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BANK SIZE AND EFFICIENCY IN DEVELOPING COUNTRIES: INTERMEDIATION APPROACH VERSUS VALUE ADDED APPROACH AND IMPACT OF NON-TRADITIONAL ACTIVITIES

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ABSTRACT

Following the using a panel of 402 commercial banks from 15 developing countries over the period between 2000-2003 period, we assess the effect of bank size on technical efficiency and its two components: pure technical and scale efficiencies. We use in this study data envelopment approach (DEA) under specifications that allow the examination of the impact on results of the choice to measure banking activities with an intermediation or a value added approach, and of course a test for the relevance of including non traditional activities. Results indicate that examined banks suffer from serious problems of technical inefficiency involving a total average waste of resources that exceeds 46% of their actually levels. This inefficiency is mainly due to pure technical inefficiency for all size of banks except the largest banks for which we found high levels of scale inefficiency. The conducted test results show that the models with and without non-traditional activities are equivalent in terms of overall technical efficiency for banks of all size classes except for those of the smallest size. However, it is proved by these tests that the choice of an intermediation or a value added approach for measuring banking activity can significantly influence the generated average levels of technical efficiency for all bank sizes, but scale efficiency estimates appeared to be less sensitive to this choice.

Keywords: Size, technical efficiency, bank performance, developing countries.

INTRODUCTION

In the last two decades, a vast movement of concentration and restructuring of the banking sector has characterized almost all developed countries and many developing countries. In this field, merger operations of banks supported by economic policy makers and managers of banks have imposed a new scale of size-based banks. They constitute a specific response to the decrease in profitability charged by firms on traditional intermediation activities and the erosion of their charter values induced by deregulation and increased competition from both banking and non-banking institutions. Also, there is an obligation for banks to grow at the same rate as large companies they are funding. But more importantly, it is expected that through these acquisitions – mergers, banks will be able to achieve better cost structures benefiting from economies of scale and scope provided by their size and therefore improving the efficiency of their production. Better banking sector efficiency will have its impact on the economic well-being and social development of any country through improved profitability, greater amounts of intermediated funds, better prices and quality of services offered to clients and increased financial system's strength and stability.

Despite these opportunities theoretically related to the increasing of banks size and the shift towards more concentrated structures, the empirical literature does not seem to reach a consensus in the empirical validation attempts. Indeed, if we consider the benefits of size in terms of economies of scale, we note that the majority of studies have led to estimated cost functions with U-shaped profile. They are decreasing with size up to a certain value of total assets and unit costs rise beyond this level, indicating that medium-sized banks are more scale efficient than large and small banks (Berger *et al.*, 1987; Noulas *et al.*, 1990; Mester, 1992; Clark, 1996). However, more recent literature has identified some empirical evidence on the existence of scale economies in banking. For example, Hughes *et al.* (2001) found economies of scale that increase with the size of examined banks, once their risk-taking and capital structure are controlled for in the bank production function. Wheelock and Wilson (2009) and Feng and Serlitis (2010) highlighted the existence of economies of scale in U.S. banks. Moreover, it is worth noting that despite the rising importance given to the evaluation of bank efficiency and the proliferation of empirical investigations carried out on the banking sectors of several countries, it was found by many researches such as Berger and Humphrey (1997) and Staikouras *et al.* (2008), that developed countries have received the most attention in this area and the empirical evidence is still limited for banks belonging to developing countries. In this context, this paper provides useful empirical evidence on the cost structure and production efficiency of commercial banks in developing countries and on the existence of systematic difference in bank performance that is explained by size differences. Moreover, it is noted that despite the significant development of studies attempting to assess the efficiency and productivity in the banking industry, a major problem remains and lets their results difficult to compare and concerns the definition of bank inputs and outputs. Mlima and Hjalmarsson (2002) have shown that efficiency scores in the banking industry are very sensitive to the choice of variable inputs and outputs. Thus, the proposed empirical approach adopted in this paper will allow a comparison and discussion of results in different approaches to measuring banking activity.

Empirical evidence provided in the present study focusing on efficiency of commercial banks in developing countries will allow particularly assessing the situation of banks from these countries in the new competitive environment imposed by national and international competition. Moreover, the decomposition of the overall efficiency of banks orientates corrective actions of banking managers to the most important sources of inefficiency. Finally, in examining the possible differences in production performance of banks according to their size, it is possible to determine the size of banks associated with better performance indices and therefore guide banks managers and policy makers towards the best strategies and policy restructuring.

The rest of the paper will be organized as follow. In the second section, we will present a review of related literature about the relationship between size and performance in banking and the treatment in efficiency studies of deposits and non traditional activities in the measure of banking activity. The third section of the document will be devoted to the description of the empirical methodology of the research. The results of its application on our data will be presented and their implications discussed in the fourth section. Finally, we will conclude in section five.

RELATED LITERATURE

Size and Efficiency in Banking

Literature aiming to generate empirical evidence on the potential impact and significance of size on measured efficiency of banks yields no consensus. The results are subtle and sometimes ambiguous about the direction of the possible effect. Intuitively, we can expect a positive relationship arising from the fact that larger banks are more able to develop technical, financial, human and material resources enhancing their efficiency. In a reverse direction, since agency, coordination and dysfunction problems, are more accentuated in greater firms, we can expect smaller banks to generate inefficiency scores lower than those of larger banks. A majority of studies have led to functions of estimated average cost with U-shaped profile. They are decreasing with size up to a certain value of total assets and unit costs rise beyond this level, indicating that it is the medium-sized banks that seem to have a more efficient scale than large and small banks (Berger *et al.*, 1987; Noulas *et al.*, 1990; Mester, 1992; Clark, 1996). But, we notice that more recent literature has identified some empirical evidence on the existence of economies of scale in banking. For example, Hughes *et al.* (2001) found for examined banks economies of scale that increase with size, once the risk-taking and capital structure are controlled for in the bank production function. Feng and Serlitis (2010) and Wheelock and Wilson (2009) also highlighted the existence of economies of scale in U.S. banks. Moreover, the study of Drake and Hall (2003) provides empirical evidence on the existence of a strong relationship between bank size and technical efficiency and scale efficiency in Japan. In addition, Mitchell and Onvural (1996) leads to the result of a lack of inefficiency for large American banks retained. Miller and Noulas (1996) arrived to establish a significant positive correlation between the size and pure technical efficiency of banks. The largest banks have appeared to be relatively more efficient in the study of Hasan and Marton (2003) on Hungarian banks. A positive relationship between the size and the overall efficiency of banks was also found for Australian banks by Sathye (2001). Also, he also has established that technical inefficiency is more important as source of overall inefficiency than allocative component. On Turkish banks, Isik and Hassan (2002) have arrived to similar results about the dominance of technical inefficiency, but the relationship between size and efficiency has emerged strongly negative.

According to Berger and Mester (1997), larger banks have shown a slightly higher efficiency than small ones, when they considered efficiency on the cost side. But in terms of profit efficiency, smaller banking firms appeared more efficient. All, these results indicate that when banks increase in size, they are more able to control their costs, but it becomes difficult for them to be efficient in creating income and generate profit. On Indian banks, Srivastava (1999) found higher average efficiencies for medium-sized banks, followed by large banks. Small banks appeared the less efficient, which show that relationship between size and efficiency isn't positively monotonic. In contrast, in the study of Allen and Rai (1996), the largest banks have been marked by higher levels of inefficiency for the majority of the 15 countries studied. Also, for a sample of banks from 11 European countries, Goldberg and Rai (1996) suggest that larger banks did not show higher efficiencies. However, no clear relationship between estimated efficiencies and size has been proved by Fukuyama (1993) and Altunbas *et al.* (2000) for Japanese banks, and by Lang and Welzel (1996) for German cooperative banks.

Measuring Bank Activity: Are Deposits Input or Output?

A major problem arising while measuring banks' activity is about the treatment o deposits. It was pointed out by Wykoff (1992) as follows: "When deposits are outputs, why are they so cheap? When they are inputs, why do people provide them to banks? "(p. 12)

According to the intermediation approach, taking into account the asset transformation function, we assume that the bank uses deposits as well as other purchased inputs to produce different categories of bank assets such as loans and investments, measured by their monetary values. In this case, bank costs include the interest paid on borrowed funds as additional input with operational costs (costs of physical factors). Among studies adopting this approach, we can cite Kim (1986), Fukuyama (1993), Zaim (1995), Vennet (1996), Bhattacharaya *et al.* (1997) and Chaffai (1997). Indeed. This approach is a reduced form of modeling the banking activity which focuses exclusively on the role of banks as financial intermediaries between depositors and final users of banking assets. From this perspective, deposits and other liabilities, in addition to real resources (labor and capital) are defined as inputs, while outputs include only assets such as bank loans

However, other currents of thought (including value-added and user cost approaches) suggest that deposits should be considered as output since they constitute elements on which the customers bear opportunity costs and they participate in the value added creation. Indeed, according to the user cost approach, we can determine whether a financial product is an input or an output depending on its net contribution to banking income. If the financial performance of an asset exceeds the opportunity cost of funds, or alternatively if the financial cost of a liability is less than the opportunity cost, they are considered as outputs, in other cases, they are considered as inputs (Hancock, 1985). In the value added approach, we identify the categories of bank balance sheet (assets and liabilities) as outputs by their contribution to the value or because they are associated with the consumption of real resources (Berger *et al.*, 1987). Considering that banks provide two main categories of financial services: intermediation and credit services on one hand, and care, payment and cash on the other hand, in the value added approach, deposits are considered as input and output at the same time. Thus, under this approach, the major categories of deposit products (demand, savings and term deposits) and credits are considered as outputs because they are responsible for a significant proportion of the value added. Among the studies using this approach we find Carvallo and Kasman (2005), Sathye (2001), Dietsch and Lozano (2000) and Lozano *et al.* (2002).

Non Traditional Activities of Banks

It should be noted that banks around the world have diversified away from traditional financial intermediation activities in the off-balance sheet and fees and commissions generating activities. Thus, it may be inappropriate to focus exclusively on traditional remunerative assets and neglect an important part of modern banking operations. Therefore, several recent studies have included additional output variables to capture the non-traditional activities and operations of banks. In the literature, two types of measures were used to capture these non-traditional activities one measure is in flow terms (the non-interest income), and other measures are expressed in terms of stocks (off-balance sheet items in nominal or weighted for risk values). Indeed, although the off balance sheet items are not technically paying assets, they constitute a growing source of bank income (Hakimi *et al.*, 2012) and should therefore be included in attempts to model the characteristics of bank costs in order not to have a total output that is under-determined (Jagtiani and Khanthavit, 1996; Altunbas *et al.*, 2000; Altunbas *et al.*, 2001). Isik and Hassan (2003) showed that the exclusion of off-balance sheet elements from the production bank specifications led to a significant deterioration in efficiency scores and average productivity of the entire industry. According to these authors, the extent of bias is more pronounced among the banks most involved in nontraditional activities, for which the deteriorating levels of efficiency is more important.

Berger and Mester (1997) consider that off-balance sheet items should be included because they are effective substitutes for direct lending and can be a source of comparable income. Also, they require similar costs to gather information for initialization and for subsequent monitoring and control. Similarly, according to Isik and Hassan (2002), off-balance sheet items are comparable to credits in terms of risk and income. But, since the of off-balance sheet activities are generally four or five times greater than the balance sheet items, their inclusion in efficiency models in notional values can cause a bias. Therefore, in many studies such as those of Akhigbe and McNulty (2003), Berger and De Young (1997), Cuesta and Orea (2002), De Young and Hasan (1998), Drake and Hall (2003), Hasan and Marton (2003), Lang and Welzel (1996), Resti (1997), Stiroh (2000) and Vennet (2002), researchers used non-interest income (measured by total of revenues from net commissions and fees, and other non-interest operating revenues), as a variable approximating for non traditional bank operations. Moreover, Vennet (2002), Cuesta and Orea (2002) and Rogers (1998) highly recommend the inclusion of this variable as a non-traditional banking output and suggest that traditional specifications tend to underestimate the measured efficiency of banks.

METHODOLOGY

To measure the efficiency of commercial banks in our sample, we adopt Data Envelopment Approach. The main advantage of this method is that it does not require a priori knowledge of the functional form of the production function and the structure of error terms or inefficiency (Avkiran, 1999; Wheelock and Wilson, 1999; Sathye, 2001; Lozano *et al.*, 2002; Isik and Hassan, 2003; Obafemi, 2012). However, it has the disadvantage of not taking into account the existence of measurement errors or data.

DEA is a nonparametric technique for measuring efficiency that is extremely flexible in modeling the production technology of a sample in a multi-inputs and multi-outputs framework. It doesn't impose a functional form or an error structure on data and uses linear programming to construct a production frontier with a linear convex form. This frontier envelops the data so that no observed point is situated on the left or below it. Thus, the DEA frontier is the set of efficient observations ensuring that no unit or linear combination of production units can use less input to produce the same amount of outputs, or can generate more outputs without altering the quantities of used inputs. DEA oriented in input allows us to determine the inputs saving that can be achieved for each unit of the sample if it was as efficient as the firm of best practices (ie located on the frontier).

Data Envelopment Analysis Approach (DEA)

Measuring efficiency by frontier estimation is due to the work of Farrell (1957) proposing to define simple measures of firms' efficiency which take into account multiple inputs cases. DEA in its current form was originally introduced in 1978 by Charnes, Cooper and Rhodes who proposed a model oriented in inputs and assumes constant returns to scale. Several subsequent studies have considered various alternative hypotheses including the assumption of variable returns to scale suggested by Banker *et al.* (1984). In the model of Charnes *et al.* (1978), with an inputs oriented view, the construction of an efficiency frontier from a set of observations leads to solving a sequence of linear programs. In fact, for each of the n firms (or observations), this program is:

$$K(x, y) = \underset{\theta, z}{Min} \qquad (1)$$

Subject to

$$y \leq z.Y$$

$$\theta\, x \geq z.X$$

$$z = (z_1, z_2, \ldots, z_n) \geq (0,0,\ldots,0)$$

where y = $(y_1, y_2, \ldots, y_q)$ is the row vector of observed outputs produced by a particular firm, and x = $(x_1, x_2, \ldots, x_p)$ is the row vector of inputs used by the firm. The $(n \times q)$ matrix of observed inputs for all firms is denoted Y. The $(n \times p)$ matrix of observed inputs for all firms is denoted by X. K (x, y) indicates the overall technical efficiency of the i^{th} firm as measured by the obtained value of.θ. Here θ indicates the fraction by which a firm can contract its inputs while continuing to produce outputs in quantities of at least equal to current levels. θ must be less than or equal to unity, with a value of 1 indicating a firm located on the efficiency frontier and therefore is technically efficient. z is a vector of intensity weights attached to each of the n observations. Coelli *et al.* (2005) suggest that the production technology associated with the program (1) can define according to Färe *et al.* (1994) a closed and convex set of production which admits constant returns to scale and strong disposability of inputs. The alteration of the constraint on the intensity vector z can permit to build production frontiers that satisfy various assumptions such as variable returns to scale found in the model of Banker *et al.* (1984). The following linear programming problem has to be solved in the case of variable returns to scale and leads to pure technical efficiency scores:

$$T(x,y) = \underset{\theta, z}{Min} \qquad (2)$$

Subject to

$$y \leq z.Y$$

$$\theta\, x \geq z.X$$

$$\sum_{i=1}^{n} z_i = 1$$

$$z = (z_1, z_2, \ldots, z_n) \geq (0,0,\ldots,0)$$

where T (x, y) is a measure of pure technical efficiency, other variables are defined as in equation (1). For a given firm, if there is a difference between the efficiency score obtained with constant returns to scale assumption and that obtained with variable returns to scale assumption, this difference will be due to scale inefficiency of the firm. The scale efficiency is measured by the ratio of linear programming problems with and without the constraint of constant returns to scale, and is written as follows:

$$S(x,y)=\frac{K(x,y)}{T(x,y)} \quad (3)$$

And so:

$$K(x,y)=S(x,y).T(x,y) \quad (4)$$

The overall technical efficiency is therefore partly due to scale efficiency of and partly to pure technical efficiency. A value of S (x, y) equal to unity would indicate scale efficiency.

Data

The sample included in this study is composed of 402 commercial banks belonging to 15 developing countries over the period 2000-2003, making a total of 1608 bank-observations. All data used on individual banks are obtained from Bankscope, a financial database distributed by IBCA - Bureau Van Dijk. For this sample, all monetary values are expressed in U.S. dollars and were reduced to constant 2000 prices using the GDP deflator relative to each country as published in The International Financial Statistics. Our sample is divided according to the average total assets criterion in four size classes. In this subdivision, we have considered a representative number of observations for each of the four following size classes:

Class1: Very small banks: Banks with total average assets less than 300 million U.S. dollars.
Class 2: Small banks: Banks with total average assets between $ 300 millions and $ 1.3 billions of U.S. dollars;
Class 3: Medium sized Banks: Banks with total average assets between 1.3 billion and 5 billions of U.S. dollars;
Class 4: Large banks: Banks with total average assets greater than 5 billions of U.S. dollars.

Table (1) provides a description of our sample's observations classified by country and size class. All size classes are almost equally represented in our sample, which eliminates any bias in the results from the dominance of one class by another.

Table-1. Observations by country and by size class

Size classes	***Total number of observations***	***South Africa***	***Argentina***	***Brazil***	***Chili***	***South of Korea***	***Arab Unite Emirates***	***India***
Class 1	416	28	112	80	24	0	0	12
Class 2	424	8	44	104	12	0	28	56
Class 3	376	4	24	44	28	0	8	76

Class 4	392	16	20	56	16	60	20	72
Total	1608	56	200	284	80	60	56	216
Size classes	***Indonesia***	***Lebanon***	***Malaysia***	***Morocco***	***Philippine***	***Thailand***	***Tunisia***	***Turkey***
Class 1	68	48	4	0	28	0	0	12
Class 2	40	40	28	0	28	8	20	8
Class 3	28	36	32	20	20	12	20	24
Class 4	8	4	40	8	4	36	0	32
Total	144	128	104	28	80	56	40	76

Source: Auteur

Selection of Input and Output Variables

Based on the analysis presented above and aiming to examine the sensibility of estimated efficiency scores to alternative methods of measuring banking activity, this study focuses on two major approaches: the intermediation approach and the value added approach.

Our first model (DEA-A Model) is based on the intermediation approach as proposed by Sealey and Lindley (1977). Banks are considered as funds intermediates between savers and investors. Banks produce intermediation services through the collection of deposits and other liabilities and their allocation to different interest producing assets such as loans, securities and other investments. In the DEA-A model, we use the outputs Y1: loans, Y2: other paying assets. The considered inputs are X1: work, X2: physical capital and X3: borrowed funds. To test the value added approach, we compare the results provided by this model with those of a second model considering deposits as a further output in addition to all previously selected outputs (DEA- B Model). So, we retain in the DEA-B model, in addition to the outputs already defined Y1 and Y2, the output Y3: deposits, and as inputs X1, X2 and X3.

Moreover, in order to take into account non-traditional banking activity, two alternative models are also tested. In these models, we include as additional output the variable Y4: non-interest income. It is added to the basic outputs (Y1: loans and Y2: other paying assets) in the intermediation approach (to have DEA-C model) and considering also the output Y3: deposits in the value-added approach (to have DEA-D model). Input and output variables involved in the tested models are described in the table (2). Their descriptive statistics are reported in table (3).

Table-2. Inputs and outputs variables

Variables	Definitions
Inputs	
- **X1** : Work	- Total of labor expenses
- **X2** : Capital	- Total of fixed assets
- **X3** : Borrowed funds	- Total of deposits and other borrowed funds

Outputs - **Y1** : Loans	- Total of short term and medium-term loans
- **Y2** : Other paying assets	- Total of investments in securities and other revenue generating bank assets.
-**Y3** : Deposits (in the value added approach)	- Total of checking accounts and time and saving deposits
- **Y4** : Non-interest income	- Non-interest revenues provided from services charges oh loans and transactions, income from renting an fiduciary activities, commissions and other operating income

Table-3. Descriptive statistics of inputs and outputs variables (2000-2003)*

	Y1	**Y2**	**Y3**	**Y4**	**X1**	**X2**	**X3**
2000-2003							
Mean	2396143	1928360	3422196	1155615	65669	92779	3089256
Median	433505	412340	688313	557502	15208	16863	818776
Standard deviation	6681665	4230920	8033991	1359381	165080	212942	6179755
Year 2000							
Mean	1785726	1543991	2663400	696865	59000	77047	2534480
Median	367562	378304	567051	723025	12199	15136	699288
Standard deviation	3916723	3298910	5657060	190441	156456	168768	4872757
Year 2001							
Mean	2047621	1751789	2970924	3413105	60301	85605	2740014
Median	405053	398440	689685	3644046	13332	16463	802260
Standard deviation	5333904	3802246	6997684	581006	151302	191594	5299447
Year 2002							
Mean	2541399	1915267	3561994	328066	62092	95210	3050154
Median	441752	404355	679527	283820	15706	16613	767943
Standard deviation	7467408	4023525	8626953	163565	143001	221717	5902402
Year 2003							
Mean	3209827	2502392	4492466	184426	81283	113256	4032376
Median	563238	514663	934233	102977	19122	19885	1020406
Standard deviation	8841889	5449599	10065754	229888	202630	258149	8065537

* Values are expressed in thousands of U.S. dollars.

RESULTS

The results were generated using the DEAP software developed by Coelli (1996). Their descriptive statistics for the four size classes and with different DEA models constructed are shown in Table (4). They appear successively for the three efficiency concepts used (overall technical, pure technical and scale) for the entire study period and for each year separately. The efficiency estimates obtained from DEA models constructed are tabulated and analyzed to identify how efficiency scores vary with bank size and to what extinct the analyzed relations depend on methodological choices of non-parametric specifications and the definition of inputs and outputs variables. More precisely, we examine the results provided by the intermediation approach versus those generated by the value-added approach and test for the impact of the introduction of banking non-traditional activity.

The Overall Technical Efficiency

The results about the overall technical efficiency estimates for our sample of developing countries banks are presented in the panel A of Table (4). Their observation can lead to the following key findings. First, on the 2000-2003 period, the overall technical efficiency of our sample banks generated by the built frontiers is comprised between 33% and 53,7% depending on size and selected model. A value of one indicates an efficient use of inputs, that is to say, the current inputs are at the minimum feasible level that lets to produce the actual outputs. So, the banks in our sample could produce the same level of outputs with approximately 46 to 67% fewer resources than those currently employed.

Second, we note that large banks (belonging to class 4) are the most efficient in overall technical terms over the entire period of study and with all used models (for mean and median values). They are followed by small banks (of class 2) and then those of medium size (of class 3). Very small banks (of class 1) seem to have the more serious problems of technical inefficiency indicating waste of resources between 62% and 67% of the levels currently used on the 2000-2003 period, when non-traditional activities are not taken into account (ie. with DEA-B and DEA-A models, respectively). When these activities are included in the outputs, the inefficiency level of the banks of this class is less important and is at a percentage of 56.3% with the model DEA-C and 52.4% with the model DEA-D, which correspond respectively to 129% and 106% of the actually used resources of a 100% efficient bank from the same sample to produce the same outputs. The analysis of the evolution of the overall technical efficiency indicates deterioration in the average performance of banks of our sample from one year to the other for banks of the three classes from 1to 3 in all combinations of inputs and of outputs studied, except in 2001 under the value added approach (DEA and DEA-B-D) for banks of classes 2 and 3. The evolution of the Class 4 banks performance over our study period seems to be less influenced by the decrease since we detect stability of the average performance of these banks between 2000 and 2001 under the intermediation approach, and an improvement between 2000 and 2002, under the value added approach. The downward trend in average scores efficiency observed may reflect a reduction in management practices over the period of study and / or it may be a consequence of the deteriorating environmental (macroeconomic, institutional or regulatory) conditions. The last observation leads to the recognition of best management practices in the larger sized banks compared to smaller banks that can be also reflected through the better adaptation ability or resistance to changes of the environment characteristics.

Table-4. Size and technical efficiency estimates

Panel A : Global technical efficiency measures

Models	*DEA-A*				*DEA-B*				*DEA-C*				*DEA-D*			
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
2000-2003 period																
Mean	0,330	0,452	0,422	0,469	0,379	0,526	0,502	0,537	0,437	0,461	0,423	0,469	0,486	0,535	0,502	0,537
Median	0,297	0,386	0,389	0,419	0,344	0,464	0,480	0,505	0,394	0,400	0,391	0,419	0,451	0,467	0,480	0,505
Stand. Dev.	0,181	0,208	0,174	0,211	0,206	0,225	0,194	0,213	0,214	0,210	0,175	0,212	0,228	0,225	0,194	0,213
Year 2000																
Mean	0,361	0,476	0,456	0,479	0,398	0,529	0,516	0,524	0,486	0,490	0,457	0,479	0,519	0,539	0,516	0,524
Median	0,328	0,407	0,424	0,427	0,354	0,486	0,490	0,486	0,448	0,427	0,424	0,427	0,483	0,497	0,490	0,486
Stand. Dev.	0,215	0,213	0,179	0,227	0,228	0,233	0,202	0,227	0,232	0,213	0,179	0,227	0,239	0,230	0,202	0,227
Year 2001																
Mean	0,332	0,465	0,453	0,479	0,373	0,536	0,528	0,539	0,436	0,474	0,453	0,479	0,476	0,545	0,528	0,539
Median	0,286	0,389	0,416	0,427	0,328	0,472	0,495	0,517	0,395	0,403	0,416	0,427	0,428	0,484	0,495	0,517
Stand. Dev.	0,207	0,234	0,206	0,205	0,226	0,250	0,220	0,216	0,228	0,232	0,205	0,205	0,244	0,250	0,220	0,216
Year 2002																
Mean	0,317	0,443	0,404	0,469	0,371	0,525	0,496	0,545	0,416	0,451	0,405	0,469	0,473	0,534	0,496	0,545
Median	0,296	0,379	0,381	0,411	0,328	0,476	0,480	0,527	0,364	0,383	0,382	0,411	0,425	0,478	0,480	0,527
Stand. Dev.	0,183	0,225	0,180	0,209	0,224	0,240	0,200	0,210	0,226	0,226	0,181	0,209	0,245	0,240	0,200	0,210
Year 2003																
Mean	0,308	0,423	0,376	0,450	0,373	0,513	0,468	0,538	0,410	0,431	0,378	0,450	0,476	0,520	0,468	0,538
Median	0,264	0,343	0,331	0,393	0,327	0,455	0,444	0,511	0,345	0,346	0,331	0,393	0,428	0,461	0,444	0,511
Stand. Dev.	0,188	0,233	0,174	0,229	0,217	0,236	0,192	0,223	0,233	0,236	0,176	0,229	0,243	0,235	0,193	0,223

Table-4. continued

Panel B : Pure technical efficiency measures

Models	*DEA-A*				*DEA-B*				*DEA-C*				*DEA-D*			
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
2000-2003 period																
Mean	0,440	0,468	0,483	0,666	0,489	0,538	0,569	0,721	0,510	0,532	0,545	0,734	0,549	0,577	0,601	0,770
Median	0,394	0,404	0,423	0,683	0,455	0,475	0,529	0,768	0,468	0,466	0,514	0,755	0,512	0,542	0,565	0,804
Stand. Dev.	0,214	0,214	0,211	0,242	0,228	0,227	0,233	0,239	0,218	0,221	0,213	0,219	0,225	0,223	0,225	0,214
Year 2000																
Mean	0,495	0,495	0,507	0,639	0,528	0,543	0,571	0,685	0,567	0,558	0,573	0,699	0,589	0,582	0,603	0,730
Median	0,457	0,434	0,466	0,642	0,485	0,497	0,533	0,705	0,553	0,496	0,562	0,696	0,573	0,547	0,578	0,754
Stand. Dev.	0,233	0,218	0,215	0,267	0,241	0,233	0,234	0,259	0,255	0,238	0,221	0,269	0,257	0,240	0,227	0,261
Year 2001																
Mean	0,443	0,476	0,491	0,646	0,484	0,548	0,579	0,707	0,539	0,564	0,562	0,703	0,558	0,598	0,611	0,733
Median	0,392	0,403	0,434	0,635	0,455	0,482	0,552	0,743	0,510	0,518	0,546	0,714	0,523	0,581	0,582	0,772
Stand. Dev.	0,230	0,236	0,230	0,246	0,243	0,254	0,250	0,244	0,267	0,263	0,233	0,251	0,269	0,265	0,242	0,250
Year 2002																
Mean	0,421	0,456	0,471	0,682	0,479	0,538	0,567	0,726	0,509	0,549	0,557	0,764	0,558	0,593	0,613	0,795
Median	0,372	0,394	0,402	0,698	0,445	0,479	0,518	0,793	0,439	0,477	0,510	0,817	0,498	0,537	0,588	0,850
Stand. Dev.	0,227	0,230	0,229	0,255	0,248	0,241	0,249	0,251	0,247	0,251	0,239	0,231	0,248	0,244	0,247	0,224
Year 2003																
Mean	0,400	0,445	0,464	0,697	0,467	0,525	0,560	0,764	0,427	0,455	0,487	0,770	0,492	0,535	0,576	0,821
Median	0,337	0,365	0,414	0,697	0,411	0,472	0,520	0,830	0,349	0,380	0,438	0,792	0,439	0,474	0,546	0,906
Stand. Dev.	0,229	0,237	0,216	0,251	0,241	0,239	0,243	0,242	0,241	0,241	0,222	0,233	0,249	0,241	0,242	0,216

Table-4. continued

Panel C : Scale efficiency measures

Models	DEA-A				DEA-B				DEA-C				DEA-D			
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
2000-2003 period																
Mean	0,758	0,965	0,896	0,724	0,771	0,973	0,900	0,756	0,880	0,886	0,797	0,656	0,897	0,934	0,849	0,709
Median	0,837	0,976	0,920	0,731	0,851	0,980	0,913	0,755	0,914	0,890	0,794	0,640	0,929	0,952	0,846	0,704
Stand. Dev.	0,186	0,036	0,089	0,161	0,184	0,024	0,075	0,142	0,113	0,088	0,106	0,164	0,099	0,061	0,081	0,148
Year 2000																
Mean	0,726	0,962	0,915	0,765	0,749	0,971	0,916	0,776	0,874	0,890	0,813	0,702	0,894	0,931	0,862	0,733
Median	0,800	0,977	0,930	0,774	0,826	0,983	0,933	0,768	0,940	0,928	0,812	0,680	0,948	0,976	0,870	0,733
Stand. Dev.	0,219	0,043	0,074	0,160	0,216	0,036	0,070	0,148	0,154	0,114	0,120	0,179	0,133	0,089	0,100	0,171
Year 2001																
Mean	0,744	0,975	0,936	0,759	0,763	0,976	0,925	0,771	0,849	0,865	0,823	0,699	0,875	0,923	0,874	0,746
Median	0,841	0,991	0,971	0,792	0,839	0,987	0,945	0,790	0,952	0,918	0,840	0,684	0,961	0,981	0,892	0,759
Stand. Dev.	0,223	0,031	0,076	0,163	0,220	0,031	0,075	0,153	0,202	0,157	0,146	0,165	0,168	0,108	0,111	0,153
Year 2002																
Mean	0,770	0,971	0,893	0,711	0,770	0,971	0,899	0,767	0,840	0,841	0,754	0,629	0,858	0,908	0,827	0,696
Median	0,833	0,992	0,958	0,700	0,846	0,984	0,915	0,755	0,950	0,866	0,750	0,606	0,966	0,968	0,833	0,697
Stand. Dev.	0,208	0,056	0,133	0,174	0,204	0,040	0,096	0,146	0,222	0,176	0,162	0,193	0,218	0,157	0,127	0,179
Year 2003																
Mean	0,793	0,952	0,840	0,659	0,801	0,974	0,859	0,710	0,957	0,946	0,800	0,596	0,962	0,973	0,832	0,661
Median	0,858	0,981	0,893	0,640	0,861	0,984	0,864	0,702	0,985	0,974	0,824	0,565	0,985	0,988	0,837	0,652
Stand. Dev.	0,191	0,081	0,142	0,203	0,182	0,038	0,108	0,167	0,068	0,084	0,145	0,217	0,063	0,040	0,104	0,191

Source : Authors

Moreover, we note that the introduction of non-traditional activities as additional output has no effect on measures of overall technical performance of banks in classes 3 and 4. This effect seems to be obvious for the small banks (class 1 and class 2 but in lesser magnitudes). Indeed, taking into account income from non-traditional activities in the outputs of banks in developing countries of our sample has increased the overall average technical efficiency over the period 2000-2003 for banks belonging to class 1 of 32 4%, with the intermediation approach and 28.2% with the value added approach. These increases were respectively of 18.4% and 1.7% for class 2 banks and are near to zero for larger banks. To test whether the differences observed by the introduction of non-traditional activities are significant, we proceeded to the non parametric individual statistical test of Wilcoxon (Table (5). The Wilcoxon test was recommended by Cooper *et al.* (2007) to statistically test the differences between two groups in terms of efficiency. According to the authors, the non-parametric statistics are appropriate in this case because "the theoretical distribution of efficiency scores with the DEA method is generally unknown" (P. 233).

Under the intermediation approach (value-added), these tests confront for each size class, scores on the DEA-A model (DEA-B) scores against the DEA-C model (DEA-D). The test results indicate that the models with and without non-traditional activities are equivalent in terms of overall technical efficiency for all size classes except for Class 1, where the differences are significant at the 1% level. Thus, the smaller banks tend to be more involved in these non-traditional activities relatively to the total volume of business than their competitors of larger size. This type of activity seems to generate income for these banks whose negligence may involve technical efficiency scores which are abnormally low.

Our results confirm the study of Isik and Hassan (2003), suggesting that the exclusion of non-traditional activities may result in distortions in efficiency measures especially against banks that are most active in this type of transactions. The same nonparametric test of Wilcoxon was conducted to test the significance of differences between the scores obtained with the intermediation approach and the value added approach successively without the additional output Y4 (for non-traditional activities) and with it (Table (5). This led us to compare the scores of DEA-A model to those of the DEA-B model (in the absence of Y4) and scores of DEA-C model to scores of DEA-D model (in the presence of Y4). The test results indicate that the differences are significant for all size classes at a confidence level of 1%. The improvement of overall technical efficiency levels for all categories of banks is then considered significant, when deposits are introduced into the banking outputs as suggested by the value added approach. Indeed, the passage from an intermediation approach to a value-added approach has increased the average overall technical efficiency over the entire period for classes 1 to 4, respectively of 14.8%, 16.4%, 19% and 14.5%, in the absence of Y4. In the presence of Y4, this increase is respectively of 11.2%, 16.1%, 18.7% and 14.5% for these classes. Thus, we can say that although the choice of one approach of measuring banking activity may alter the estimated levels of technical efficiency, it doesn't seem that this choice would favor one class size compared to another or deepen the gaps already identified in their performance levels.

Table-5. Tests of the impact of differences in treatment methods on efficiency estimates*

	Models using intermediation versus models using value added approaches		**Models with versus models without the introduction of non-traditional activities output (Y4)**	
	Without Y4 (A/B)	***With Y4 (C/D)***	***Intermediation approach (A/C)***	***Value added approach (B/D)***
Class 1				
ETG	3,179 (0,002)	3,067 (0,002)	7,185 (0,000)	6,672 (0,000)
ETP	3,06 (0,002)	0,339 (0,019)	3,994 (0,000)	3,433 (0,001)
EECH	0,740 (0,459)	1,251 (0,211)	10,759 (0,000)	12,118 (0,000)
Class 2				
ETG	5,517 (0,000)	5,505 (0,000)	0,883 (0,377)	0,733 (0,463)
ETP	5,224 (0,000)	3,205 (0,001)	4,114 (0,000)	2,444 (0,14)
EECH	0,581 (0,561)	5,033 (0,000)	7,433 (0,000)	2,753 (0,006)
Class 3				
ETG	5,978 (0,000)	5,964) (0,000)	0,046 (0,963)	0,026 (0,979)
ETP	4,972 (0,000)	3,218 (0,001)	3,989 (0,000)	1,962 (0,050)

EECH	1,006 (0,314)	4,692 (0,000)	9,424 (0,000)	6,440 (0,000)
Class 4				
ETG	5,110 (0,000)	5,106 (0,000)	0,005 (0,996)	0,005 (0,996)
ETP	3,024 (0,003)	2,084 (0,037)	3,853 (0,000)	2,993 (0,003)
EECH	2,374 (0,018)	4,379 (0,000)	4,878 (0,000)	3,595 (0,000)

Source : Author's calculations

* ETG, ETP and EECH indicate overall technical, pure technical and scale efficiencies, respectively. It is provided for each test the value of the wilcoxon statistic and its significance level (between parentheses).

The Pure Technical and Scale Efficiencies

The results for the two components of overall technical efficiency, namely pure technical efficiency and scale efficiency are allocated respectively in panels B and C of Table (4). First, we can observe for all study years that pure technical inefficiency is the major source of overall technical inefficiency for all size classes of banks except for the largest ones.

More precisely, the results of all the models constructed show that developing countries examined banks of the three size classes from one to three suffer more from lower pure technical inefficiency than scale inefficiency. The largest banks (banks of class 4) are an exception to this general result. Their pure technical efficiency average scores generated by the DEA-C and the DEA-D models on the study period are respectively of 73.4% and 77% and those of scale efficiency are respectively of 65.6% and 70.9%. It should be noted that for these same banks of class 4, the results of DEA-A and DEA-B models join the previously general observation about the dominance of pure technical inefficiency on scale inefficiency, but the difference between the two types of inefficiency appears to be less important for this size class banks than for banks belonging to other classes. We can thus conclude that although the introduction of the Y4 output had no significant effect on the overall technical efficiency scores of the largest banks, neglecting the importance of non-traditional activities in the banking production, may involve irregularities in its decomposition into pure technical and scale efficiencies for these banks. The introduction of the Y4 output resulted in an improvement in pure technical efficiency average scores of all categories of banks of our sample over the four years of study, and has reduced the scale efficiency of banks of class 2 to class 4. For class 1 banks, taking into account the output Y4 has improved both pure technical and scale efficiencies, which can explain the result previously observed on the significant effect of its introduction on the overall technical efficiency. At a significance level of 5%, statistical tests discerned in Table (5) indicate that the introduction of the Y4 output has a significant effect on pure technical and scale efficiency scores of banks belonging to all size classes. Moreover, the choice to measure banking activity with a value-added approach leads to pure technical and scale efficiency scores for all sizes of banks that are superior to those generated by intermediation approach. However, at a 1% significance level, statistical tests indicate that the established differences are not significant for scale efficiency of banks belonging to class 1 (with and without the output Y4) and also for other size classes when the output Y4 is excluded. Inversely, the improvement that affects pure technical efficiency scores when moving from an intermediation approach to a value-added approach is significant for all size classes if we accept a significance level of the 5%. At a level of 1%, both approaches involve average levels of pure technical efficiency which are statistically equivalent for banks belonging to the two extreme classes (1 and 4) in the presence of Y4 in the outputs. Thus, it seems that in models neglecting the non-traditional activities, it is the scale efficiency that is the less sensitive to the choice of the measuring banking activity approach. However, when these activities are considered among the outputs, this choice can have a significant impact on the derived levels of technical efficiency for all banks sizes and those of scale efficiency of all banks except the smallest ones.

On the other hand, the largest banks show in all considered combinations of inputs and outputs pure technical efficiency average levels that are largely higher than banks of smaller sizes. Indeed, with DEA-C model and under the assumption of variable returns to scale, a bank from class 4, seems to have on the study period an average performance level that exceeds with 22 4% the class 1 bank average level. This gap is of 20.2% and 18.9% compared to banks from classes 2 and 3, respectively. Similarly, with DEA-D model and on the entire period, the differences between the average scores of pure technical efficiency of the class 4 banks and those of classes 1, 2 and 3 are of 22.1%, 19.3 % and 16.9%, respectively. Thus, it appears that the pure technical efficiency is monotonically increasing with the size of banks in developing countries, whatever the chosen model chosen and the adopted method of measuring banking activity.

Moreover, it is noted that banks of class 2 size, seem to be the closest to the optimal scale with an average of scale efficiency over the entire period situated between 88.6% and 97.3 % depending on the model. The relationship between the scale inefficiency and bank size seems to be U-shaped, with a maximum of inefficiency reached for banks belonging to class 4. These banks show relatively poor levels of scale efficiency that are even lower than those found for very small banks (class 1) regardless of the used model. Thus, for these banks, despite the existence of serious problems of inefficiency related to their scale, their superior managerial practices in the use of inputs relatively to banks in other size classes, has lead to overall technical efficiency average scores that are the highest of the sample. For class 2 banks, since they seem to operate on a scale that is very close to the optimal scale (constant returns to scale), we can say that the resolution of the majority of their productive inefficiency problems can be realized through a more efficient use of banking inputs, and therefore through the introduction of best management practices of inputs allocation to the various outputs production. Moreover, although the smallest banks of our sample seem to be less concerned than the biggest ones by the resources waste resulting from scale inefficiency, the combination of this type of inefficiency with a relatively high pure technical inefficiency has resulted in very low levels of overall technical efficiency levels. It should be also noted that models without the output Y4 have resulted for class 3 banks in scale efficiency scores that approximate an average of 90%, while for class 1 banks, they are to around 76%. When Y4 is considered in the outputs, the average level of bank performance of class 1 finds an increase that exceeds the 16%. Then, the class 1 will be classified in terms of scale efficiency in the second range just after banks of class 2 and before those of class 3. We can thus conclude that the exclusion of non-traditional activities in nonparametric models of efficiency studies on developing countries banks may involve distortions that play particularly against the smallest banks.

CONCLUSION

By using a DEA non-parametric frontier approach on a sample of 402 commercial banks from various developing countries, the current study investigates the relationship between bank size and productive efficiency performance under different combinations of inputs and outputs banking. The results show low levels of overall technical inefficiency with a recorded average maximum approximating 54%. Overall, all specifications tested prove the existence of high technical inefficiency in banks of developing countries, implying an average waste of resources (inputs) that exceeds 46% of the current used levels while generating the same level of outputs. It was also demonstrated that the principal source of the waste in the majority of these banks is constituted by pure technical inefficiency and in smaller importance by scale inefficiency. This finding is found for banks of all size classes except for the category of the largest banks (class 4), for which the results indicate the highest levels of pure technical efficiency and the most serious problems of scale inefficiency. The study showed a monotonic increasing relationship between pure technical efficiency and size of banks in developing countries, whatever the model chosen and the adopted approach of measuring banking activity. However, relating to scale efficiency, it is the banks of the intermediate size (class 2) that appeared the most close to the optimal scale with an average level over the entire period between 88.6% and 97.3% depending on the model. The relationship between the inefficiency of scale and the size of banks seems to be U-shape with a maximum of inefficiency reached by class 4 banks. In addition, another main contribution of our study is to confront the efficiency scores generated by the two major approaches for measuring banking used in literature (the intermediation approach and the value added approach of the added value), and to test the impact on the results of the consideration of non-traditional activities among the banking outputs.

The test results indicate that the models with and without non-traditional activities are equivalent in terms of overall technical efficiency for banks of all size classes except for those of the smallest size. In this regard, some works of literature, including that of Isik and Hassan (2003) have suggested that the exclusion of non-traditional activities may result in distortions in efficiency measures especially against banks that are most active in this type of transactions. We can infer that they are the smallest banks of our sample that seem to be the most involved in the non-interest income generating activities, which can be explained by a better specialization and/or by supply of differentiated services to their customers. Our results also indicate that the choice of an intermediation approach or a value added approach for measuring banking activity can significantly influence the generated average levels of technical efficiency, but scale efficiency estimates appeared to be less sensitive to this choice. However, it is demonstrated by our study that this choice can participate to favor a size class compared to another or to dig already observed gaps in their performance levels. Our data thus suggest that the examination of the relationship between size and productive efficiency performance of banks is generally weakly affected by the adoption of some approach to measuring banking activity.

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