ALBANIAN BANKING EFFICIENCY ANALYSIS: A PRODUCTION DEA APPROACH - COMPARISION OF CRS AND VRS MODEL

Erjola BARBULLUSHI (SAKTI)
University of Shkodra "Luigj Gurakuqi", Economic Faculty, Finance-Accounting Department,
Sheshi 2 Prilli, Rektorati, postal code 4001, Shkoder, Albania
esakti@unishk.edu.al
(corresponding author)

Orfea DHUCI
University of Tirana, Faculty of Economy, Finance Department, Rr. Elbasanit, Tirane, Albania
odhuci@alpha.gr

Abstract

For performance evaluation purposes of economic entity one should consider different aspects of its activity. In case of banks this objective is quite difficult since they offer a wide range of services and the activities performed are such complex. Researchers all over the world have adopted different approaches and techniques for bank evaluation from different point of view: from shareholder`s or regulators. From the literature review we cannot observe the most preferred approach implemented for this purpose. Last years the economic models , parametric and non-parametric approaches have gained much interest in the field. In this study we propose a non-parametric approach for bank evaluation known as Data Envelopment Analysis (DEA). Shortly, here in it is presented the DEA background and its development from the original work of Charnes, Cooper and Rhodes (1978), followed by a literature review on the implementation of this approach in the banking sector in the region and more. Third, there are discussed some important issues on adoption of DEA in banking sector followed by its implementation in Albanian Banks for 14 out of 16 banks, for the period from 2006-2013. We found that larger and smaller size banks can be either efficient and the inefficiencies are found also from different capital ownership.

Keywords: efficiency, DEA, production approach, CRS, VRS, Albanian banks
JEL classification: G210

1. Introduction

According to literature review there are two main deterministic approaches for efficiency evalua-tion: parametric and non-parametric. DEA, as a non-parametric approach, is a data oriented model for evaluation of relative efficiency of a set of economic entities called as decision making units (DMU), which convert multiple inputs in multiple outputs (Cooper, Seiford, Zhu:2004). The term DMU is flexible since it was first used for the purpose of implementing DEA approach in different sectors. Then it was used in evaluating the efficiency of profitable and non-profitable entities, government units, educational institutions, study program etc. During the last years, DEA is used in different con-text, countries and purposes due to a few number of constraints which allow a successful implementa-tion.

The first efforts made from Farrel (1957), were followed by the introduction of the linear pro-gramming terms from Rhodes (1966) and Afriat (1972). The final shape of the model was material-ized from Charnes, Cooper and Rhodes (1978), which called the approach Data Envelopment Analy-sis. The basic concept of this approach relates to efficiency evaluation which consist on the opportu-nity to estimate the outputs relative to inputs consumed to realize them.

Through DEA, we can estimate different aspects of efficiency like technical efficiency (TE), allo-cative efficiency (AE), cost efficiency(CE), scale efficiency (SE) etc.

TE represents the input conversion in outputs relative to the best performer of the DMU group. TE changes due to the size of operations known as SE, or due to management practices known as non-SE. AE refers to the situation when in every production level, inputs are used

in that proportions in order to minimize the production costs where the input prices are known.

On the other hand if a DMU operates in circumstances of TE and AE, with a known production level, quality and output mix with minimal costs, in terms of known technological level, it is the case of CE.

In their first model CCR, Charnes, Cooper and Rhodes proposed that the efficiency can be achieved from any DMU if it can maximize the ratio between the weighted outputs relative to its weighted in-puts, subject to the situation where all other DMU`s are evaluated with the same efficiency ratio which can take values from 0 to 1.

This definition was presented in the following form:

ors and x_{2j} = number of nurses used by
;) y_{1j} = number of outpatients and y_{2j} = (1)

ure the efficiency of each DMU once and
each DMU_j to be evaluated. Let the D

y_{rj}, x_{rj}, represent the known outputs and inputs of DMU j, and u_r, $\upsilon_i \geq 0$, are the variables weights that are generated from the solution of the model. This model is known as the Primar Model of DEA. So through DEA we can estimate from a group of **n** DMUs that consume **m** inputs to produce **s** outputs, which is or are more efficient relative to the others. DEA is an approach which is oriented through frontiers and not to central tendencies, identifying in this way the set of efficient DMUs. The other DMUs are compared to the efficient ones. So the relative efficiency score is from 0 to1. The relative efficiency allows us to estimate the efficiency of DMUs also if we do not have information of input prices or variables weights. If the input prices are known than TE can be either developed in terms of AE and PE(price efficiency).

The first improvement to the above models were made by Banker, Charnes and Cooper (1984) referring to the returns to scale. The basic DEA models were developed under constant return to scale (CRS) which means that an increase in the amount of input is followed by the proportional increase in the amount of output. The new DEA model, BCC, was extended to the fact that DMUs perform usually at different return to scale known as variable return to scale (VRS) in either input or output maximization. So in this context, VRS means that an increase in the input amount may decrease or increase the output quantity non – proportionally.

According to Anounze (2010), since models with CRS give the same results, their application is equal if it is expressed in terms of number of studies. On the other hand he states that the CRS model should be used if all the banks operate in optimal operating scale otherwise the VRS model should be used. In banking sector factors like imperfect competition, market concentration, bank regulation etc. affect condition of the operating environment (Wheelock,Whilson:1999).

Avkiran (1999) dhe Noulas (1997) state that the CRS model is more favorable since it allows to compare banks with different size. This model was the base for further improvements. The most important improvements to the basic DEA model, according to Cooper, Seiford, Zhu (2004), Hayes (2005) can be grouped as below:

discrete and non-discrete variable-some variables are important to the analysis and some others not. Some of this variables are under control of management while the others not.

-categorical variables- in some cases variables are not expressed in quantity measures so this should be considered in DEA approach.

-apriority limitations of the weight variables- the basic models are based on the fact that the variables must have zero or positive values.

-relationship between weights of variables-a given amount of output needs a given level of input.

-variable substitution-sometimes is common where different DMUs consume different levels of inputs and realize the same level of output. In this case there is a relationship between the inputs rather than input-output.

Later some other forms of DEA are called “additive” and “multiplicative”, also some modifications are made due to the limitation of the value of variables since all of them have

positive values. The latest forms known as RDM (Radial Measure), SORM (Semi Oriented Radial Measure) and VRM (Variant Radial Measure) consist on the modification of DEA forms considering the new variable values.

2. Literature review

According to Moulynex (1996) for financial bank evaluation the first users of DEA were Sherman and Gold (1985). Seiford (1995) classified about 400 studies till 1995 while Emrouznejad (2008) declared that the publications which adopted DEA were increased about 226 per year for the period 1995-2005 and about 360 per year from 2003-2007. If we refer to the banking sector in 2007 there were about 135 journal published papers (Emrouznejad, 2008). According to Berger and Humphrey (1997), who realized 130 parametric and non-parametric studies in 21 countries, about 75% of the studies werw realized in financial institutions in USA, 20% in other developed countries and only 5% in developing countries like Mexico, India etc.

DEA is implemented also in developing countries from different researchers (Arjomandi,2011). Actual studies in these countries are focused in identifying the inequality between banks with different size and ownership. Among other reasons we can distinguish the developing level of the banking system of these countries, banks may be government owned, or the privatized banks are followed by foreign investments.

According to Arjomandi (2011) there are two main directions that drive bank efficiency evaluation in developing countries: first, in order to evaluate the policy implementation for banks and from banks such as the effect that privatization, market structure and mergers and acquisition between banks can affect their efficiency. Second, DEA is used for efficiency comparison in different time periods.

Casu and Moulynex (2003) realized a study for productivity evaluation purposes in EU banks from 1993-1997, at the time of UMP (Unified Market Programm), to identify if there is a convergence between 750 banks studied. They found that there was little improvement in productivity efficiency except Italy. The differences identified between banks were due to specific aspects of information systems adopted from banks in different countries. As a result the UMP had not given the right results in the period of study.

Hallo and Naggy ( ), realized a study for evaluation of efficiency differences in banks from new EU member countries against banks from older EU member countries. The study was realized in 2459 banks, from 25 EU member countries for the period 1999-2003.

From the study the new member EU countries showed weak X-efficiency and profit efficiency compared to the older member countries.

Other important studies on bank efficiency evaluation that have adopted DEA are; Comanho and Dyson (1999, 2005, 2006), Vujcic and Jeremic (2002), Fiorentino, Karmann and Koetter (2006), Brown (2006), Sherman and Zhu (2006), Sherman and Rupert (2006), Das et al (2007), Pasioras (2007), Noulas et al (2008), Kosmidou and Zopounidis (2008), Tahir et al (2009), Toci (2009), Nitai (2009), Brack and Jomboreon (2009), Havraneck and Irsova (2013), Titko and Jureviciene (2014) etc.

The authors mentioned above have implemented different forms of DEA in their studies.

Finally we can conclude that there are some important opportunities to implement DEA since:

- It is not necessary to define the production function between the variables,
- Through the studies are found relationship between variables that cannot be identified with other methods,
- The variables selected for analysis can be of multiple kinds,
- The variables can be measured in different units,
- The inefficiency source can be measured and analyzed for any DMU,
- It can be used even there are a small number of DMU under study.

On the other hand there are some constraints that limit DEA application or have to be considered carefully during implementation:

- The results are sensitive to the selection of the variables,
- The results cannot be statistically tested,

- With the increase of the number of variables there is the possibility that the number of the efficient units in the frontier increases too. There is a limitation in the number of the variables selected, usually the number of variables should be 1/3 of the DMUs in the sample, (Avkiran, 2010)

3. Data and Methodology

According to Berger and Humphrey (1992) commercial banks represent a service industry for which it is difficult to identify the output, technological change and productivity increase. The variable identification and selection process for DEA implementation purposes in banking sector is still developing. This can be observed from the above mentioned studies.

The process of variable selection- inputs and outputs- is a very important part of performance evaluation. Actually, there are three main approaches for this purpose in banking sector. First, asset approach, known also as intermediation approach (Humphrey, 1985), value added approach known also as production approach and user cost approach. Each of the above approaches is based on the traditional micro economy theory in the banking sector. Their difference consists on the way the banking activities are defined (Kumar, Gulati, 2014).

The production approach, first mentioned by Benston (1965), considers banks as service providers and does not any categorical distinction between inputs and outputs. Outputs are considered the services the banks offer to its clients like number of transactions realized, number of documents filled etc (Kumar, 2014). If this data is not available, then can be used the number of deposit accounts, loan accounts etc., while for inputs one can consider physic variables like labor, number of employees, information systems or their respective costs. This approach focuses on operating costs, avoiding interest and revenue expenses.

Asset approach proposed by Sealey and Lindley (1977), considers banks as intermediary institutions that receives deposits to convert in assets like loans, commercial investments etc. The most important difference between the two approaches is the treatment of deposits. Asset approach considers deposits as input while the production approach as output. Neither of the approaches cannot represent all the functions that a bank fulfills. The production approach was met in studies of Cook, Hebabou and Tueter (2000), Comanho and Dyson (1999,2005,2006), Porembski et al (2005), Sawlati and Paradi (2004), Giokas et al (2008b), Sherman and Zhu (2006) etc.while the asset approach was met in studies of Parkan and Wu (1999), Das et al (2007), Noulas (2008), Giokas (2008a), Athanassopouss and Giokas (2000) etc.

Finally, the user cost approach selects the inputs and outputs according to the net contribution the variable gives to the bank revenues. Hancock (1985) was the first that used this approach in the banking sector in order to determine the weights to alternative assets and liabilities for output index and price output calculation.

For variable selection purposes there is another point of view. Marita and Avkiran (2009) propose statistical experiments to distinguish variables in inputs and outputs. They suggested that inputs should be considered those undesirable variables and vice-versa for outputs. In their study they used external variables as Nikkei Index 500.

Anounze (2010), reviewed 204 studies about bank efficiency from which 109 used DEA forms. He found that about 63% of the studies used asset approach, and 19% of the studies used the combination of asset and production approach. The most interest of this review was that deposits were considered as inputs in 148 studies and outputs in 48 ones[1].

Lou, Bi and Liang (2012), proposed the cash flow added for variable selection. They implemented this form on Chinese banks, using the financial statements data.

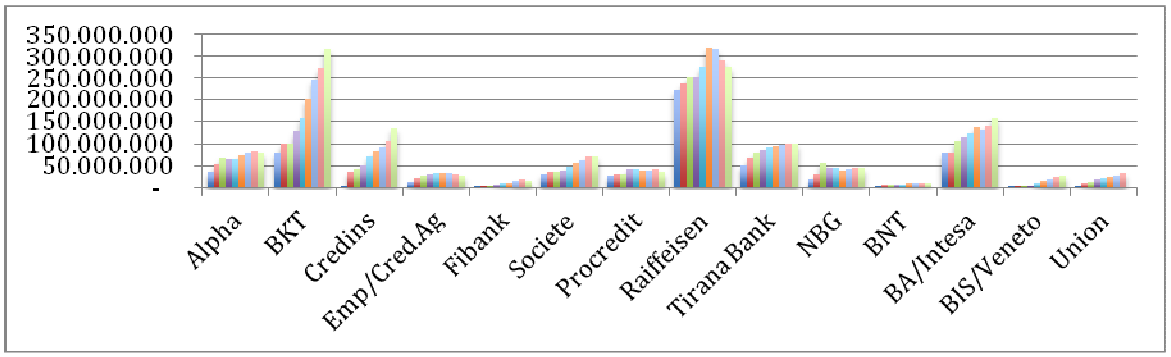
After analyzing the above studies we can conclude that in all the variables considered neither of them reflect the risk inherent in bank activity. So, it is important to include either variables that reflects somehow bank risks.

[1] Abel Anounze (2010), "Evaluating Productive Efficiency.Comperative study of commercial banks in Gulf Countries", PhD thesis, p. 40-65

4. Empirical Analysis

Banking system in Albania is comprised of 16 banks two of which are Islamic banks and are excluded from the analysis. The rest are commercial banks mostly foreign ownership: Alpha Bank Albania, National Commercial Bank (BKT), Credins Bank, Credit Agricole Albania, First Investment Bank, International Commercial Bank (BNT), National Bank of Greece (NBG), Tirana Bank, Procredit Bank, Raiffeisen Bank Albania, Societe Generale Albania, Veneto Bank, Intesa San Paolo (ISP) and Union Bank. Herein is presented the trend of bank activity increase during 2006-2013. BKT and Raiffeisen Bank are the largest banks in the country with Turkish and Austrian ownership respectively, the second group in size may be Alpha Bank, Tirana Bank, Credins Bank and Intesa SanPaolo Bank with Greek ownership (the first two), Albanian and Italian ownership the last. While in the third group we can include Credit Agricole Bank, Societe Generale Bank with French ownership, Procredit Bank with German ownership and NBG with Greek ownership. The last group are the smallest size banks like First Investment Bank, BNT, Veneto and Union Bank.

Graph 1. Assets of banks from 2006-2013 (in ALL)



Source: Author's presentation (Annual Reports)

From the observations we see that until 2011 -2012 there is an expansion in bank activities while at the middle of 2012 and on some banks are restructured or even decreased their coverage in terms of employees, number of branches and capital employed.

Almost the same trend is observed in other variables like number of employees and bank branches.

For this study is chosen the production approach for variable selection purposes. In this context the inputs are: number of employees, number of bank branches and capital (expressed in ALL), while for outputs are considered the deposits (expressed in ALL).

In this way the number of variables (inputs and outputs), fulfill the constraint requirement ($3 + 1 \leq 14 \times 1/3$). The analysis was based on the annual reports of the banks from 2006-2013. For this study we employed the DEA model under VRS and output oriented and CRS output oriented.

These models should be solved in two stages. First by maximizing the output, ignoring slacks or wasted inputs and then optimizing them.

For data analysis is used DEAOS an online software. The descriptive statistics about the sample from 2006-2013 are given in appendix.

In our case n= 14, m=3, s=1 and we are trying to maximize the deposits in order to optimize the usage of inputs selected.

For the period analyzed there are calculated the efficiency scores under constant return to scale and variable return to scale or each of the banks. Also, it is important that before any calculation the data under evaluation are normalized due to differences in size between the banks under study.

Below there are presented the efficiency scores under CRS , output oriented.

Table 2: DEA-score, CRS model-Output oriented

	2006	2007	2008	2009	2010	2011	2012	2013	Av.
BA	100.00%	100.00%	94.81%	76.94%	64.95%	100.00%	84.22%	82.37%	0.879
BKT	100.00%	100.00%	100.00%	100.00%	100.00%	94.85%	100.00%	100.00%	0.994
BK	61.20%	94.86%	87.79%	94.00%	100.00%	74.30%	85.82%	90.93%	0.861
BCA	32.41%	29.36%	27.08%	28.02%	32.38%	27.65%	36.24%	42.38%	0.319
BPI	12.42%	6.72%	16.12%	31.46%	48.97%	43.02%	94.16%	100.00%	0.441
BSG	86.69%	52.80%	70.64%	61.65%	72.15%	68.92%	77.09%	74.56%	0.706
BP	56.91%	61.80%	55.27%	53.16%	70.90%	42.55%	69.85%	63.27%	0.592
BR	100.00%	91.36%	100.00%	89.32%	97.15%	100.00%	100.00%	90.16%	0.960
BT	67.87%	56.68%	58.14%	63.74%	75.57%	75.50%	79.18%	78.41%	0.694
BKG	39.42%	45.16%	40.38%	38.98%	52.30%	59.11%	60.85%	62.05%	0.498
BNT	25.80%	32.91%	28.31%	37.12%	37.43%	38.97%	44.82%	43.21%	0.361
BISP	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.000
BV	17.72%	22.00%	29.08%	27.30%	48.58%	47.85%	56.43%	62.58%	0.389
BU	14.00%	24.24%	62.44%	54.32%	75.39%	41.45%	100.00%	98.52%	0.588
Av	0.5817	0.5842	0.6215	0.6114	0.6970	0.6530	0.7776	0.7775	

Source: Author's calculation

Under normalized data set, we can compare the banks as DMU's, as presented above. From 2006-2013, the banks operate in different efficiency levels. As it can be observed there are calculated the mathematical average efficiency score for each of the banks and the average efficiency score per year of the entire system comprised of 14 banks. The only full efficient bank from 2006-2013 seems to be BISP. If we refer to the same group where BISP is classified, it has better performed than BA, BK and BT. The last three also has distinguished differences since BA is an efficient DMU for three of eight years, followed by BK one of eight, and the last one BT which has never performed at full efficiency. The first group seems to have differences too. BKT and RB are the largest banks in the system so it is expected also to be full efficient banks. As we can see, BKT had a decrease in 2011 but for the rest is efficient, while BR was efficient at half of the period. The largest decline in efficiency is observed in 2009. Since it is a very large bank, BR has significantly a large impact in system's efficiency. Among the small size banks, the one that improved its efficiency rapidly is BU which in 2013 is full efficient and BPI which has improved its position at the last years. On the other hand the rest of the banks has never been full efficient, and their efficiency scores are less than annual average. So, if we rank the banks for the entire period according to their average scores, BISP is followed by BKT, BR, BA, BK, BSG, BT, BP, BU, BKG, BPI, BV, BNT, BCA.

Table 3: Average bank efficiency scores for 2006-2013

DMU	Ranking	Group	Ownership	DMU	Ranking	Group	Ownership
BISP	1	2	Italy	BP	8	3	Germany
BKT	2	1	Turkey	BU	9	4	Albania
BR	3	1	Austria	BKG	10	3	Greece
BA	4	2	Greece	BPI	11	4	Bulgaria
BK	5	2	Albania	BV	12	4	Italy
BSG	6	3	France	BNT	13	4	Malaysia
BT	7	2	Greece	BCA	14	3	France

Source: Author's calculation

In the summary above it is obvious that large size banks are more efficient than small size ones, since the five first ranked are banks from the first and the second group. Relating to ownership of capital, there is not a clear result since Greek banks seems to be in the top five like BA, in the seventh rank like BT and in tenth rank like BKG. So differences in average efficiency may be due to the size, industry focus and practices from banks.

Another point of view of the CRS model, which is as important as the one described above, is the average annual efficiency score for the entire system. The annual average presented above, for each of the eight years, is not at optimal levels. It shows a light improvement on time, from 0.58 in 2006 to 0.77 in 2013. The efficiency frontier is made up from four banks in 2006 (BA, BKT, BR, BISP) and 2012(BKT, BR, BISP,BU), while for the rest of the period the number is smaller. It is interesting that among the largest full efficient in 2012 is at the same frontier one of the smallest size banks, BU. Even there are efficient banks in either of the years, the number of efficient banks is smaller compared to the inefficient ones. So, it must be considered the entire system performance, focusing on non-performing banks which would need more attention from stakeholders.

The second model chosen for bank efficiency analyze for the same period and data set, is VRS model –output oriented.

Table 4: DEA-score, VRS model-Output oriented

	2006	2007	2008	2009	2010	2011	2012	2013	Av
BA	100.00%	100.00%	99.77%	80.45%	100.00%	100.00%	88.00%	84.89%	0.941
BKT	100.00%	100.00%	100.00%	100.00%	100.00%	98.98%	100.00%	100.00%	0.999
BK	61.22%	100.00%	100.00%	100.00%	100.00%	75.47%	85.93%	92.44%	0.894
BCA	44.03%	35.27%	32.45%	32.51%	37.16%	31.47%	41.17%	44.28%	0.373
BPI	28.46%	24.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.817
BSG	100.00%	54.02%	77.98%	68.17%	78.65%	72.10%	85.96%	78.74%	0.770
BP	71.58%	63.99%	60.29%	55.15%	71.55%	43.37%	69.88%	66.91%	0.628
BR	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.000
BT	71.63%	60.98%	58.20%	64.46%	76.38%	76.72%	80.63%	79.74%	0.711
BKG	48.89%	50.10%	45.80%	41.72%	56.00%	66.57%	69.01%	68.63%	0.558
BNT	62.85%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.954
BISP	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.000
BV	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.000
BU	37.44%	37.28%	100.00%	91.77%	90.09%	45.49%	100.00%	100.00%	0.753
Av	0.733	0.733	0.839	0.810	0.864	0.793	0.872	0.868	

Source: Author's calculation

From the table above, it is quite clear that the efficiency scores are higher under VRS compared to CRS. On average for the entire period there are three full three efficient banks: BR, BISP (the same as under CRS), and BV followed by BKT, BNT, BA, BK, BPI, BSG, BU, BT, BP, BKG and BCA.

Table 5: Average bank efficiency scores for 2006-2013

DMU	Ranking	Group	Ownership	DMU	Ranking	Group	Ownership
BR	1	1	Austria	BPI	6	4	Bulgaria
BISP	1	2	Italy	BSG	7	3	France
BV	1	4	Italy	BU	8	4	Albania
BKT	2	1	Turkey	BT	9	3	Greece
BNT	3	4	Malaysia	BP	10	3	Germany
BA	4	2	Greece	BKG	11	3	Greece
BK	5	2	Albania	BCA	12	3	France

Source: Author's calculation

As we can see from the summary of the efficient banks and the frequencies per year part of the reference set presented in the table, it is obvious that the most stable bank is Raiffeisen Bank since it is full efficient through the entire period. On the other hand, Raiffeisen Bank was a benchmark to 8 of 14 banks in 2006, that means that 8 inefficient banks could be able to reach Raiffeisen Bank standarts at that time. After 2006, this bank cannot be a benchmark to a large number of banks, diminishing from 8 to 2 and 1 till 2013, which means that it expanded efficiently its activity larger than other banks in the group analysed, that's why its results can be reachable only from one bank (Tirana Bank). The same things almost can be stated for ISP and BKT while they seem to be more stable relating to reference set.

Another interesting result of this analysis, are the small size banks that seem to be efficient. Veneto Bank and BNT Bank are efficient almost all the time.

It is obvious that some banks like Procredit Bank, Tirana Bank, NBG Bank does not appear as efficient neither of the years studied. Even some banks that appear efficient sometimes have expanded earlier to their capacities do operate in those conditions, resulting to inefficiencies.

From the results, we observed that in order to maximize the deposits, the inefficient banks should reduce the number of employees and the number of branches as the result may be better through their efficient usage.

If we see from another point of view the inefficient banks, considering their origin of capital we can state that Greek banks are inefficient except Alpha Bank in four from eight years of study. Second French banks like Societe Generale and Credit Agricole are mentioned only one time each representing the same position as the Greek ones mentioned above. Italian banks are efficient all the time: the only Albanian bank, Credins is efficient from 2007-2010, that means that even it is expanded recent years it could not keep the optimal input usage. Another important comparison holds for Procredit and Raiffeisen Bank. They are of different size but the first has not ever performed in efficient conditions and the second was always efficient. So, it is obvious that the banks under analysis differ in size, ownership and infrastructure, but that is important to be emphasized is that some of them gained and maintained the efficient position and some other not. This does not happen due to the size but especially to the capacities engaged in management and day to day operations.

5. Conclusions

To conclude this study, first we made an introduction of Data Envelopment Analysis as a non-parametric approach, followed by a literature review on banking context application. In this way we tried to apply this approach in Albanian Banking System. For this purpose the model selected is the first attempt to understand from another point of view bank activities and their efficiency.

Since Albanian banking System is a new one, as after ’90 it was organized in a two tier banking system, the opportunity to enter in Albanian Financial Market was greater from foreign banks. In this context after 25 years of development, now its time to see how efficient they are.

From this study we conclude that efficient banks are from different size; the first group banks are efficient all the time except BKT in 2011 with light decline in 98.8%; the second group banks have much differences since Tirana Bank has never operated efficiently while Intesa SanPaolo Bank was always efficient, so their difference may be affected from the country’s origin of capital in this case Greece; also in the third group French banks are inefficient followed by the fourth group while the last one seems to have differences too. Veneto Bank is efficient at all the time, followed by First Invest-ment and Union. Due to the differences found in the banks analyzed the interested parties should go further or deeper analysis of the banks itself, analyzing the individual bank branch efficiency. This may generate more accurate and interesting results.

References

Afriat, S.N., (1972), "Efficiency Estimation of Production Functions", International Economic Review, Vol. 13 (3): 556-598.

Anounze, A., (2010), "Evaluating Productive Efficiency.Comperative study of comercial banks in Gulf Countries", PhD thesis, p. 40-65.

Arjomandi, A., Efficiency and productivity in Iran's financial institutions, Doctor of Philosophy thesis, School of Economics, Faculty of Commerce, University of Wollongong, 2011.

Avkiran, N., (2006), "Productivity Analysis of Service Sector with Data Envelopment Analysis", 3rd.edition, N.K.Avkiran.

Banker, R.D., Charnes, A., Cooper, W.W, (1984), "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis," Management Science, Vol.30(9), 1078-1092.

Banker, R. D, Cooper, W. W, Seiford, L. M, Thrall, R. M and Zhu, J., (2004), ―Returns to Scale in Different DEA Models‖, European Journal of Operational Research, Vol. 154(2):345-62.

Berger, A. N., & Humphrey, D. B. (1992). "Measurement and Efficiency Issues in Commercial Banking In: Output Measurement in the Service Sectors". Retrieved from RePEc.

Berger, A., N., Humphrey, D.,B., (1997), "Measurement and Efficiency Issues in Commercial Banking". National Bureau of Economic Research. Output Measurement in the Service Sectors . University of Chicago Press: 245 - 300).

Brown, R. (2006), "Mismanagement or mismeasurement? Pitfalls and protocols for DEA studies in the financial services sector", European Journal of Operational Research, Vol.174:1100-1116.

Charnes, A., Cooper, W., Rhodes, E. (1978), " Measuring the efficiency of decision making units", European Journal of Operational Research,Vol. 2:429-444.

Coelli, T. (1996). A Guide to DEAP Version 2.1, A Data Envelopment Analysis (Computer) Program, CEPA Working Paper 96/07.

Coelli, T., Rao, D.S.P. and Battese, G.E. (1998). An introduction to efficiency and productivity analysis. Dordrecht: Kluwer Academic Publishers.

Cooper. W.W., Seiford, L., Zhu, J.,(2004), Handbook on Data Envelopment Anlysis, Kluwer Academic Publishers, Norwall, MA.

Casu,B., Molyneux, P.,(2003), "A Comprehensive Study of Efficiency in European Banking, Applied Economics, Vol.35 (17):1865-1876.

Camanho, A.S., Dyson R.G., (1999), "Efficiency, Size, Benchmarks and targets for bank branches: an application of data envelopment analysis",Journal of Operations Research Society, Vol. 50:903–915.

Comanho, A.S., Dyson, R.G., (2006), "Data envelopment analysis and Malmquist indices for measureing group performance", Journal of Productivity Analysis, Vol.26: 39-45.

Das, A., Ghosh,S., (2006), "Financial deregulation and efficiency: An empirical analysis of Indian banks during the post reform period", Review of Financial Economics, Vol.15 (3):197-199.

Emrouznejad, A., Parker, B.R., Tavares,G.,(2008), "Evaluation of research in efficiency and productivity: A survey and analysis of the first 30 years of scholarly literature in DEA, .

Farell, M.J., (1957), " The Measurement of Productive Efficiency", Journal of Royal Statistical Society, Vol.120 (3):253-290.

Fiorentino E, Karmann A, and Koetter M.,(2006), "The cost efficiency of German banks: a compareson of SFA and DEA", Discussion Paper Series 2: Banking and Financial Studies, 10, Deutsche Bundesbank.

Hallo, D., Nagy, M. ( ), "Bank Efficiency in the Enlarged European Union", BIS Papers, No.28.

Hancock, D., (1985),"Bank Profitability, Interest Rates, and Monetary Policy". Journal of Money, Credit, and Banking Vol.14:179-92.

Lou, Y., Bi, G., Liang, L. (2012), "Input/output indicator selection for DEA efficiency evaluation: An empirical study of Chinese commercial banks Expert Systems with Applications". Vol 39(1):1118-1123.

Marita,H., Avkiran, N.K (2009), "Selecting Inputs and Outputs in Data Envelopment Analysis by Designing Statistical Experiments". Journal of Operations Research Society of Japan,Vol 52(2):163-173.

Molyneux, P., et al (1996), "Efficiency in European Banking", Chichester, UK: John Wiley and Sons

Noulas, A.,(1997), "Productivity Growth in Hellenic Banking Industry: state versus private banks", Applied Financial Economics, Vol 7(3): 223-228.

Kumar,S., Gulati, R.,(2014), "Deregulation and Efficiency of Indian Banks" , Springer

Kosmidou,K., Zopounidis, C (2008), "Measurement of Bank Performance in Greece". Southern Eastern Europe Journal of Economies.Vol 1:79-95

Sealey, C., Lindley, J.T., 1977. Inputs, outputs and a theory of production and cost at depository financial institution. Journal of Finance Vol.32:1251-1266.

Seiford, L., (1996), "Data Envelopment Analysis:The Evolution of the State of the Art (1978-1995), Journal of Productivity Analysis, Vol. 7: 99-137.

Sherman, H. D.; Zhu, J. (2006): Service Productivity Management - Improving Service Performance using Data Envelopment Analysis (DEA). New York: Springer.

Sherman, H. D. and T.J. Rupert (2006), "Do bank mergers have hidden or foregone value? Realized and unrealized operating synergies in one bank merger", European Journal of Operational Research, Vol.168:253-68.

Thanassoulis, E.,(2003), "Introduction to the Theory and Application of Data Envelopment Analysis: a foundation text with integrated software, 2nd edition, Kluwer Academic Publishers.

Titko, J., Jureviciene, D., (2014), "DEA Application at Cross-Country Benchmaking: Latvian versus Lithuanian Banking Sector", Contermporary Issues in Business Management and Education, Social and Behavioral Sciences, Vol. 110:1124-1135.

Vujcic,B., Jeremic, I., (2002), "Efficiency of Banks in Transition: DEA Approach", Current Issues in Emerging Market Economies, National Croatian Bank.

Wheelock, D.C., Whilson, P.W., (1999), "Technical Progress, Inefficiency and Productivity Change in US Banking", Journal of Money, Credit and Banking, Vol.31(2): 212-234.