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Impact of main idiosyncratic and exogenous factors on cost Efficiency: The case of MENA banking industries - SFA approach

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Abstract. *This study explores the impact of main idiosyncratic endogenous (Capital ratio, Diversification, Liquidity, Return on equity (ROE), Banks assets' size) and macroeconomic exogenous (Inflation rate, GDP growth rate and HHI concentration index) determinants of the banking firm that influence banks' cost efficiency. Using the SFA (Stochastic Frontier Approach) we estimate cost efficiency of the MENA banking sectors through a two-stage model: i) Including idiosyncratic and macroeconomic factors at a first stage under SFAW (SFA With) and ii) excluding these factors under SFAWO (SFA without) at a second stage. By using this method, SFAW versus SFAWO, we compare between the efficiency frontiers and scores obtained and understand the effect of the integration of main determinants on efficiency of banks in the MENA region. Using a sample of 240 observations for MENA banks collected from 18 banking sectors, we analyze whether these criteria had impact on cost efficiency throughout 1999-2017. We find that SFAW scores of efficiency are higher than SFAWO. Furthermore, our results show clearly the impact of determinants selected on cost efficiency frontier. Finally, notwithstanding ongoing fundamental changes in MENA's banking industries, the empirical results, show that these inefficiencies can be explained by the idiosyncratic factors (Assets 'size, liquidity, profitability, etc.) which are under the control of bank managers and the macroeconomic environment (economic growth, inflation) which largely depends on the economic, monetary and financial policies adopted in each country of the MENA region.*

Keywords: (In) Efficiency, Stochastic frontier, Efficiency scores, Banks, MENA countries, Liberalization.

JEL Classification: C13, D24, G21, H21.

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Introduction

More subject to requirements of globalization, liberalization and regulatory reforms and operating in an uncertain environment, banks are challenged not only with their performance, resiliency and solvability but also with their efficiency.

Inefficiency, i.e. management failure in cost control and allocation of resources appear to generate additional costs than those resulting from sub-optimal scale or diversification. Mac Allister and Mac Manus (1993) integrate assets' risks into a cost function via approximating the cost of required capital needed to offset loan portfolio risks. Based on their model, authors deduce classic measures of economies of scale; a more diversified bank benefits from economies of scale and needs less capital to keep its insolvency risk constant. Authors observe the existence of economies of scale for the largest banks, whereas other studies that do not introduce risk control into costs, report the absence of economies of scale or even diseconomies of scale for the largest banks (Berger and Humphrey (1997) and Noulas, Ray and Miller (1990)). Along the same lines, Hughes and Mester (1998), Hughes, Lang, Mester and Moon (1996) explicitly integrate risk into

a cost function and derive measures of economies of scale. Their methodology consists of questioning the assumption of risk neutrality which underlies the cost minimization approach from which the classic measures of productivity are deduced. Authors also observe the existence of larger economies of scale than without taking risk aversion into account.

Studies on banking efficiency have also looked at the variables likely to explain the level of efficiency (Allen and Rai, 1996; Lozano – Vivas and Dietsch, 2000; Grogorian and Manole, 2002; Kablan 2007, Dannon, 2009; Song and Fouopi, 2016). Literature identifies different types of variables: decision-making and control (endogenous factors), environmental, macroeconomic and institutional factors (exogenous factors). The few studies conducted in the MENA region have focused solely on organizational and managerial variables (Ary Tanimoune, 2003, Kablan, 2007; Dannon, 2009) or on macroeconomic, institutional and environmental variables (Ary Tanimoune, 2003, Kablan, 2007).

As for the institutional variables such as the preference of managers in risk taking (agency theory) which could generate costs, the cost of management in the banking firm while exploiting banks' assets, the know-how and the strategy adopted by managers in estimation of the (In) Efficiency, the asymmetry of information in the definition of forms of contracts to limit the opportunism of the agent (Jensen and Meckling, 1976) and finally the behavior of managers whether "Riskophiles" or "Risquophobes" (de) favoring risk taking are revealed to be the important factors on the productivity and efficiency of the banking sector.

Since the 1970s and due to liberalization, globalization and reforms required by regulatory authorities, MENA banks tried to conserve their resilience and more importantly their performance while developing their activities and expanding their chains. "Financial sector development in the region has been closely associated with the policy objectives of economic diversification, privatization, and liberalization" (World Bank, 2015). MENA banking industries have grown from Assets/GDP ratio at 1time (2002) to 1.2 time (2017) and its contribution to the MENA economy has increased significantly[1].

This fast growing lending activity might expose banks in the MENA region to higher risks, (Increasing capital needs[2]) and more specifically to banks (In) Efficiency.

How endogenous (idiosyncratic) and exogenous (environmental and macroeconomic) factors affect the level of efficiency of banks in MENA countries?

The contribution of this study on the determinants of banking efficiency is to associate traditional variables (Solvability, liquidity and Profitability) with institutional ones (Management, diversification and concentration). Analyzing the impact of these variables on efficiency could generate valuable information to have another reading on financial reforms and to guide decision makers to review a particular policy.

Main part

Cost efficiency defines and measures the best allocation between inputs and outputs that helps producing the optimal level of outputs while minimizing production cost. This approach leads to a cost objective through measuring efficiency.

Artus (2011), explored the implications of liquidity ratios and their interaction with capital ratios and in particular explained the effects on risk taking and the procyclical effects of capital ratios that lead banks to hold low-risk assets if they are sufficiently discriminating. The author asserted that prudential rules provide banks with capital ratios linked to the level of risk of held assets as well as liquidity ratios which seem to increase the level of the liquidity buffer held by banks. These results corroborate those found by Guidara et al. (2010).

It is important to note that, in addition to capital and risk ratios and to regulatory requirements, other variables have been introduced and rigorously analyzed in the specifications of these previous empirical contributions in order to better explain banking behavior.

[1] Source: MENA Central Banks (Assets) and the International Monetary Fund (Nominal GDP) and Bankscope Fitch IBCA-2018.

[2] BCBS, (2010): Countercyclical capital buffer proposal. Available online at: http://www.bis.org

Sample description

The empirical study uses financial statements and data related to 240 banks of to the MENA banking sectors (18 selected countries: Algeria, Bahrain, Egypt, Israel, Iraq, Jordan, Kuwait, Morocco, Malta, Lebanon, Mauritania, Oman, Qatar, Saudi Arabia, Tunisia, Turkey and Yemen). Data is sourced from the international banking database Bankscope of BVD-IBCA[3] (financial statements) ranging from year 1999 to year 2017.

Methodology

To quantify and measure the efficiency of MENA banking industries selected in the sample, we adopt a trans-logarithmic function in a parametric frontier approach (SFA) being a function that fits best with functional forms (Kablan, 2007; Poshacwale and Kian, 2011; Benzai 2016) and described as the most reliable method in cost function valuation (Bukart & al. 1999).

SFA is applied at 2 levels SFAW and SFAWO.

Construction of the cost frontier

We estimate hereafter the cost frontier function with respect to inputs, outputs and explanatory factors defined hereafter.

General formula

We adopt the intermediation approach defined by Wrenches Sealey and John Lindley (1977) for this analysis to define efficiency scores, coefficients and the estimation of cost function[4]. Cost function can be written as follows (Fouopi & Song, 2016);

$$Ln\ CT = C_0 + \sum_{rj} \beta_r\ Lny_{rj} + \sum_{ij} \beta_i\ LnP_{ij}$$
$$+ \quad \frac{1}{2}\sum_i \sum_k \beta_{ik}\ Lny_{ij} Lny_{kj}$$
$$+ \quad \frac{1}{2}\sum_i \sum_z \beta_{iz}\ LnP_{ij} LnP_{zj}$$
$$+ \quad \sum_r \sum_i \beta_i\ Lny_r\ LnP_i$$
$$+ \quad vj + uj$$

Where;

i : number of countries in the sample,

t : number of years (1999 à 2017) ;

j : number of input prices.

C : total operating cost

Y_r : r =1…3 are outputs

P_i : i =1…3 are input prices

C_0 : is an intercept accounting for all other cost determinants

v_{it} and u_{it} are two components of error terms. The random error term vj is assumed iid with vj ~ N(0, σ2 v) and independent of the explanatory variables. The inefficiency term is iid with uj ~ N|(0, σ2 u)| and independent of the vj. It is drawn from a non-negative distribution truncated at zero.

Following these assumptions, the estimation of the cost function was carried out, and this in two different ways SFAW and SFAWO.

[3] We note that only commercial banks were considered in this paper in order to maintain a homogeneous sample.

[4] With CT: Total Cost (financial and operational costs), Y1: Total Earning Asset, Y2: Total Customer Deposit, Y3: Off Balance Sheet, P1: Total Interest Paid/ Total Customer Deposit, P2: Labor cost= Personnel Expenses/Total Asset and P3: Assets cost = Administrative Expenses/Fixed Asset. β Coefficient $C0$ an intercept accounting for all other cost determinants and vit & uit components of error terms.

The translog cost function estimated using the SFA method to assess the total cost of the banking firm in each MENA country represents the link between the outputs together, the price of the inputs together and also studies the link between the outputs and the price of the inputs.

Specific formula

$$
\begin{aligned}
&LnCT = \\
&c(1) + \\
&c(2)*\ln y1 + c(3)*\ln y2 + c(4)*\ln y3 + \\
&c(5)*\ln p1 + c(6)*\ln p2 + (1 - c(5) - c(6)*\ln p3 + \\
&c(8)*\ln y1\ln y1 + c(9)*\ln y1\ln y2 + c(10)*\ln y1\ln y3 + \\
&c(11)*\ln y2\ln y2 + c(12)*\ln y2\ln y3 + c(13)*\ln y3\ln y3 + \\
&c(14)*\ln p1\ln p1 + c(15)*\ln p1\ln p2 + (-c(14) - c(15))*\ln p1\ln p3 + \mathrm{c}(17)\ln p2\ln p2 + \\
&(-\mathrm{c}(15) - \mathrm{c}(17)*\ln p2\ln p3 + (\mathrm{c}(14) + 2*\mathrm{c}(17) + \mathrm{c}(15))*\ln p3\ln p3 + \\
&\mathrm{c}(20)*\ln y1\ln p1 + \mathrm{c}(21)*\ln y1\ln p2 - (\mathrm{c}(20) + c(21))*\ln y1\ln p3 + \\
&c(23)*\ln y2\ln p1 + c(24)*\ln y2*\ln p2 - \\
&(c(23) + c(24))*\ln y2\ln p3 + \mathrm{c}(26)*\ln y3\ln p1 + \mathrm{c}(27)*\ln y3\ln p2 - (\mathrm{c}(26) + \mathrm{c}(27))*\ln y3\ln p3 + \\
&\mathrm{c}(28)*\mathrm{CAP} + \mathrm{c}(29)*\mathrm{DIV} + \mathrm{c}(30)*\mathrm{LIQ} + \mathrm{c}(31)*\mathrm{ROA} + \mathrm{c}(32)*\mathrm{SIZE} + \mathrm{c}(33)*\mathrm{GGDP} + \mathrm{c}(34)*\mathrm{INF} + \mathrm{c}(35)*\mathrm{HHI}
\end{aligned}
$$

For this, an analysis and a comparison of the coefficients (reflecting the impact made by each factor retained on another factor) and of the efficiency scores (reflecting the level of efficiency of each banking sector) was made in the following.

The choice of imputs, outputs and explanatory factors

Frise and Taci (2005) consider physical capital and labor as inputs in banking production. Other authors (Das and Drine, 2011 and Weill, 2013) have also added borrowing as a contribution to the bank production function. Sherman and Gold (1985) used labor, rental expense and supply costs as inputs, following the DEA method. Fiorentino et al. (2006), in their analysis of the efficiency of German banks consider deposits as inputs.

The choice of input prices is simple given the availability of information and the harmonization of data on the Bankscope database.

The total cost (TC) represents the endogenous variable. It includes all financial costs and operating costs. In other words, it is made up of personnel costs and general operating costs (Kablan, 2007; Fouopi and Song, 2016). The total cost is approximated by the sum of the cost of labor, the cost of physical capital and the cost of financial capital (Rouabah, 2009).

Defining what exactly constitutes a bank's output is problematic (Clark and Siems, 2002). Several arguments can be given in favor of different measures of output. If we choose a model with several outputs, all the banks in the sample must produce all the products offered, since the translog function requires non-zero variables (Clark and Speaker, 1994). Sherman and Gold (1985) suggest the total number of transactions processed as the basis for output. This measure can be problematic in studies using a large number of banks, because data on the number of transactions may not be available for all observations. In addition, the number of transactions processed ignores the off-balance sheet output which can be quite significant for a bank (Clark and Siems, 2002).

It is true that a bank produces services which it provides to its customers, so the number of customers also represents an output. But since customers are not homogeneous, this could be particularly problematic when comparing banks of different sizes, or banks from different countries, the principle that the output is equal to each customer is invalid. Fries and Taci (2005) suggest using two outputs: customer loans and bank deposits. Another potential variable that can be used as a datum for output is total assets (Weill, 2013).

In this study, we will adopt a "hybrid approach" combining the "production approach"[5] and the "intermediation approach"[6] to select variables. This approach is based on the exploitation of Customer deposits, labor and banking management in the production of assets and off-balance sheet commitments that will cost the price of the deposits offered to customers, the price of the labor factor and the price paid to the management of the banking firm. And it goes perfectly with the business model of most of banks in MENA countries.

Table 1. Matrix of variables

Inputs	Input Price	Outputs
Customer Deposits	**P1:** Deposits Cost= Total Interest paid/Total customer deposits	**Y1 :** Total Earning Assets
Labor	**P2:** Labor cost = Personnel expenses/ Total Assets	**Y2 :** Total Customer Deposits
Management	**P3:** management Cost = Administrative expenses/Fixed Assets	**Y3 :** Off Balance sheet

Source: prepared by the author.

Banks face many factors that can affect their efficiency and productivity. The economic literature identifies internal factors (liquidity, provisioning policy, capital adequacy, bank size, etc.) and external factors identified as environmental variables (banking concentration, competition, GDP, inflation, etc.) (Athanasoglou et al. 2005). Previous studies have reported a positive association between inflation and bank profitability (Benzai, 2016). Indeed, high inflation rates are generally associated with high interest rates on loans, and therefore high incomes. However, if inflation is not anticipated and banks do not adjust their interest rates correctly, there would be a possibility that banking costs would increase faster than revenues and therefore affect the profitability of banks. As for Capital, it is an influential variable because Equity policy is determined by banks 'external and internal factors. Among the internal factors, we can cite cost control (Dannon, 2009).

We explain hereafter explanatory factors to be integrated in our cost efficiency frontier.

Table2. Explanatory factors

	Factors	Definition
Macroeconomic Variables	G GDP	Growth of GDP
Macroeconomic Variables	G GDP	Growth of GDP
	Inflation rate	Annual average rate of inflation(CPIt- CPIt-1)/ CPIt-1
	Concentration Index HHI	Sum of squares of the market share of each firm competing in the market
Idiosyncratic variables	Capital	CAR=Regulatory Capital/Risk Weighted Assets
	Liquidity	Liquid Assets/Total Assets
	Assets size	Logarithm of total assets
	ROE	Net Profit /average total equity
	Diversification	Non-interest income to Total Assets

Source: prepared by the author.

Table 3. Results of the estimation of stochastic frontier SFAW (With) and SFAWO (Without)

Constante	1.37385	0.14256	9.63734	0	3.64582	0.17685	20.6149	0
Lny1	-0.0145	0.04661	-0.3118	0.7552	-0.1998	0.06482	-3.0826	0.0021
Lny2	0.29891	0.03899	7.6671	0	0.54501	0.04901	11.1212	0
Lny3	0.06616	0.01811	3.65246	0.0003	0.29028	0.02107	13.7788	0
Lnp1	0.28944	0.01856	15.5949	0	0.30494	0.02431	12.5433	0
Lnp2	0.45813	0.01824	25.1145	0	0.57125	0.02375	24.0501	0
Lny1Lny1	0.03899	0.0041	9.50646	0	0.09926	0.0058	17.1098	0
Lny1Lny2	-0.0842	0.00442	-19.033	0	-0.1443	0.00702	-20.544	0
Lny1Lny3	0.00176	0.00309	0.569	0.5694	-0.028	0.00371	-7.5455	0

[5] According to this approach, bank must mainly consume factors (capital and labor) with the aim of producing loans and deposits. This approach considers that banks offer transaction and information services to customers.

[6] "Intermediation approach" that is the alternative of the production approach is proposed by Wrenches Sealey and John Lindley (1977). These authors point out that to offer the outputs yi, banks will need to demand quantities of input xi at a price pi while minimizing the total operating costs C. Bank collects the resources in the form of deposits and other liabilities (other than equity) and invests them in the form of loans and profitable assets by employing capital and labor in the process of transformation.

Lny2Lny2	0.05612	0.00196	28.5674	0	0.0771	0.0028	27.5293	0
Lny2Lny3	-0.012	0.00244	-4.9037	0	-0.0043	0.00285	-1.4939	0.1352
Lny3Lny3	0.00177	0.00104	1.70184	0.0888	0.00796	0.00125	6.3915	0
Lnp1Lnp1	0.06053	0.00104	58.1201	0	0.06483	0.0013	49.9806	0
Lnp1Lnp2	-0.0579	0.00121	-48.021	0	-0.0517	0.00139	-37.195	0
Lnp2Lnp2	1.30E-05	0.00084	0.01556	0.9876	-0.0039	0.00099	-3.9237	0.0001
Lny1Lnp1	-0.0604	0.00268	-22.568	0	-0.0634	0.0038	-16.686	0
Lny1Lnp2	0.05256	0.00307	17.1187	0	0.04101	0.00401	10.2251	0
Lny2Lnp1	0.0976	0.00218	44.7512	0	0.10411	0.00296	35.1287	0
Lny2Lnp2	-0.0821	0.00245	-33.54	0	-0.0851	0.00292	-29.19	0
Lny2Lnp3	-0.0125	0.00181	-6.9114	0	-0.0128	0.00204	-6.2927	0
Lny3Lnp1	0.00075	0.00197	0.3789	0.7048	0.00734	0.00226	3.25452	0.0011
Capital	**0.28162**	**0.02512**	**11.2129**	**0**				
Diversification	**3.679**	**0.05742**	**64.0682**	**0**				
Liquidity	**-0.0166**	**0.0033**	**-5.0348**	**0**				
ROE	**-1.5261**	**0.07099**	**-21.498**	**0**				
Size	**0.49553**	**0.01136**	**43.6051**	**0**				
GDP Growth	**-0.3247**	**0.07769**	**-4.1797**	**0**				
Inflation	**0.41168**	**0.02871**	**14.3376**	**0**				
HHI	**0.04051**	**0.04481**	**0.90416**	**0.3659**				

Note: Estimation Method: Full Information Maximum Likelihood. (BFGS)

Cost efficiency scores by year and by country of the sample

Comparing efficiency scores for SFAW and SFAWO, we can conclude that scores as per SFAW are higher than scores of SFAWO throughout the period 1999-2017 and by country as well as shown in below charts.

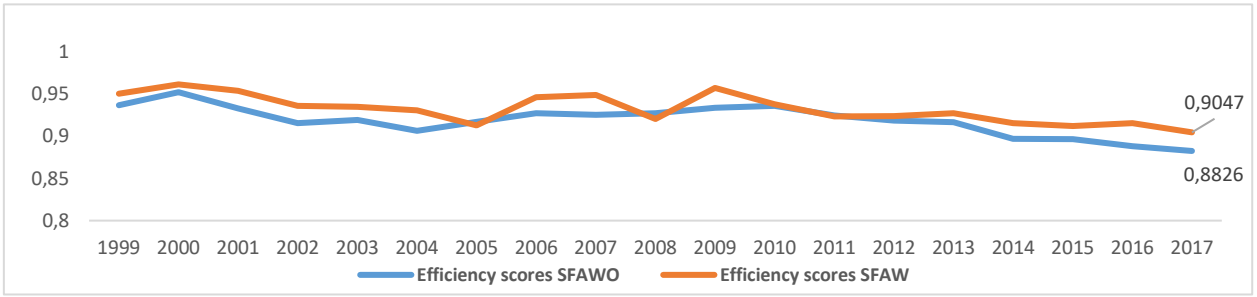

Figure 1. Evolution of Efficiency SFAWO versus SFAW (1999-2017)

Source: compiled by the author. MENA Central Banks, the International Monetary Fund (Nominal GDP) and Bankscope Fitch IBCA-2018.

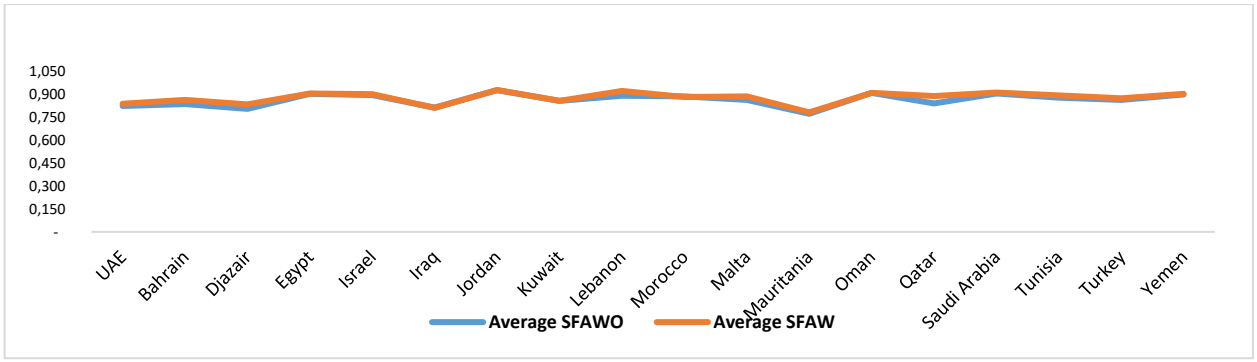

Figure 2. Evolution of Efficiency SFAWO versus SFAW by country

Source: compiled by the author. Idem.

Results and discussion

Following the observation of the results highlighted in above tables related to coefficients linked to explanatory variables, the following can be deduced:

There is a strong positive relationship between the size of the balance sheet and the Cost Function (CT). This relationship means the larger the bank, the more it tends to take advantage of economies of scale in the consumption of resources. Good management in cost allocation is important and well mastered in MENA countries. Hypothesis is confirmed by Dietsch (1992) and Battese-Coelli (1992).

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There is a strong positive relationship between diversification and (CT), which means that there is a large cost that banks pay by diversifying their portfolio. According to Kohler (2013), diversification in the composition of bank income (in particular in commissions, bank charges and income from foreign exchange transactions) increases the stability of banks, since it allows them to become more resilient to global economic conditions that could affect their loan portfolio, but this seems to be very costly for banks in MENA countries.

There is a positive relationship between capital and the (CT), which means that the more the proportion of equity in total the balance sheet increases, the more it becomes costly to the banking firm in the region of the MENA. Therefore, the process of transforming resources into equity capital is costly to the banking firm. Moreover, risk-averse behavior from managers or their risk aversion by accumulating more equity in balance sheet, is costly to the banking firm in this region. On the other hand, the moral hazard factor, as suggested by Jeitschko and Jeung (2005), indicates that managers tend to take more risk when banks have a poor level of capital or when banks are inefficient. The problem of moral hazard pushes banks' managers to take more risk. On the other hand, cost reduction practices will be adopted by banks to increase the level of capital and reduce the effect of moral hazard. In addition, the level of risk taken reveals the strategic niche of banks which is one of the factors that can be strongly correlated with banking efficiency (Berger and Mester, 1997).

There is a positive relationship between inflation rate level and the (CT). Thus, a phase of economic decline measured by the level of the inflation rate which is most often accompanied by an increase in the level of non-performing loans affects profitability of the banking firm. These costs are mainly due to three main factors: i) the increase in the allocation of provisions on non-performing loans, and ii) the increase in supervision and control costs in the management of these loans. (iii) Increased operating costs such as interest charges, administrative charges, salaries and non-operating charges. While the relationship is negative between profitability (ROA) and the cost function (CT) since usually when profits of the firm increase costs decreases.

However, this also means that banks must have better control on their costs in their choice of inputs in order to increase their margins, especially in a competitive environment like that of the majority of MENA countries and when they do not really have the power to market, that would allow them to make significant profits. On the other hand, it seems that banks in MENA countries, although some are well positioned and endowed with a fairly significant market force, solve less successfully than others reorganization problems. Moreover, these banks would not have a reservoir of profit or market power and would be encouraged to make additional production efforts to control production costs (X-inefficiency hypothesis, Leibenstein, 1970)

There is also a negative relationship between GDP growth and the Cost Function (CT Indeed, a phase of economic expansion which is accompanied by an improvement in economic activity, an increase in the profitability of companies and a decline in bad loans should result in a reduction in the costs of the banking firm.

Liquidity also has a negative relationship with the (CT). This depends above all on the way in which banks direct their investments, which can lead to inefficiency in the transformation of resources. This result could be explained by the fact that banks rather prefer to direct their resources towards cash uses which are less risky and less profitable than customer loans.

The HHI has no impact on the cost of the banking firm. Indeed, the results and observations obtained do not draw any conclusions with respect to the HHI factors.

Conclusion

The study is conducted to estimate the cost efficiency (CT) of MENA banks during 1999-2017, while identifying efficiency scores and explanatory variables for (In) Efficiency. This analysis is conducted with a two-stage model applied to a translogaritmic function (Battese &Coelli, 1992). The objective is to identify specific factors, whether endogenous or exogenous factors, that impact efficiency of banks and to help managers to adopt, change of or disregard certain strategies knowing the impact of explanatory variables on (In) Efficiency.

In the light of this study of (In) Efficiency of MENA banking industries throughout 1999-2017, results show that SFA models estimate higher scores under SFAW than those retrieved under SFAWO and this deduction is by year (except 2008) and by country of our sample.

Moreover, the results of determinants of efficiency (explanatory variables) used in SFAW cost frontier (CT) demonstrated that assets size, diversification, capital and inflation rate positively impacted the efficiency measurement in the MENA banking industries whereas, variables like ROE, GGDP, liquidity and HHI have negative impact on (In) Efficiency, these results were confirmed in literature.

Finally, our analysis shows that MENA banks efficiency can evolve with improving policies in allocation of banks' assets among different levels of risks, diversifying returns, attracting deposits and managing liquidity while staying compliant to a good capital level.

This study is of great interest as it makes it possible to explain the variations of efficiency between MENA banking industries. It helps to detect bank-specific and exogenous factors on which MENA bank managers can act to enhance their levels of Efficiency and be able to compete.

New dimensions can be integrated in future studies with a more granular analysis on efficiency scores, coefficients and levels with a separate analysis by determinants of efficiency cost of banks in the MENA so that to guide decision makers to encourage, discourage or modify a particular policy.

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