} x_i^*}{\sum_{i=1}^{n} w_{io} x_{io}}, \tag{6}$$

where CE_o is the ratio of minimum cost to observed cost for the *oth* firm. Clearly, this approach implies that all observed input-cost combinations are measured with no error. Outliers may be classified as very efficient simply because data error.

Similar to cost efficiency, the profit efficiency (PE) can be estimated by solving the following linear programming problem n times; each time for a different bank in the sample. Therefore, the profit-maximization problem of a multiple-output, multiple-input firm facing input and output prices w and p, respectively, can be formulated as the following DEA problem:

$$\pi = py^* - wx^* = max \sum_{r=1}^{m} p_r y_r - \sum_{i=1}^{n} w_i x_i, \tag{7}$$

$$\text{subject to: } \sum_{j=1}^{N} x_{ij} \lambda_j \leq x_i \quad (i = 1, 2, \ldots, n), \tag{8}$$

$$\sum_{j=1}^{N} y_{rj} \lambda_j \geq y_r \quad (r = 1, 2, \ldots, m), \tag{9}$$

$$\sum_{j=1}^{N} \lambda_j = 1, \tag{10}$$

$$\lambda_j \geq 0 \quad (j = 1, 2, \ldots, N). \tag{11}$$

The profit-maximizing input and output quantities x_i^* $(i = 1, 2, \ldots, n)$ and y_r $(r = 1, 2, \ldots, m)$ are obtained along with the other decision variables λ_j^* $(j = 1, 2, \ldots, N)$ at the optimal solution of this problem. The maximization problem is calculated for each bank of the sample, thus identifying for each a benchmark combination of inputs and revenue. Based on an optimal solution (x^*, y^*, λ^*) of the above problem, return to the maximum profit attainable for bank *o_th* given the production technology and the input prices w_i it faces. The profit efficiency of DMU_o is defined as the ratio between the observed profits and the maximum profits as follows:

$$PE_o = \frac{\pi_o}{\pi_{max}} = \frac{\sum_{r=1}^{m} p_{ro} y_{ro} - \sum_{i=1}^{n} w_{io} x_{io}}{\sum_{r=1}^{m} p_r y_r^* - \sum_{i=1}^{n} w_{io} x_i^*}, \tag{12}$$

where $PE_o \leq 1$ and equals unity when the bank operates on the estimated frontier and is deemed profit efficient.

The efficiency scores generated from the DEA program were used as independent variables in a panel regression model to explain bank performance, the dependent variable (Lehmann, Warning, Weigand, 2004) .Using panel regression, a non-parametric method and multivariate analysis may assist in understanding and validating behavioural relationship in the banking sector (Jalan, 2002). For second step, a linear regression model is estimated to be in following form:

$$y_{it} - y_{it-1} = (1 - \alpha) y_{it-1} + \beta(\mathrm{L}) X_{it} + \eta_i + \varepsilon_{it}, \tag{13}$$

where y_{it} represents the efficiency score of bank i at time t, X represents the set of explanatory variable (environmental variable), η_i can be described as an unobserved specific effect of the country and ε_{it} can be described as an error term.

In order to control for cross-country differences in the environment that banks operate, there are some approaches that can be utilized for incorporating environmental variables (modifying for the environment) in DEA applications. The term of "environmental variable" is usually utilized for describing factors which could have an impact on firm's efficiency but be outside of the manager that covers banking sector, macroeconomics countries specification (Coelli, Rao, Donnell, Battese, 2005). Finally, model one is developed to investigate relationship of cost and profit efficiency with environmental variables.

Bank efficiency
= f (Lag of Bank efficiency + Population density
+ Economic condition + Financial deepening rate + Banking activity (14)
+ Bank network extension + Profitability
+ Loan management activity).

Formula (14) is extended for the purpose of reflecting the variables. The baseline regression model is formulated as below:

$$EF_{ijt} = \alpha + \lambda EF_{ijt-1} + \beta_1 POPD_{ijt} + \beta_2 \ln(GDP)_{ijt} + \beta_3 FDEEP_{ijt} + \beta_4 CLAIMS_{ijt} + \beta_5 BRANCH_{ijt} + \beta_6 ROE_{ijt} + \beta_7 LOANTA_{ijt} + \eta_j + \mu_{ijt}, \quad (15)$$

$i = 1, \ldots, 126, t = 1, \ldots, 14, j = 1, \ldots 17.$

In the banking literature, the significance of specifying the environmental variables for the purpose of avoiding bias in models has been identified (see, for example Dietsch and Vivas, 2000; Vivas et al., 2001; Vivas et al., 2002). Based on this first model, across country efficiency differences are ascribed to managerial inside the commercial banks while the difference in efficiency can be explained through different environment and economic regulatory across countries (see Berger and Mester, 1997). Three groups of environmental variables (bank specific and countries, banking industry factors) was employed for all 126 selected bank from all 17-Euro area Member States including Spain, Austria, Cyprus, Slovenia, Belgium, Portugal, Estonia, the Netherlands, Finland, Malta, France, Luxembourg, Germany, Italy, Ireland, and Greece from 1999 to 2012.

Based on above-mentioned studies, three groups of variables that are supposed to be connected with changes in efficiency across banks are formed. Country level variables are the first group that explains macroeconomics situations such as population density, economic condition, and financial deepening ratio. According to Yildirim and Philippatos (2007), demand of banking services' supply is positively affected by favourable economic conditions, which brings about an improvement in bank efficiency as well.

The second group includes variables that describe the structure of banking industry for each Member States (activity in the banking activity, bank network extension). According to Kasman and Yildirim (2006), the overall banking network that is measured through the market size of banking and the banking activity is measured by bank claim to private sector over the GDP encourage higher efficiency. Therefore, we employ those variables as explanatory variables in two-step approach.

Last group consists of variables describing bank specific characteristic in each bank. The bank specific variables are: *LOANTA* is a total loan of bank to total assets ratio and can be described as a measure of loan management activity; *ROE* can be described as pre-tax profit divided by equity. These variables have been utilized in previous studies to show the bank-specific characteristics that influence efficiency (Allen and Rai, 1996; Fries and Taci, 2005; Isik and Hassan, 2003; Pasiouras, 2008).

3 DATA

The current study explored the extent of a possible relationship between the efficiency of bank and environmental variables. For the current study, data was collected from various sources, "Bankscope" database of BVD-IBCA, Eurostat, World Bank, ECB during the period of 1999–2012. For a sample, unconsolidated accounting data of EU-17 Member States including Spain, Austria, Cyprus, Slovenia, Belgium, Portugal, Estonia, the Netherlands, Finland, Malta, France, Luxembourg, Germany, Italy, Ireland, and Greece was used. This sample is adequate for investigating the evolution in bank efficiency of EU Member States because main EU countries are included in it.

The sample of banks have been selected from about total 6,000 credit institutions (entire population) in the euro area which is covered by almost 85 percent of total banking assets in the euro area. From this list of credit institutions, 126 active credit institutions was selected (6 from Austria, 6 from Belgium, 3 from Cyprus, 3 from Estonia, 3 from Finland, 11 from France, 25 from Germany, 4 from Greece, 5 from Ireland, 15 from Italy, 6 from Luxembourg, 3 from Malta, 6 from the Netherlands, 4 from Portugal, 3 from Slovakia, 4 from Slovenia, 18 from Spain) based on the European Central Bank (ECB) decision which are prepared to deal with tasks of new banking supervision as a part of a single supervisory mechanism. These credit institutions are directly supervised by ECB based on one of significance criteria (including size, economic importance, cross-border activates, direct

public financial assistance). They will work closely with the national well qualified authorities with the aim to supervise all other credit institutions.

Almost 85 percent of total banking assets in the area of Euro represented by these 126 credit institutions that will be identified in accord with significant criterion. Significance criteria include total value of assets exceeding €30 billion, significance for the specific country or the EU economy as a whole and significance cross-border activities by ratio of its cross-border assets/liabilities in more than one other participating Member State to its total assets/liabilities to be more than 20% and direct public financial assistance by requested or received funding from the European Stability Mechanism or the European Financial Stability Facility.

4 RESULTS

4.1 Summary Statistics

Based on practical consideration, to estimate cost and profit efficiency score, the present study focuses on the intermediation approach to construct the DEA frontiers. Under the intermediation approach (following Berger and Humphrey, 1992), we assume deposits (X_1): deposits & short term funding, labor (X_2): number of employees, physical capital (X_3): fixed assets as inputs and loans (Y_1): total loan, investment (Y_2): other earning assets as outputs. Although, we consider price of borrowed funds ($w1$): interest expenses over deposit, price of labour (w_2): personnel expenses over total labor, price of physical capital (w_3): non-interest expenses over fixed assets as input price and price of loan (P_1): interest income on loans over total loan, price of investment (P_2): total non-interest operating income plus other interest incomes over other earning assets as output price. Table 1 shows summarized descriptive statistics for inputs, outputs and their prices that were employed for the estimation of the cost and profit efficiency by the DEA approach.

Table 1 Descriptive summary of inputs, outputs, and prices for estimating efficiency

Variable (symbol)	Obs	Mean	Std. Dev.	Min	Max
Deposits (X_1)	1 142	124 000	224 000	30.1	1 740 000
No. of employees (X_2)	1 142	16 243.01	30 997.18	5	193 349
Fixed assets (X_3)	1 142	1 510	3 190	0.11	24 600
Total loan (Y_1)	1 142	104 000	178 000	7.3	1 030 000
Other earning assets (Y_2)	1 142	120 000	277 000	1.1	2 450 000
Price of fund (W_1)	1 142	0.078	0.412	0	9.598
Price of labor (W_2)	1 142	123 598.5	468 316.9	9 703.714	9 588 510
Price of physical capital (W_3)	1 142	10.010	87.977	–1.205	2 304
Price of loan (P_1)	1 142	0.191	1.466	0.0001	37.634
Price of investment (P_2)	1 142	0.087	1 171 443	–0.143	1.168

Note: The unit of input and output variables is US $ Million.
Source: Own construction

4.2 Estimation of Efficiency by DEA

The DEA models' results are summarized in Tables 2–4. Table 2 reports the results of the models run using the entire 126-listed bank dataset for 17-Euro area Member States from 1999 to 2012,

while Table 2 provides cost efficiency score with the breakdown of the results by country and year. Table 3 reports the results of the profit efficiency models by country and year.

From Table 2, it is observed that the three lowest averages of cost efficiency of sample are reported for Slovakia, Greece, and Portugal banking sector which stood at 11.12%, 11.23%, and 16.79%, respectively. Conversely, for three highest averages of cost efficiency, the Netherlands, France, and Germany bank cost efficiency stood at 70.95%, 56.69%, and 48.03%, respectively. For whole the euro area, cost efficiency ranged for a low of 30.62% in 2005 to a high of 43.52% in 2002 and totally, average of cost efficiency is 35.84% from 1999 to 2012. The average cost efficiency level is 35.84%, meaning that on average they are 65.12% inefficient in costs. Inefficiency levels show by how much costs can fall if inputs were used as efficiently as the unit located on the best practice frontier was.

The trend of the dispersion of cost efficiency values as measured by its standard deviation remains indistinct at best. The standard deviation of the scores was of 30.84 for the Euro area while the minimum standard deviation of cost efficiency sore remained at 4.32 for Slovakia, and maximum standard deviation score stood at 56.69 for France.

It is observed that over the sample period, the Netherlands banking sector reported higher cost efficiency for all years except for 2003 that Luxembourg banking sector stood at 61.15%, and it was varying from a low of 63.2% in 2007 to high of 100% in 1999, 2000, and 2001. A plausible reason could be assigned to the fact that during the period under study, the Netherlands banking sector was relatively efficient in its basic function as an intermediary between savers and borrowers. It should be mentioned here that decreasing of cost and profit efficiency of the Netherland banking system is because of the SNS bank's and Nederlandsche Bank's NV (De) performance during 2005 to 2012. The SNS bank has a negative profit value (loss) and Nederlandsche bank NV has high level of deposit and low value of loan which is made a low level of efficiency. Although, lower cost efficiency was recorded for Slovakia's banking sector across the sample period except for 2004, 2006, and 2007 that Greece's banks were inefficient bank in the sample and it was varying from a low of 7.16% in 2012 to high of 16.27% in 2002. In constant, the empirical results indicated a large asymmetry between countries regarding their profit efficiency level. Although, the evaluation of profit efficiency in each country shows that there doesn't seem to be a clear trend in general, efficiency scores had been decreasing from starting to ending years in most of the countries in sample.

The results of the profit efficiency estimation are presented in Table 3. From Table 3, it could be observed that the Netherlands, Germany, and France are three highest average profit efficiency members across the euro area during the period under study with 63.95%, 44.58%, and 37.99% respectively. It means; these most efficient banking sectors did not use extra excess input resources in comparison with an inefficient banking sector, while the inefficient banking sector used more extra excess resources to produce the same amount of outputs as the efficient country banking sector.

In comparison, Portugal, Slovakia, and Greece had the lowest average profit efficiency members across the euro area with 2.56%, 3.29%, and 4.52%, respectively. It means these county banking sectors were operated in the most inefficient manner, all other conditions being equal. For the euro area, profit efficiency ranged from a low of 20.69% in 2010 to a high of 38.79% in 2000 and, finally, average of profit efficiency was 24.55 % from 1999 to 2012. The average profit efficiency level is 24.55%, meaning that on average, they were 75.45% inefficient in profit. Inefficiency levels show by how much the profit (costs) can increase (decrease) if inputs were used as efficient as the unit located on the best practice frontier. The trend of the dispersion of profit efficiency scores as measured by its standard deviation remains indistinct at best.

It is observed that over the sample period, the Netherlands banking sector had the highest profit efficiency for all years except 2003 that Luxembourg banking sector stood at 67.14%, and it is varying from a low of 48.26% in 2008 to high of 100% in 1999, 2000, 2001, and 2002. Although, lower profit efficiency was recorded for Estonia's banking sector across the sample period except for 2004, 2011, and 2012

Table 2 Summary of cost efficiency of banks across the euro area member states estimated by DEA form 1999 to 2012

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Mean	Std.Dev/Obs
Austria	39.73	29.72	30.19	36.71	14.81	21.50	13.74	16.36	20.49	20.98	19.19	15.9	17.47	15.75	20.49	10.76/69
Belgium	28.06	23.69	28.46	29.55	26.39	24.05	41.56	37.92	37.22	36.74	37.20	34.30	27.84	33.22	34.46	25.52/50
Cyprus	17.42	19.23	21.25	23.16	21.70	23.01	12.76	17.58	22.29	22.57	20.84	14.61	11.62	11.55	18.54	9.73/42
Estonia	13.10	15.72	17.09	24.52	24.59	25.68	10.38	17.58	26.47	31.91	28.22	16.43	41.92	42.25	25.21	22.70/30
Finland	.	.	.	.	.	24.43	13.16	19.59	22.52	24.27	21.00	22.31	44.80	45.11	26.51	23.24/25
France	.	.	.		.	82.11	58.87	59.14	59.01	59.50	58.69	46.50	49.09	57.70	56.69	35.65/86
Germany	67.10	61.43	64.09	67.70	53.83	49.38	34.40	49.28	46.26	47.60	49.20	43.28	43.66	41.19	48.03	33.65/254
Greece	.	.	.	.	.	8.28	6.05	8.04	12.05	17.31	15.29	11.91	11.61	10.56	11.23	3.89/36
Ireland	.	.	.	.	.	25.69	45.99	52.79	53.39	48.92	45.19	40.27	40.00	36.72	44.03	31.73/43
Italy	.	.	.	.	.	8.50	23.17	25.16	31.15	35.99	31.90	23.25	26.72	25.47	27.77	24.62/119
Luxembourg	34.37	47.32	73.08	57.14	61.15	75.10	28.58	24.38	25.19	17.45	13.02	10.43	11.17	10.82	28.65	30.60/65
Malta	10.92	13.11	14.96	20.14	19.23	22.30	40.57	45.3	47.47	46.78	40.80	42.68	17.72	27.74	31.33	31.22/36
Netherlands	100	100	100	80.58	35.33	78.58	68.60	63.26	63.62	68.43	68.57	72.14	73.09	70.92	70.95	35.34/52
Portugal	.	.	.	.	.	10.07	8.59	10.45	15.79	23.33	21.28	20.83	19.37	16.33	16.79	6.23/33
Slovakia	7.56	7.73	12.82	16.27	14.53	17.67	5.36	9.34	13.54	14.11	13.38	7.24	6.67	7.16	11.12	4.32/40
Slovenia	18.48	18.59	17.46	26.64	25.08	25.37	20.27	37.37	36.32	30.83	30.51	13.05	12.52	13.49	23.65	18.03/48
Spain	.	.		.	.	31.90	31.07	40.96	37.73	40.87	37.60	31.93	39.10	33.02	36.05	27.44/114
Euro Area	35.91	35.43	40.77	43.53	35.40	38.08	30.62	36.87	37.72	39.30	37.73	32.25	34.12	33.37	35.84	30.84/1 142

Notes: Efficiency score is in percentage; Obs: number of observations; Std.Dev: standard deviation.
Source: Own construction

Table 3 Summary of profit efficiency of banks across the euro area member states estimated by DEA form 1999 to 2012

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Mean	Std.Dev/Obs
Austria	8.03	8.22	8.64	10.38	6.88	9.02	8.97	6.02	4.92	3.75	4.41	4.20	3.99	3.26	6.06	4.08/69
Belgium	100	100	100	30.04	28.11	31.21	29.49	27.54	13.59	23.32	23.12	23.02	5.18	20.38	25.79	35.69/50
Cyprus	5.84	7.07	9.08	8.68	6.43	36.25	3.20	2.93	3.87	1.47	1.28	1.42	1.60	1.68	6.49	15.15/42
Estonia	1.01	1.66	2.10	2.34	2.44	3.85	1.93	2.07	1.61	0.06	0.41	0.060	34.14	34.04	8.19	24.98/30
Finland	.	.	.	.	.	6.10	10.60	14.34	10.30	6.22	11.73	18.13	34.20	34.61	17.06	28.02/25
France	.	.	.	.	.	73.57	60.10	44.44	31.30	34.17	47.84	45.34	42.86	45.68	44.58	41.19/86
Germany	85.51	85.12	69.24	56.25	47.96	42.53	31.17	45.82	36.77	29.79	29.19	29.15	25.45	26.68	37.99	43.40/254
Greece	.	.	.	.	.	6.16	7.75	7.12	5.02	2.38	3.61	4.03	2.55	2.06	4.52	3.06/36
Ireland	.	.	.	.	.	15.62	32.34	34.19	31.07	25.60	31.10	26.24	22.11	29.57	28.7	35.82/43
Italy	.	.	.	.	.	11.13	19.51	15.41	15.08	14.64	15.51	15.30	17.00	15.72	15.92	31.74/119
Luxembourg	35.39	66.74	75.50	71.68	67.14	68.22	42.07	36.02	35.18	17.30	17.53	1.79	19.08	3.28	33.04	45.05/65
Malta	7.23	8.38	8.96	8.85	6.25	3.23	35.21	34.98	35.52	34.17	34.02	33.98	34.38	34.53	25.43	40.51/36
Netherlands	100	100	100	100	1.86	77.00	62.26	61.93	49.40	48.26	61.06	56.09	67.56	68.27	63.95	45.80/52
Portugal	.	.	.	.	.	2.39	3.72	4.42	3.62	1.07	2.14	2.05	1.53	2.00	2.56	1.40/33
Slovakia	4.95	7.99	5.77	5.42	3.68	3.23	2.78	2.72	3.00	1.52	1.59	1.34	2.12	2.03	3.29	1.98/40
Slovenia	4.09	4.00	4.87	5.75	3.89	3.35	4.07	27.18	27.00	2.67	1.53	1.77	1.30	1.22	7.02	19.70/48
Spain	.	.	.	.	.	14.23	11.53	29.69	18.48	12.56	15.47	13.57	10.68	16.59	15.28	25.98/114
Euro Area	38.23	38.79	37.60	32.44	25.70	28.96	25.08	29.46	23.64	19.03	22.07	20.71	20.69	22.11	24.55	37.27/1 142

Notes: Efficiency score is in percentage; Obs: number of observations; Std.Dev: standard deviation.
Source: Own construction

that Slovenia's banks were inefficient banks in the sample, and it was varying from a low of 0.06% in 2010 to high of 2.34% in 2002.

To be useful for regulatory policy purposes, efficiency measures should be stable over the time. For this purpose, standard deviation was used for dispersion of profit efficiency. The standard deviation of the scores was of 37.27 for the euro area while the minimum standard deviation of profit efficiency sore remained at 1.40 for Portugal, and maximum standard deviation score stood at 45.80 for the Netherlands.

As a result, from both Tables 2 and 3, it can be mentioned that average cost efficiency which estimates for the banks over the sample period was higher than profit efficiency, and the Netherland banking sector was more efficient than others except for 2003. This result suggested that the banks' performance on the cost side was not matched by their ability to generate enough revenues. On the other hand, we found high levels of efficiency in costs and lower levels in profits, verifying the importance of inefficiencies on the revenue side of banking activity. Furthermore, we found the cost efficiency rankings were more stable over the time than profit efficiency according to standard deviation.

In addition, it is observed that over the sample period, both cost and efficiency measures display significant variation and did not archive sustained efficiency gain across the euro area banking sector. This result could be due to changing competitiveness and dynamic environments and new technologies in banking markets. In this case relative changes of efficiency rankings over the time are reasonable. Therefore, in next section, we try to investigate the influence of dynamic environment (at country, market, and bank level) on cost and profit efficiency.

4.3 Bank Efficiency and Environmental Conditions

For implementation of environmental variables (modifying for the environment) in the dynamic efficiency model which is used to avoid bias in efficiency models, two-step procedure was employed. At the first stage, analysis efficiency score obtained in Eurozone during the year 1999 and 2012 by the data envelopment analysis (DEA) was completed. Then, in the second step, GMM estimation was used to regress the measured efficiency on environmental variables. Therefore, in following section, we will present descriptive statistics, correlation matrix of explanatory variables and, finally, baseline regression results of GMM estimator.

In Table 4, the descriptive statistics is presented to analyse and measure the environmental variable into three categories of country level, industry of banking sector and bank specific characteristics. The table shows the mean, standard deviation, minimum, maximum, and number of observations. Mean represents the average value; standard deviation shows the deviation of value from the mean, minimum reports the smallest value of variable, maximum shows the biggest value of variable and number of observations calculated by number of time to cross section ($t \times n$).

The table shows that average cost efficiency is 0.358 with a standard deviation of 0.308 while profit efficiency mean is 0.246 with a standard deviation of 0.373. The population density (POPD) average in the euro area Member States is 207.711 with a standard deviation of 216.805, the minimum and maximum values are 17.16 and 1 302.1, respectively. The economic condition (LGDP) average is 26.842 and standard deviation is 1.843. The ratio of financial deepening (FDEEP) mean is 4.415 and standard deviation is 5.410. The banking activity average (CLAIMS) and bank network extension (BRANCH) average are approximately 1.259 and 85.701, respectively. The profitability (ROE) mean is 0.09 and shows standard deviation value 1.961 with the minimum and maximum values of 17.16 and 1 302.1, respectively, while the loan management activity (LOANTA) varies between 0.001 to 0.96 with a standard deviation of 0.210 and mean of 0.521. Number of observation is 1 124 for all variables that shows that data set is an unbalance panel.

Having estimated the cost and profit efficiency levels for each of the banks in the sample, it is of interest to analyse the factors that may explain the differences in efficiency among the banking

Table 4 Descriptive statistics of country, industry, and bank characteristics variables

Variable (symbol)	Obs	Mean	Std. Dev.	Min	Max
Cost efficiency (*CE*)	1 142	0.358	0.308	0	1
Profit efficiency (*PE*)	1 142	0.246	0.373	0	1
Country level variables					
Population density (*POPD*)	1 142	207.711	216.805	17.165	1
Economic condition (*LGDP*)	1 142	26.842	1.843	302.113	28.754
Financial deepening rate (*FDEEP*)	1 142	4.415	5.410	0.562	31.945
Industry of banking sector					
Banking activity (*CLAIMS*)	1 142	1.259	0.481	0.224	3.021
Bank network extension (*BRANCH*)	1 142	85.701	62.546	4.279	363.924
Bank specific characteristics					
Profitability (*ROE*)	1 142	0.094	1.961	–21.386	53.044
Loan management activity (*LOANTA*)	1 142	0.521	0.210	0.001	0.963

Notes: The independent variables, population density (POPD) calculated as people per sq. km of land area; economic condition (LGDP) calculated as the natural log of the GDP (constant 2005 US$); financial deepening rate (FDEEP) calculated as total bank asset (domestic and foreign bank) to GDP current price; banking activity (CLAIMS) calculated as domestic credit (bank claim) to private sector over the GDP; bank network extension (BRANCH) calculated as number of domestic and foreign branches of credit institutions (per 1 000 km^2); profitability (ROE) calculated as total pre-tax profit over total equity; loan management activity (LOANTA) calculated as total loan over total assets.
Source: Own construction

systems of the Eurozone. The baseline regression results focusing on the relationship between bank cost efficiency and explanatory variables (environmental variables) are presented in Table 5. Several diagnostic tests are made to show that results are warranted. The model performs reasonably well with most of the variables remaining stable across the various regressions tested. We report results for both difference and system GMM estimator for both one-step and two-step version. A lot of applied work using GMM estimator has rather focused on results for the two-step estimator than on one-step estimator. This is partly because in two-step estimation, the standard covariance matrix is robust to panel-specific autocorrelation and heteroscedasticity, but the standard errors are downward biased. Thereupon, in this study we have focused on the two-step estimator which suggested very modest efficiency gain than the one-step version, nevertheless, the one-step estimator was reported in all GMM estimation tables. System panel GMM requires more assumptions (which are employed to generate consistent and efficient parameter) than the first difference panel GMM, but if the assumptions hold, it will achieve a greater efficiency. Therefore, system panel GMM estimations are focused while first difference panel GMM is presented in all tables.

Although, for controlling huge number of instruments which is a real danger of over fitting the endogenous variables when the time period is long, GMM has instructed to use only maximum one lag depth for the endogenous variables as instruments. Furthermore, number of instruments is less than cross-sectional observations (banks) when the rule of thumb is to keep the number of instruments

Table 5 Baseline analysis for effect of country, industry, and bank characteristics on cost efficiency (controlling endogeneity)

Regressors	GMM-DIF One-step	GMM-DIF Two-step	GMM-SYS One-step	GMM-SYS Two-step	GMM-SYS♣ One-step	GMM-SYS♣ Two-step
Initial of cost efficiency (L1)	0.3024***	0.3001***	0.3664***	0.3659***	0.3659***	0.3646***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population density	–0.0024*	–0.0024***	–0.0006***	–0.0006***	–0.0006***	–0.0006***
	(0.091)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Economic condition[1]	0.1411	0.1394***	0.0102***	0.0105***	0.0106***	0.01061***
	(0.243)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Financial deepening rate	0.0039	0.0046***	0.0111***	0.0111***	0.0111***	0.0112***
	(0.577)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Banking activity	–0.0370	–0.0373***	–0.0746***	–0.0744***	–0.0706***	–0.0677***
	(0.349)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bank network extension	0.0052***	0.0053***	0.0025***	0.0025***	0.0025***	0.0025***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	–0.0022	–0.0022***	–0.0011	–0.0012***	–0.0012	–0.0015***
	(0.317)	(0.000)	(0.622)	(0.000)	(0.600)	(0.000)
Loan management activity	–0.0810	0.0797***	–0.1759***	–0.1735***	–0.1800***	–0.1772***
	(0.405)	(0.000)	(0.004)	(0.000)	(0.004)	(0.000)
Sargan test (*p*-value)[2]	0.0001	0.1895	0.0001	0.4902	0.0001	0.4660
Serial correlation test						
AR(1) (*p*-value)[3]	0.0001	0.0006	-	0.0006	-	0.0006
AR(2) (*p*-value)	0.3227	0.2410	-	0.3232	-	0.3090
Wald test for joint significance (*p*-value)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
No. of instruments	96	96	120	120	121	121
Cross-sectional observations	123	123	126	126	126	126

Notes: The independent variables, population density (POPD) calculated as people per sq. km of land area; economic condition (LGDP) calculated as the natural log of the GDP (constant 2005 US$); financial deepening rate (FDEEP) calculated as total bank asset (domestic and foreign bank) to GDP current price; banking activity (CLAIMS) calculated as domestic credit (bank claim) to private sector over the GDP; bank network extension (BRANCH) calculated as number of domestic and foreign branches of credit institutions (per 1 000 km^2); profitability (ROE) calculated as total pre-tax profit over total equity; loan management activity (LOANTA) calculated as total loan over total assets.

♣ The regressions also include time trend variable for the different time periods that are not reported. [1] In the regression, this variable is included as log (variable). [2] The null hypothesis is that model and overidentifying conditions are correct specified. [3] The null hypothesis is that there is no serial correlation in the first-differenced disturbances. Values in parenthesis are *p*-value. ***, **, * indicates significance at 1%, 5% and 10% levels respectively.

Source: Own construction

less than or equal to the number of groups. It should be mentioned that in the baseline estimation, endogeneity problem of economic condition variable (GDP constant 2005 USD) is controlled by the variables which are instrumented with GMM-style instruments, *i.e.* lagged values of the variables in levels. For all the GMM estimation models discussed in the following subsections, the Sargent test (under Sargent thought)[3] for overidentifying restriction, and the Arrelano-bond tests (AR(2)) show that at the 5% significance level, our instruments are appropriately orthogonal to the error and no second-order serial correlation is detected, respectively (see Baum et al., 2010).[4]

The first two columns of Table 5 report the results for GMM-DIF and next two columns report GMM-SYS, respectively. Using the first-differenced GMM estimator in this panel, the coefficient on the lagged dependent variable is only 0.3001, suggesting implausibly low returns to scale. Using the system GMM estimator that exploits the moment conditions, the coefficient on the lagged dependent variable is 0.3659, which is important to speed up the adjustment of error to reach long run equilibrium.

The coefficients of all environmental variables are significant at least at 1% level system panel GMM in two-step version. Hence, macroeconomic, banking industry condition, and bank specific characteristic factors play an important role in determining cost efficiency. In the first set of variables, to capture the potential for retail banking services and its correlation with bank cost efficiency, *population density* variable has a negative sign, indicating that higher population and deposit densities contribute to higher banking costs. One reason can be found in the characteristics of banking competition. In particular, if banks compete by opening more branches for strategic reasons, this creates excessive bank operating costs. The sign of the *real GDP* is positive which shows that whenever development level of the economy is higher; the operating and financial costs are lower. Therefore, countries with a higher real income have a banking system that operates in a mature environment resulting in more competitive interest rates and profit margins. The sign of the coefficient of the *financial deepening ratio* variable is also positive, which suggests that higher level of financial intermediation of banking sector contributes to lower banking costs (*i.e.*, increase in cost efficiency). Therefore, on average a larger volume of financial intermediation through the banking sector can be associated with somewhat higher efficiency levels. This result is in line with the results of Dietsch and Vivas (2000).

A second set of variables was used to capture the banking market structure in specific countries. The sign of the coefficient of *banking activity* variable is negative, which suggests higher amounts of loans per unit of GDP will increase banking costs. The *bank network extension* index is positive, which implies that banks have higher cost efficiency in highly extended bank markets. Therefore, a larger number of banks should indicate a more competitive environment and banking service accessibility, indicating development of banking service could be connected with higher cost efficiency.

The third set of variables representing individual bank characteristics consists of the following variables. The coefficient on *profitability* has an expected negative sign, indicating that higher amounts of profit per unit of equity increase banking costs (*i.e.*, decrease in cost efficiency). In essence, the empirical findings seem to suggest that in case of the euro area banking system, the more profitable banks may not necessarily those which exhibit higher cost efficiency level. The coefficient on *loan management activity* is negative, which is indicating that whenever the loan per unit of asset rate is higher; the banking costs are higher. On the other hand, banks with a higher ratio of loans to assets are found to be less cost efficient.

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[3] The Sargent test is the most common diagnostic utilized in GMM estimation to evaluation the suitability of the model. A rejection of the null hypothesis implies that the instruments are not satisfying the orthogonality condition required for their employment (Baum et al., 2007).

[4] Baum et al. (2010) points out that in a dynamic panel data context, the first order serial correlation could be expected, but the second-order serial correlation should not be detected if the instruments are appropriately uncorrelated with the error term.

The results of first-difference panel GMM in two-step version estimation shows that coefficients of all environmental variables are significant at least at 1% level as like as the system panel GMM with the same sign but different amount of coefficients. Moreover, system panel GMM regression which includes time trend variable was estimated (column 5 and 6), and results are consistent with two-step system GMM regarding sing and level of significance, but the amount of coefficients are different. Although, adjustment speed of lag dependent variable (0.3646) is significant and positive but less amount than two-step system GMM.

The first two columns of Table 6 report the results for first difference panel GMM and next two columns report system panel GMM, respectively. Using the first-differenced GMM estimator in this panel, the coefficient on the lagged dependent variable is only 0.3564, suggesting implausibly low returns to scale. Using the system GMM estimator which exploits the moment conditions, the coefficient on the lagged dependent variable is low (0.4233) and statistically significant. These results suggest that the profit efficiency of the previous year (L1) is significantly and positively related to the efficiency of the current year in both models.

It could be argued that the efficiency of the previous year may represent a certain level of accumulated knowledge and technological endowment that may help banks to generate higher outputs with their inputs by adapting relatively quick to the changes brought by the environmental conditions.

The results of both specification tests, that is AR(2) for testing the serial correlation and the Sargent test for testing the validity of instrument adopted are also valid. As shown in Table 10, the *p*-values for the AR(2) and Sargent tests are higher than 0.10, that is, statistically insignificant at the ten percent significance level. This implies that the empirical model has been correctly specified because there is no serial correlation (autocorrelation) in the transformed residuals, and the instruments (moments conditions) used in the models are valid.

In general, the influence of the environmental variables is in line with our expectations. All of the coefficients on the environmental variables in estimation of the profit efficiency model are significant at the 1% confidence level for first difference and system panel GMM in two-step version. It appears that macroeconomic, banking industry condition and bank specific characteristic factors in the banking sector play a more important role for both profit efficiency and cost efficiency. Therefore, these findings confirm our belief that the environmental variables are an important factor in explaining differences in euro area banking efficiency.

As can be seen in Table 6, in the two-step system GMM estimation, the first group which is called *country level variables* (including population density, economic condition and financial deepening ratio) is positively and statistically significant in influencing the banks' profit efficiency except population density sign. Contrary to expectations, the coefficient of the population density variable has a negative sign. Higher density contributes to an increase in banking costs instead of the expected decrease in costs, causing lower profit efficiency. Two reasons can be found in the characteristics of non-price banking competition. In particular, banks create an excessive bank operating cost when they compete by extending branches for the strategic reasons. Therefore, banks should suffer more cost where real estate is more expensive and salaries are higher for opening branches in large when supplying a given level of services. Real GDP is positively linked with bank profit efficiency. Specifically, a one percentage point increases in the real GDP leads to a contemporaneous increase in banks' profit efficiency by 0.0105 percentage point. This factor is expected to affect the demand and supply of deposits and loans in numerous ways. In particular, the countries with higher real income have a banking system that operates in a mature environment resulting in more competitive interest rates and profit margins. The effect of financial deepening ratio, measured by total bank asset to GDP in a given country, is also statistically significant and positively influence the banks' profit efficiency, indicating that on average a larger volume of financial intermediation through the banking sector can be associated with somewhat higher profit efficiency levels.

Table 6 Baseline analysis for effect of country, industry, and bank characteristics on profit efficiency (controlling endogeneity)

Regressors	GMM-DIF One-step	GMM-DIF Two-step	GMM-SYS One-step	GMM-SYS Two-step	GMM-SYS♣ One-step	GMM-SYS♣ Two-step
Initial of cost efficiency (L1)	0.3565***	0.3564***	0.4226***	0.4233***	0.4182***	0.4175***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population density	–0.0022	–0.0021***	–0.0006***	–0.0006***	–0.0006***	–0.0005***
	(0.250)	(0.000)	(0.005)	(0.000)	(0.005)	(0.000)
Economic condition[1]	–0.5147***	–0.5146***	0.0062**	0.0063***	0.0066**	0.0069***
	(0.001)	(0.000)	(0.018)	(0.000)	(0.015)	(0.000)
Financial deepening rate	0.0185*	0.0184***	0.0090**	0.0088***	0.0093**	0.0086***
	(0.057)	(0.000)	(0.040)	(0.000)	(0.036)	(0.000)
Banking activity	–0.0630	–0.0630***	–0.1075***	–0.1068***	–0.1048***	–0.1041***
	(0.248)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bank network extension	0.0026**	0.0027***	0.0026***	0.0026***	0.0026***	0.0025***
	(0.038)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	–0.0064**	–0.0063***	–0.0057*	–0.0056***	–0.0058*	–0.0057***
	(0.037)	(0.000)	(0.070)	(0.000)	(0.068)	(0.000)
Loan management activity	0.1322	0.1326***	–0.0782	–0.0800***	–0.0850	–0.0891***
	(0.320)	(0.000)	(0.418)	(0.000)	(0.380)	(0.000)
Sargan test (*p*-value)[2]	0.0072	0.3278	0.0001	00.4942	0.0001	0.5090
Serial correlation test						
AR(1) (*p*-value)[3]	0.0001	0.0004	-	0.0003	-	0.0003
AR(2) (*p*-value)	0.5034	0.7047	-	0.4173	-	0.6676
Wald test for joint significance (*p*-value)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
No. of instruments	96	96	120	120	121	121
Cross-sectional observations	123	123	126	126	126	126

Notes: The independent variables, population density (POPD) calculated as people per sq. km of land area; economic condition (LGDP) calculated as the natural log of the GDP (constant 2005 US$); financial deepening rate (FDEEP) calculated as total bank asset (domestic and foreign bank) to GDP current price; banking activity (CLAIMS) calculated as domestic credit (bank claim) to private sector over the GDP; bank network extension (BRANCH) calculated as number of domestic and foreign branches of credit institutions (per 1 000 km^2); profitability (ROE) calculated as total pre-tax profit over total equity; loan management activity (LOANTA) calculated as total loan over total assets.

♣ The regressions also include time trend variable for the different time periods that are not reported. [1] In the regression, this variable is included as log(variable). [2] The null hypothesis is that model and overidentifying conditions are correct specified. [3] The null hypothesis is that there is no serial correlation in the first-differenced disturbances. Values in parenthesis are *p*-value. ***, **, * indicates significance at 1%, 5% and 10% levels respectively.

Source: Own construction

The second group consists of variables, describing the *structure of the banking industry* in specific countries. The sign of the coefficient of loans per unit of GDP ratio or so-called *banking activity* is negative. In essence, the empirical findings seem to suggest that in case of the euro area banking system, the more profit efficient banks may not necessarily be the one which performs in county with high loan per unit of GDP level. The accessibility of banking services for the customers, measured by dividing number of domestic and foreign branches of credit institutions by the number of 1 000 square kilometres, has a positive sign. A higher banking density may favour bank efficiency by making the access to banking products easier for customers. Thus, the higher density of bank branches, the higher is the banking profit efficiency.

The third group consists of variables, describing the bank specific characteristics in specific banks. *Profitability* prove to have a negative influence on profit efficiency, indicating that higher amounts of profit per unit of equity decrease banking profit (*i.e.*, decrease in profit efficiency). The results imply that more profitable banks may not necessarily be those which exhibit higher profit efficiency level. The *loan management activity* also seems to be negatively connected with profit efficiency, indicating that whenever loan per unit of asset rate is higher, the banking profits are lower. The empirical findings seem to suggest that banks with higher ratio of loans to assets are found to be less profit efficient.

The results of first difference panel GMM estimation in the two-step version shows that coefficients of all environmental variables are significant at least at 1% level as like as a system panel GMM with same sign in most cases, but the amount of coefficients is different. The economics condition and loan management activity variables has a different sign from system panel GMM. The sign of real GDP is negative and loan per unit of asset rate is positive which is not consistent with the two-step system GMM estimation. Moreover, the system panel GMM regressions includes estimated time trend variable (column 5 and 6) and the results are consistent with the two-step system GMM regarding the sign and level of significance, but coefficients are different. Although, the adjustment speed of lag dependent variable (0.4175) is significant and positive but less amount than the two-step system GMM.

4.4 Robustness Test

In order to check for the robustness of the results, we have estimated both the cost and profit model with similar regression models but endogeneity problem of economics condition variable has not controlled the model estimation with GMM estimator.

The empirical findings are presented in Tables 7 and 8 seem to suggest a perspicuous relationship between the level of environmental variables and bank efficiency in the euro area countries. Following Arellano and Bond (1991), three additional conditions should be satisfied to avoid model misspecification: a significant AR(1) serial correlation, lack of AR(2) serial correlation and a high Sargan test statistics.

Using the first-differenced GMM estimator in this panel, the coefficients on the lagged cost and profit efficiency variables are only 0.3634 and 0.4145, respectively, suggesting implausibly low returns to scale. Using the system GMM estimator which exploits the moment conditions, the coefficients on the lagged cost and profit efficiency variables are low (0.3871 and 0.4396) and statistically significant. These results suggest that cost and profit efficiency of the previous year (L1) is significantly and positively related to the efficiency of the current year in both models.

It can be observed from both tables that, all in all, the results remain qualitatively similar in terms of directions and significance level. Similar to baseline regression model, the population density, banking activity, profitability, and loan management activity variables have negative association with cost and profit efficiency in system GMM. Although, it can be observed from Tables 7 and 8

Table 7 Robustness analysis for effect of country, industry, and bank characteristics on cost efficiency (dynamic panel estimation)

Regressors	GMM-DIF One-step	GMM-DIF Two-step	GMM-SYS One-step	GMM-SYS Two-step	GMM-SYS♣ One-step	GMM-SYS♣ Two-step
Initial of cost efficiency (L1)	0.3622***	0.3634***	0.3874***	0.3871***	0.3912***	0.3897***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population density	–0.0043***	–0.0039***	–0.0010***	–0.0010***	–0.0010***	–0.0010***
	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Economic condition[1]	0.0130	0.0212	0.0086***	0.0085***	0.0083***	0.0077***
	(0.913)	(0.120)	(0.001)	(0.000)	(0.003)	(0.000)
Financial deepening rate	0.0144**	0.0139***	0.0166***	0.0164***	0.0165***	0.0165***
	(0.046)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Banking activity	–0.0510	–0.0559***	–0.0757**	–0.0777***	–0.0822**	–0.0844***
	(0.247)	(0.000)	(2.04)	(0.000)	(0.032)	(0.000)
Bank network extension	0.0039***	0.0040***	0.0040***	0.0040***	0.0040***	0.0041***
	(0.000)	(0.000)	(6.58)	(0.000)	(0.000)	(0.000)
Profitability	–0.0023	–0.0023***	–0.0021	–0.0013	–0.0021	–0.0016*
	(0.317)	(0.000)	(0.88)	(0.257)	(0.382)	(0.086)
Loan management activity	0.1399	0.1463***	–0.2401***	–0.2378***	–0.2379***	–0.2338***
	(0.167)	(0.000)	(3.44)	(0.000)	(0.001)	(0.000)
Sargan test (*p*-value)[2]	0.0001	0.1236	0.0001	0.087	0.0001	0.076
Serial correlation test						
AR(1) (*p*-value)[3]	0.0001	0.0006	-	0.0005	-	0.0006
AR(2) (*p*-value)	0.351	0.2665	-	0.3015	-	0.3137
Wald test for joint significance (*p*-value)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
No. of instruments	85	85	97	97	98	98
Cross-sectional observations	123	123	126	126	126	126

Notes: The independent variables, population density (POPD) calculated as people per sq. km of land area; economic condition (LGDP) calculated as the natural log of the GDP (constant 2005 US$); financial deepening rate (FDEEP) calculated as total bank asset (domestic and foreign bank) to GDP current price; banking activity (CLAIMS) calculated as domestic credit (bank claim) to private sector over the GDP; bank network extension (BRANCH) calculated as number of domestic and foreign branches of credit institutions (per 1 000 km^2); profitability (ROE) calculated as total pre-tax profit over total equity; loan management activity (LOANTA) calculated as total loan over total assets.

♣ The regressions also include time trend variable for the different time periods that are not reported. [1] In the regression, this variable is included as log (variable). [2] The null hypothesis is that model and overidentifying conditions are correct specified. [3] The null hypothesis is that there is no serial correlation in the first-differenced disturbances. Values in parenthesis are *p*-value. ***, **, * indicates significance at 1%, 5% and 10% levels respectively.

Source: Own construction

Table 8 Robustness analysis for effect of country, industry, and bank characteristics on profit efficiency (dynamic panel estimation)

Regressors	GMM-DIF One-step	GMM-DIF Two-step	GMM-SYS One-step	GMM-SYS Two-step	GMM-SYS♣ One-step	GMM-SYS♣ Two-step
Initial of cost efficiency (L1)	0.4149***	0.4145***	0.4413***	0.4396***	0.4426***	0.4402***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population density	0.0003	0.0003***	–0.0016***	–0.0016***	–0.0017***	–0.0017***
	(0.873)	(0.007)	(0.001)	(0.000)	(0.001)	(0.000)
Economic condition[1]	–0.4316***	–0.4029***	0.0075	0.0071***	0.0068	0.0067***
	(0.010)	(0.000)	(0.155)	(0.000)	(0.197)	(0.000)
Financial deepening rate	0.0182*	0.0173***	0.0074	0.0074***	0.0070	0.0069***
	(0.053)	(0.000)	(0.134)	(0.000)	(0.160)	(0.000)
Banking activity	0.0040	–0.0032	–0.0019	–0.0015	–0.0082	–0.0069***
	(0.947)	(0.419)	(0.968)	(0.432)	(0.865)	(0.007)
Bank network extension	0.0046***	0.0044***	0.0036***	0.0036***	0.0036***	0.0037***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	–0.0074**	–0.0077***	–0.0078**	–0.0073***	–0.0077**	–0.0079***
	(0.021)	(0.000)	(0.018)	(0.000)	(0.019)	(0.000)
Loan management activity	0.0325	0.0304***	–0.0205	–0.0197***	–0.0245	–0.0245***
	(0.813)	(0.000)	(0.867)	(0.000)	(0.842)	(0.000)
Sargan test (*p*-value)[2]	0.0001	0.5254	0.0001	0.2423	0.0001	0.2222
Serial correlation test						
AR(1) (*p*-value)[3]	0.0001	0.0003	-	0.0003	-	0.0003
AR(2) (*p*-value)	0.3227	0.6558	-	0.6567	-	0.7110
Wald test for joint significance (*p*-value)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
No. of instruments	85	85	97	97	98	98
Cross-sectional observations	123	123	126	126	126	126

Notes: The independent variables, population density (POPD) calculated as people per sq. km of land area; economic condition (LGDP) calculated as the natural log of the GDP (constant 2005 US$); financial deepening rate (FDEEP) calculated as total bank asset (domestic and foreign bank) to GDP current price; banking activity (CLAIMS) calculated as domestic credit (bank claim) to private sector over the GDP; bank network extension (BRANCH) calculated as number of domestic and foreign branches of credit institutions (per 1 000 km^2); profitability (ROE) calculated as total pre-tax profit over total equity; loan management activity (LOANTA) calculated as total loan over total assets.

♣ The regressions also include time trend variable for the different time periods that are not reported. [1] In the regression, this variable is included as log (variable). [2] The null hypothesis is that model and overidentifying conditions are correct specified. [3] The null hypothesis is that there is no serial correlation in the first-differenced disturbances. Values in parenthesis are *p*-value. ***, **, * indicates significance at 1%, 5% and 10% levels respectively.

Source: Own construction

that the impact of economic conditions, financial deepening rate and bank network extension are positive on the cost and profit efficiency of banks operating in the euro area countries which is consistence with baseline estimation.

CONCLUSION AND POLICY IMPLICATION

The purpose of the current descriptive and quantitative correlational study was to examine the relationship between environmental variable and level of bank cost and profit efficiency in the euro area. The two-step quantitative research design was employed to accomplish the purpose of the current study: Data Envelopment Analysis (DEA) and panel regression analysis. At the first stage, we estimated the cost and profit efficiency level of entire 126 listed bank dataset for 17-euro area Member States by using the nonparametric DEA approach to investigate whether the cost and profit efficiency of the euro area banking system improved between 1999 and 2012, and to compare the efficiency scores of the financial sectors of the euro area Member States. At the second stage, we regressed the efficiency level obtained from the first stage on factors that could influence the efficiency of banks by using a GMM regression model the period of study. We choose an unbalanced panel rather than a balanced panel, to take banks gone into bankrupt or those being absorbed into account. Indeed, the use of a balanced panel may overestimate cost efficiency as it ignores these banks, which may be less efficient on average.

The average cost efficiency of the banks in the sample has been estimated to be 35.84%, indicating that banks could reduce their costs by 65.12% on average. Reassuringly, evidence on increasing average cost efficiency over the time is found. The study also detected differences in average cost efficiency of banks among countries. The highest average bank efficiency scores were achieved by the three states, the Netherlands, France, and Germany with value of 70.95%, 56.69%, and 48.03%, respectively. The lowest average efficiency scores were obtained for Slovakia, Greece and Portugal, where bank efficiency on average amounted to only 11.12%, 11.23%, and 16.79%, respectively.

Concerning profit efficiency, the average efficiency level is 24.55%, meaning that on average they are 75.45% inefficient in profit. Inefficiency levels show by how much profit (costs) can increase (decrease) if inputs where used as efficiently as the unit located on the best practice frontier. It could be observed that the Netherlands, Germany and France are three highest average profit efficiency members across the euro area during the period of study with 63.95%, 44.58%, and 37.99%, respectively. In comparison, Portugal, Slovakia, and Greece have the lowest average profit efficiency members across the euro area with 2.56%, 3.29%, and 4.52%, respectively. Finally, the empirical results indicate a large asymmetry between countries regarding their profit efficiency level. Although, the evolution of profit efficiency in each country shows that there does not seem to be a clear trend in general. The efficiency scores have been decreasing from starting to ending years in most of the countries in the sample.

This study also investigates the influence the environmental conditions on the cost and profit efficiency of banks operating in the banking industries of the seventeen members from the euro area over the period 1999–2012. In particular, the specific environmental conditions of each country play an important role in the definition and specification of the common frontier of different countries. We formed three groups of variables that are assumed to be associated with changes in efficiency across banks. The first group includes country level variables explaining macroeconomic conditions (population density, economic condition, and financial deepening rate). The second group consists of variables describing the industry of the banking sector in specific countries (banking activity and bank network extension). Finally, variables in the third group describe bank specific characteristics that could determine differences in efficiency levels achieved (profitability and loan management activity). Overall, our results demonstrate that environmental variables contribute significantly to the difference in efficiency scores between the Member States.

As for the first set of variables, a higher population density contributes to lower cost and profit efficiency, most likely due to an increase in bank operating costs. GDP (constant 2005 US$) proved to have a positive influence on cost and profit efficiency, while the effect of financial deepening seems to be positive, indicating that banks in financially more developed markets on average operate at somewhat lower inefficiency levels. Results indicated that higher banking activity, measured by the domestic credit to private sector over the GDP, results in lower average cost and profit efficiency levels. Other banking industry characteristics, namely bank network extension, measured by the number of banks operating in a given country is found to have a significant and positive influence on cost and profit efficiency. Furthermore, the cost and profit efficiency of a given bank was found to be on average negatively related to its banking activity and loan management activity which measured by loan over total assets. The bank profitability indicator, ROE, as expected, turned out to be negatively related to bank efficiency.

For policy implication, bank regulators and management in Slovakia, Greece, and Portugal (as the most inefficient banks), under the condition of a market economy and facing a fiercely competitive banking market, should focus on how to improve management, innovate technology and enhance the quality of employees. The result of this would contribute to improvement of their cost and profit efficiency and their competitive power in the euro area banking market, rather than to enlarging the scale of production and increasing outputs by increasing inputs. In addition, the least inefficient banks could be closed and their resources transferred to the relatively efficient banks, the result of this would be that the euro area banking industry could also improve the cost and profit efficiency and produce more outputs with less resources.

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