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Are Islamic Banks More Efficient Than Conventional Banks? The Meta-regression Verdict

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Are Islamic banks more efficient than conventional banks? The meta-regression verdict

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Abstract

This paper aims to conduct a comparison of the efficiency of Islamic banks versus conventional banks based on meta analysis. Empirical studies in this field mainly in MENA or GCC regions, usually provide mixed conclusions and we do not know the reasons of this discrepancy in the results. We conduct a meta regression analysis which is based on 35 studies and includes 484 estimates of efficiency scores by bank type among other characteristics. We employ Bayesian averaging technique to identify the main covariates explaining the heterogeneity of the results. Our findings suggest first, no evidence of the superiority of one banking system over the other, neither in terms of technical, cost or profit efficiency. Second we identify several important bank's and sample characteristics which have also important impacts on the provided efficiency estimates. Third, when we compare the studies into those who conduct a deep statistical comparison of the efficiency distributions by bank type and those who omit to do it, we find that conventional banks outperform Islamic banks, suggesting a potential publication bias. Finally, with respect to the inefficiency, meta regression analysis suggests that the regions banking systems suffers from the inability of banks to maximize profit so they are much less profitable than it should be. There are also some managerial deficiencies linked to cost minimization, rendering the region's banking system costly, compared to some deficiencies in the overall banking production process itself (technical efficiency).

JEL. C13, C81, D24, G21, L25

Keywords: Banking performance, frontier models, meta-analysis

1. Introduction

Evaluating and comparing banking performance is now one of the most studied topic in Islamic banking and finance. For example, Narayan and Phan (2019) recently report in their survey study on Islamic banking and finance which is restricted to 112 papers published in ranked journals over these last five years, that 44% of the publications is about Islamic bank performance. Moreover, the comparison of Islamic banks (IB) and conventional banks (CB) is one of the most important topic studied in these empirical studies. The fact that IB has experienced a strong growth rate during these last years, from $700 billion (Economist,2008) to reach $1.88 trillion in 2016, global Islamic banking assets represents 79% of the industry's assets according to (IFSI report,2016). This is one of the important cited motive behind these studies effervescence. Let us mention that, even if the Gulf cooperation countries (GCC)[1] and Iran remain the most important countries in terms of the importance of IB, some other South Asian countries, for example, Malaysia and Bangladesh observe important development of this industry over the last decade.

Beck et al. (2013) suggest that in theory the two banking systems, IB and CB, are surely different. Contrary to conventional banking system, interest rate is prohibited by the Sharia law for IB, which is substituted by "interest free" through the so called equity finance system, Khan (2010). However, in conducting their business IB adopt the same practices as CB, some authors argue that there are few differences both in terms of banking products, IB provide near identical services for their customers but with higher costs, Khan (2010). A key research question on the efficiency superiority of one banking system against the other continue to

[1] Islamic financial industry assets are domiciled predominantly in GCC, followed by Mena and Southeast Asia, Thomson Reuters Islamic finance development report (2017).

provide mitigated results and conclusions according to these studies. Why are there heterogeneity in the results? Is it because of the differences in the efficiency metric, i.e. cost efficiency, profit efficiency, productive/technical efficiency or technology efficiency? Is it because the differences in the methodology used to estimate the efficiency, i.e. non parametric model which does not allow noise in the data versus parametric model ? Is it due to the sampling selection process, i.e. the countries retained and the number of banks selected in the analysis? or the heterogeneity is due to other characteristics?

Notice here, that the literature surveys did not establish a consensus on whether one bank type outperform the other on this topic, Abedifar et al. (2015), Hassan and Aliyu (2018) and Narayan and Phan (2019). In contrast, Meta regression analysis (MRA) could be a useful tool to provide a final conclusion on whether one banking system outperform the other one or no based on the reported authors studies, hereafter called primary studies This methodology is commonly used in many research fields, mainly in medicine and biology but also recently used in economics. This method is widely used by economists, for example to study factor substitutions, Koetse et al. (2008), firm performance and foreign direct investment Iwasaki and Tokunaga (2016), or bank efficiency Aiello and Bonnano (2016), (2018) and Irsova and Havranek (2010) among other topics.

Conducting meta analysis on bank efficiency is not new, earlier studies Irsova and Havranek (2010) and Aiello and Bonnano (2016), (2018) focus on the heterogeneity of the results linked mainly to the methodology used by the researchers to evaluate bank performance among other study characteristics. Several issues are important while conducting a deep study evaluating bank performance. First the question of the methodology used to evaluate the performance, non parametric or stochastic frontier methods. Aiello and Bonnano (2016), (2018) conduct a large meta analysis on bank efficiency over the period 2000-2014. They collect data on 120 papers and extract 1661 efficiency scores (which is the total number of observations for the meta regression). They establish significant differences on the efficiency scores obtained by parametric and non parametric methods, the former methods lead lower average efficiency levels than non parametric methods. This result contradict the meta analysis of Irsova and Havranek (2010), using a much limited sample, of 32 studies restricted to US banks and for a former period 1977-1997, they do not find a significant difference on the efficiency scores provided by the two methods. However, other efficiency meta regression studies on large samples in other fields, conclude that non parametric method provide significant higher level of efficiency scores compared to non parametric methods, for example Bravo-Ureta et al. (2007) in agriculture. Second, the question of the metric used to evaluate banking efficiency, cost efficiency, profit efficiency or technical efficiency. For example to check whether bankers are more or less efficient in managing costs than in making profit. Meta regression analysis conclude that cost efficiency are higher than profit efficiency, Aiello and Bonnano (2016), (2018) and Irsova and Havranek (2010). This result seems to reinforce the idea to investigate both the cost and the profit side in any deep analysis evaluating efficiency of banking systems. Third, the question of the inputs and outputs definition in the production process. Remind that in conducting any analysis on efficiency based on frontier modeling, i.e. in evaluating how efficient bankers are able to transform the inputs into outputs, it is fundamental to define exactly the two components entering the production process. Actually, scholars follow the flow of most of the researchers based on Sealey and Lindley (1977) who distinguish between two main approaches, i.e the so called intermediation approach and the

production approach[2]. The difference between the two are whether deposits should be considered as input or output in the production process. According to most of the empirical studies evaluating bank efficiency at the aggregate level the intermediation approach is still the dominant one in the literature, while the production approach seems to be better when evaluating the efficiency of banks at the branch level. However, we can also find in the empirical studies some hybrid approaches taking a mixture of the two aforementioned approaches. Efficiency estimates should be sensitive to such choice. The large sample meta analysis conducted by Aiello and Bonnano (2016), (2018) find evidence that the production approach provides higher levels efficiency scores than the intermediation approach which is followed by the hybrid approach, a results not shared by the very limited sample study by Irsova and Havranek (2010). Fourth, the importance of risk for bankers when evaluating their efficiency, Berger and De Young (1997). More precisely an assumption largely discussed in several empirical papers that ignoring risk or the quality of loans may underestimate the cost or profit efficiency of the banks. For example, the variables such as bad loans, equity or equity to total assets ratio sometimes are added as control or as additional input is a commonly used practice. Irsova and Havranek (2010) did not findd a significant impact of this variable as a source of potential heterogeneity in the MRA, while this issue has not been investigated in Aiello and Bonnano (2016), (2018). We can also find other important issues checking other sources of the heterogeneity in the results in meta analysis such as, the sample size, the quality of publication, the sampling bias, the data structure (panel data or cross sectional data), the functional form retained in evaluating stochastic frontier models, among other issues. So many questions that should scholars have to worry about before embarking in conducting a study on evaluating bank efficiency, its determinants or in comparing bank efficiency by ownership structure. Notice that sometimes, due to data unavailability, there is no sufficient number of studies incorporating a specific issue to really check for that component in the meta analysis (for example most of the studies using parametric frontier model use the translog functionnal form, one study employs the Cobb Douglas form and one study the Translog Fourier form).

Our objective of this paper is to provide a "verdict" on whether really one bank type IB or CB outperform the other based on synthetic performance measures as evaluated by using frontier models. Other single financial ratios measures of performance such as return to assets or total cost to total assets ratios, among other ratios are not comparable to the synthetic measures of performances[3], they have been excluded. After a careful check of the most relevant empirical literature in this field, we retain a sample of 35 studies providing a common measure of the performance, i.e. an average efficiency score by bank group. From these studies we identify in total 484 observations retained in the meta regression analysis. It is important to mention that among these selected studies, the conclusions are mixed, in some papers IB outperform CB, the opposite conclusion is found in other papers, some or no difference in efficiency in some

[2] According to the intermediation approach , there is a wide consensus among scholars on the definition of inputs, namely labor, physical capital and financial capital. However, there are some differences in the definition of the outputs, which are linked both to what is assumed to be banks' earning assets and to data availability.

[3] Several studies compare bank performances between IB and CB using this methodology, see for example Beck et al. (2013). However we can conduct a meta regression analysis by focusing on only studies using this approach.

cases according to some mean difference tests conducted. What is important, is the policy recommendations are sometimes quite opposite at least from those papers that reveal that one bank type outperform the other. The issue is particularly important for both researcher and policy makers as they may be in awkward position with this conflicting results on this important topic mainly, for MENA, GCC or even for Southeast Asia region or in any other region in the world which seeks to develop Islamic banking system for example. The fundamental question addressed in this paper is then after controlling for several sources of the heterogeneity in these studies, whether IB out or underperform CB? Using a meta regression analysis including several controls and several models, there is no evidence that Islamic banks perform better or lower than their counterparts. Other bank's characteristics, like the definition of the inputs or outputs, the sample characteristics, or the geographical region for the selected countries are important factors which explain differences in the efficiency estimates. We also identify a potential publication bias in the link between efficiency and bank ownership structure.

In what follows, Section 2 proposes a brief overview of the methodologies used to evaluate the efficiency based on frontier models. Section 3 describes how we collect the data and present a descriptive statistics of the selected studies. Section 4 presents and discusses the meta regression results. Section 5 proposes some robustness checks of the main findings and Section 6 concludes.

2. A brief review of the frontier efficiency measurements in banking

Efficiency measurement based on frontier modeling are numerous and may vary substantially across banking studies. As we will see hereafter in this brief review, the methodologies employed in evaluating banking performance literature are diverse, particularly when comparing the efficiency or the productivity between banks. First, we can distinguish between two main groups what we call non-behavioral type measures, more knowing as X-efficiency measures, and behavioral efficiency measures. Here we employ the plural for measure, because as we will see later, within each group there are also different measures of efficiency. The first type of measure refers to how productive is a producer (a bank for example), in transforming its resources or inputs into outputs or (financial services) given a technology. The efficiency measure provided is currently called X-efficiency, productive efficiency or technical efficiency. By contrast behavioral type efficiency, the second type of efficiency, refers to how efficient is a producer in achieving a particular behavioral objective like maximizing profit and revenue or minimizing cost. The efficiency scores derived are linked to which specific behavior has been retained in the study, i.e. profit efficiency, revenue efficiency or cost efficiency. Being efficient with respect to a particular objective does necessarily mean that the bank is also efficient with respect to the others. Second, even if one choose a particular type of efficiency measure (behavioral or non-behavioral), two approaches could be used to construct the frontier and the efficiency related efficiency scores, i.e. the nonparametric data envelopment analysis (DEA) method and the parametric or econometric method, currently called the stochastic frontier[4] (SFA) method. DEA approach envelops the data and construct an empirical frontier determined by the most efficient virtual producers in the sample by solving linear programs with few assumptions compared to SFA. This last approach needs two important assumptions to construct the frontier, one on the functional

[4] The old parametric method called deterministic frontier à la Aigner and Chu (1968) is cast aside since it is rarely used in the empirical literature in empirics.

form to represent the technology, the second on a the distribution of the one sided inefficiency term in the model (half normal, exponential, truncated normal, among others). The inefficiency score derived, is the projection of one observation onto the frontier for DEA, and it is a residual component for SFA. For instance, the "best practice frontier" being unknown as well as the individual efficiency scores derived by each method, it is important to mention that there is no way to prefer one approach to another. Perhaps it is important to mention that the efficiency scores derived by DEA models have no statistical properties, even if now thanks to the bootstrapping methods Simar and Wilson (2008), some recent empirical research tackle this point, Assaf et al. (2011). However, DEA efficiency measures may be highly influenced by outliers which exaggerate the level of inefficiency and need a deep analysis check of the data while running such models. SFA partly has an advantage since the model specification includes noise to take account for unusual events (shocks, or measurement errors[5]) which may impact on the construction of the frontier itself. To sum up, the debate on the superiority of one approach against the other is now overrun, in particular, in banking, it has been shown that when the data are of high quality, the two approaches provide strong rank correlation between the two types of efficiency estimates, see for example Bauer et al. (1998) for results on U.S. banking data.

However, when the researcher focusses on a particular type of measure, there are remaining caveats to be considered. For the first efficiency type, X-efficiency, three different measures could be calculated, currently called input oriented (IO), output oriented (OO) or mixed-oriented (MO) efficiency. The two first orientations, IO and OO are the most popular in banking and provide a radial measure of efficiency. The efficient producer is the one who is able to produce the observed level of outputs with less inputs, IO, or is able with the same inputs used to increase its outputs, OO. The (MO) compares a producer to other peers, if he is able to simultaneously reduce its inputs and produce more outputs[6], he is considered as more efficient. Each orientation provides then a different level of efficiency score, even if it is called X-efficiency. As we will see later, most of the X-efficiency adopted to compare the efficiency of IB versus CB, are radial measures. Only two studies, employ the MO, non parametric model, Asmild et al. (2018) and parametric model, Chaffai (2019). Notice that even with this last orientation (MO), the researcher should assign an orientation, for example favoring input reduction to output extension or the opposite, with the so called directional distance function measure or letting the data choose the optimal ray along which outputs expands and inputs contracts, the hyperbolic distance function, Chaffai (2019). With the behavioral models, we have other warnings in particular with the profit frontier specification, largely employed in banking. In theory, profit maximization implies that the producers are price takers, in which case, the prices are exogenous and the profit frontier depends on inputs and outputs prices only. It has been shown that the markets are far from being competitive in banking industry. So in evaluating the efficiency of banks which may have some market power or may specialize in some exclusive product niches, they may be able to make more profit by increasing the prices of some services, challenging the exogeneity of prices in the model. In this case, most of the researchers use the so called "alternative profit function" model, which has been first introduced by Humphrey and Pulley (1997). It is the same model as a cost frontier, the profit depends on outputs and input prices, except the homogeneity in inputs prices assumption. Notice here, contrary to the cost frontier specification using the logarithmic scale for some functional forms, i.e. the Cobb Douglas or the Translogarithmic

[5] For example, when scholars use proxies for input or output prices to estimate a cost or a profit frontier.

[6] There is also another interpretation of the three measures under additional assumptions, based on duality theory, IO is interpreted as cost efficiency, OE as a revenue efficiency and MM as profit efficiency, see Färe and Primont (1995).

for example, it happens that some banks have negative profits (losses). To avoid omitting such observations which may introduce some selection bias in the frontier estimation, the authors of the method have recommended to add the absolute value of the minimum loss for the entire banks in the sample before estimating the frontier. Such practice has been recently disapproved by Bos and Koetter (2009) who recommend other solutions, unfortunately not yet employed when comparing profit efficiency for IB and CB. Another important point to notice with DEA model is that the estimation of profit efficiency is equivalent to the standard profit function, so the efficiency scores derived should not be compared to profit efficiency scores derived from the SFA alternative profit frontier model, the objective function being entirely different.

Furthermore, the question of the technology employed which is unknown is also an important issue when comparing heterogeneous banking systems. Estimating a common frontier implies that the efficiency derived is homogeneous, far from being the case in particular when making a comparison of banks across countries or by ownership type. Meta frontier, or the "frontier of the frontiers" is a new tool recently employed to distinguish between technology inefficiency and productive or economic efficiency components, Johnes et al. (2014), Azad e al. (2017), Abdul-Majid et al. (2017), Abid et al. (2019), Chaffai and Hassan (2019), Safiullah and Shamsuddin (2019). The aforementioned methodologies of the inefficiency estimation based on frontier models still apply in this topic too.

As we can see from this brief overview, so many questions scholars should worry about before conducting a deep investigation on the evaluation of bank efficiency, or as it is the case in this paper in comparing the efficiency of banks by ownership type. Such heterogeneity in the definition of the inefficiencies, the methodologies and the estimation methods may also have important impacts on the comparison of banks with different status. In addition, the selection of inputs and outputs, the definition of the inputs and outputs prices are also an important complementary components within this framework among other sample characteristics discussed hereafter.

3. Meta data sample and descriptive statistics

In conducting this meta analysis, the first task is to identify the papers which compare the efficiency between IB and CB. Our main source, is the surveying papers references Abedifar et al. (2015), Hassan and Aliyu (2018) and Narayan and Phan (2019), we also use others sources to select papers published in peer reviewed reviews, based on Sciencedirect, Econlit, Springer. More than 50 papers are identified, until september 2019. We then collect the information's on the efficiency scores by bank type, i.e. IB versus CB as well as other common characteristics, sources of the heterogeneity in the results. Some papers evaluating the efficiency based on only Islamic banks are excluded, for the other papers making the efficiency comparison, we just retain the average efficiency scores obtained from the estimation of a common frontier. This issue is important, the so called "comparing apples to oranges" to mention that the efficiency scores provided in some papers from separate frontiers by bank type are not comparable when the reference set is not the same. For this reason we did not select the studies which provide estimates of banking efficiencies for only Islamic banks. In two cases the efficiency scores by bank type were not reported, we obtained them upon a request from their authors. In only one case, we are unable to obtain that information, Mohanty et al. (2016) compare the cost and profit efficiency in the GCC, over the period (1999-2010), they did not report the efficiency scores by bank type, but they show that there is no difference in the derived efficiencies by bank type. In another paper, Rettab et al. (2010) compare the efficiency of banks in the GCC using nonparametric DEA model, but they did

not mention whether they used an input oriented or an output oriented model. These two papers were not included in this meta analysis. Also, with respect to the nonparametric models, some authors propose estimates of the efficiency scores under two assumptions, constant return to scale (CRS) or variable return to scale assumption (VRS). We just keep the estimates based on VRS assumption for two main reasons. First, since the parametric model, SFA efficiency scores estimates are obtained from a cost frontier model with no restriction on returns to scales. The most closer model when comparing SFA to DEA estimates should be the VRS model. Second, the efficiency scores based on DEA models, are much higher under the VRS compared to CRS model. In addition, we omit to select the scale efficiency scores reported by some authors who employ DEA model, because there is no equivalent measure with parametric frontier models. We also omit to extract information on allocative efficiency reported by some authors who use DEA approach, since there is no equivalent measure from the collected SFA papers[7] who report just total cost inefficiency scores, which is retained as the efficiency measure. To sum up, we end up with 35 papers called primary studies, including one important working paper the most cited in most empirical studies, the paper by Johnes et al. (2009). Given that many of the selected papers, provide more than one average efficiency by bank type (for example when authors employ different estimation methods, conduct some additional robustness estimates of the frontier, provide estimates by year, or employ different models cost and profit efficiency estimates among other cases), the total number of observations used in our meta regression is equal to 484, among them 357 are coming from papers published in indexed journals. Table 1 reports a summary of the studies characteristics. As shown in Table 1, the two methodologies (parametric and nonparametric) are quite equally used by scholars. Of the 35 studies retained in this meta analysis, 18 studies used SFA, 16 DEA, and only one study used both approaches, Mobarek and Kalonov (2014). However, taking into account the numbers of efficiency scores reported, 484 efficiency scores, only 42.6% are obtained from parametric SFA method, which suggest a slight dominance of nonparametric method in our sample. We also notice some differences according to the geographical coverage of the studies comparing bank efficiency. Ten studies covers only one country, 10 studies covers the GCC countries only, 14 when the sample is extended to some other Asian countries, 10 studies covers the MENA. Remind that the GCC, Iran and Malaysia are the most important countries in terms of Islamic banking assets in the world which are highly represented in this meta study. The conclusion with respect to the regional dimension of the efficiency is then important in terms of economic policy for the countries in these regions.

As shown in Table 1, even if we consider a specific country or region and the methodology used SFA or DEA, the comparison of the two banking systems in terms of efficiency differs, the specific measure employed, technical efficiency and its orientation, cost or profit efficiency, but also the sample size dimension. On this last point, we were unable to check whether the sample retained of IB and CB in each study is representative of the bank population, as we do not have the population of banks in each year in the studied regions. We hope that this meta analysis, will partially provide an answer on this point since several studies employ a larger sample of IB in the comparison, particularly recent studies.

[7] To our knowledge, very limited papers are concerned with SFA cost frontier and the decomposition of total cost efficiency into technical and allocative efficiency in banking, see for example Chaffai (2002). This is mainly due to the lack of good measures for input prices in banking for the decomposition.

Table 1: Characteristics of the primary studies

Study	Author(s)	Year	Studied Period	Number of collected estimates	Efficiency Measure	Region or Country(ies)	# obs (IB/CB)	Average efficiency IB	CB
1	AlJarrah &Molyneux	2006	1992-2000	9	SFA(Cost)	BH, EG, JO,SA(#3)	(11/30)	0.982	0.944
2	Ariss	2007	1998-2003	6	SFA(Cost)	GCC(#3)	(7/ 66)	0.883	0.755
3	Al-Muharrami	2008	1993-2002	10	DEA(I)	GCC(#6)	(7/45)	0.888	0.881
4	Bader	2008	1992-2005	28	DEA(C,P,R)	Africa,Mena,Asia(#21)	(43/37)	0.857	0.887
5	Hassan et al.	2009	1990-2005	2	DEA(C,P)	Mena(#11)	(22/18)	0.879	0.867
6	Johnes et al. (a)	2009	2004-2007	4	DEA(O)	GCC(#6)	(19/50)	0.872	0.911
7	Abdul-Majid et al.(a)	2010	1996-2002	7	Dist.(SFA)	GCC&Asia(#10)	(23/88)	0.706	0.859
8	Srairi	2010	1999-2007	2	SFA(Cost, Profit)	GCC (#6)	(23/48)	0.567	0.681
9	Abdul-Majid et al.(b)	2011	1996-2002	1	SFA(Cost)	MY(#1)	(6/19)	0.669	0.826
10	Assaf et al.	2011	1999-2007	9	DEA(O)	SA(#1)	(6/3)	0.874	0.939
11	Olson & Zoubi	2011	2000-2008	4	SFA(Cost, Profit)	Mena (#10)	(17/66)	0.644	0.684
12	Rozzani&Abdulrahman	2013	2008-2011	4	SFA(Profit)	MY(#1)	(16/19)	0.439	0.460
13	Johnes et al. (b)	2014	2004-2009	6	DEA(O)	GCC&Asia(#18)	(45/207)	0.789	0.800
14	Kamarudin et al.(a)	2014	2007-2011	3	DEA(C,P,R)	GCC((#6)	(27/47)	0.478	0.718
15	Mobarek and Kalonov	2014	2004-2009	12	DEA(I),SFA(I)	GCC&Asia(#18)	(101/307)	0.613	0.666
16	Shaban et al.	2014	2002-2010	2	SFA(Cost, Profit)	IN(#1)	(7/107)	0.875	0.870
17	Yilmaz and Günes	2015	2007-2013	7	DEA(I)	TR(#1)	(4/28)	0.845	0.816
18	Kamarudin et al.(b)	2015	2007-2011	3	DEA(C,P,R)	GCC((#6)	(27/47)	0.476	0.691
19	Saeed & Izzeldin	2016	2002-2010	2	SFA(Cost, Profit)	GCC&Asia(#8)	(23/83)	0.840	0.817
20	Azad et al.	2017	2009-2013	1	DEA(O)	MY(#1)	(16/27)	0.958	0.943
21	Abdul-Majid et al.(c)	2017	1996-2010	1	SFA(Cost)	MY(#1)	(14/36)	0.832	0.888
22	Al-Jarrah et al.	2017	2007-2013	7	SFA(Cost)	Mena(#19)	(222/954)	0.774	0.776
23	Alqahtani et al.	2017	1999-2012	2	DEA(C,P)	GCC(#6)	(30/50)	0.639	0.688
24	Batir et al.	2017	2005-2013	2	DEA(I,C)	TR(#1)	(4/29)	0.857	0.643
25	Miah & Uddin	2017	2005-2014	1	SFA(Cost)	GCC(#5)	(20/28)	0.650	0.851
26	Doumpos et al.	2017	2000-2011	3	SFA(Cost, Profit)	Mena&Asia(#22)	(101/347)	0.790	0.785
27	Asmild et al.	2018	2001-2015	20	DEA(I)[8]	BA(#1)	(7/23)	0.801	0.775
28	Bitar et al.	2018	1999-2013	2	DEA(I)	Mena & Asia(#33)	(116/540)	0.597	0.558
29	Abid & Goaied	2019	2001-2015	15	SFA(Cost)	GCC(#6)	(17/47)	0.667	0.594
30	Alexakis et al.	2019	2006-2012	7	DEA(O)	GCC(#6)	(19/43)	0.753	0.765
31	Chaffai & Hassan	2019	2002-2014	13	SFA(Cost)	Mena(#15)	(106/245)	0.861	0.912
32	Chaffai	2019	2002-2014	5	SFA(Cost,Profit,M)	Mena(#16)	(94/231)	0.807	0.828
33	Hafez & Halim	2019	2003-2017	7	DEA(I)	EG(#1)	(5/25)	0.954	0.856
34	González et al.	2019	2005-2012	1	SFA(Cost)	Mena(#19)	(40/161)	0.730	0.780
35	Safiullah & Shamsuddin	2019	2003-2014	8	SFA(Cost,Profit)	Africa,Mena,Asia(#21)	(94/94)	0.775	0.819

Whatever is the methodology or the selected sample of countries across studies to evaluate the efficiency by bank type, the average efficiency score for Islamic banks is equal to 0.779 and varies between 0.345 and 0.99, slightly higher average values for conventional banks, 0.792 in the range between 0.383 and 0.99. Table 2 reports the average efficiency scores by bank type according to some characteristics. Overall there is no substantial difference in average efficiency scores between the two bank groups according to the mean difference t-test. In addition, there is also no statistical difference between the two bank groups in terms of cost efficiency, profit efficiency or technical efficiency. However, if we control for some additional characteristics across the 35 studies, we can find some differences in four cases where CB are significantly more efficient than IB, and in only one case with the opposite conclusion. For example, CB are found to be statistically much more efficient than IB (with a difference ranging from (4.3%-5.8%), according to the studies using SFA approach, or in the GCC and MENA and Asian region. However, IB are found to be more efficient (4.6%) for studies comparing the two type of banks in one country, (see Table 1 to see the list of studies and countries). According to ICD Thomson Reuters (2016) report and figures, GCC is one of the most important region in the world in terms of Islamic banking assets in 2016, with 795.673 US billion, followed by other MENA region (excluding GCC) with 511.254 US billion, and South east Asia with 200.242 billion. The most important countries in terms of assets shares, is Saudi Arabia with 46.7% in the GCC, 90.66% for Iran in other MENA, and 82.64% for Malaysia in South east Asia. From Table 2, IB in the GCC are found to be less efficient than their counterparts, but also when they are included in much larger group MENA

[8] The methodology in this paper uses a new DEA approach called multidimensional efficiency analysis which provides non radial measure of inefficiency specific to each input. Since the approach is new, and no other paper used it, we classified it as an input oriented DEA model, taking the average of the efficiency scores specific to each input.

and other regions. Finally, we notice that the authors who conduct a deep comparison of the efficiency distributions (by providing a mean t-test of the difference of the efficiency scores by bank type) find on average that CB outperform IB and the difference is statistically significant. However, there is no significant differences in the efficiency scores when the authors does not report any test for the efficiency differences. This issue will be further be assessed in our meta regression analysis below.

Table 2: Average efficiency characteristics by bank type

	Islamic banks			Conventional banks		Mean difference	
	Mean	sd	# obs	Mean	# obs	t-test	P-value
Methodology							
Parametric	0.745	(0.015)	102	0.788	(0.013) 102	-2.185	(0.030) **
Non parametric	0.804	(0.012)	140	0.795	(0.011) 140	0.540	(0.589)
Efficiency model							
Cost	0.782	(0.016)	97	0.799	(0.015) 97	-0.818	(0.353)
Profit	0.693	(0.027)	37	0.741	(0.022) 37	-1.348	(0.182)
Technical efficiency	0.806	(0.012)	108	0.803	(0.010) 108	0.195	(0.845)
Geographical zone							
One country	0.815	(0.016)	76	0.769	(0.017) 76	1.996	(0.048) **
GCC	0.720	(0.022)	66	0.778	(0.015) 66	-2.175	(0.032) **
Mena	0.848	(0.016)	50	0.844	(0.015) 50	0.189	(0.850)
Mena less Iran*	0.902	(0.028)	22	0.862	(0.022) 22	1.144	(0.259)
Mena &Asia & Africa or GCC & Asia	0.798	(0.011)	109	0.829	(0.102) 109	-2.007	(0.046)**
Studies which compare the efficiency distributions							
Mean difference test (Yes)	0.771	(0.010)	133	0.809	(0.008) 133	-2.829	(0.005)***
Mean difference test (No)	0.789	(0.017)	109	0.771	(0.015) 109	0.774	(0.439)
Average	0.779	(0.009)	242	0.792	(0.008) 242	-1.044	(0.297)

(*) we retain only the studies on MENA region where Iran has been excluded.

Another interesting result, is the importance of the profit inefficiency 30.7%, compared to cost inefficiency or technical inefficiency, 21.8% and 19.4% respectively. It seems, that both CB and IB in the reported studies, have on average much more difficulties in making profit than in controlling cost or their production process. This global result is on line with what has been found in empirical banking literature where it has been evidenced that profit inefficiency is higher than cost inefficiency, Amel et al. (2004). These authors attributes this result to bank-unobserved specific factors such as management quality, or characteristics of local demand and conclude that bankers should make more effort to increase their revenue than in reducing costs in order to become more profit efficient. This result seems to be also verified in MENA and the GCC banking systems too. We report in the appendix additional figures, which report the average efficiency by bank type and region, Figure 1, and the evolution of these efficiencies over time Figure 2. Figure 1 shows that the average highest efficiency scores are obtained in studies conducted on MENA region or for single country. While Figure 2, shows an overall downward trend on efficiency until 2009, followed by an upward trend until 2014. In fact, the impact of the financial crisis being evident, the downward trend may be explained by the high levels of efficiency scores obtained in the first studies which are generally based on small samples of banks and which use very standard frontier models. Recent studies employ much more heterogeneous samples of countries and much more advanced frontier estimation techniques providing lower levels of efficiency scores, see Table1.

4. Meta regression results

As shown in the previous section, the comparison of the average efficiency scores reported in the primary studies highlights important heterogeneity as mentioned by different criteria's. The issue here is to investigate the variability of the efficiency scores by adding additional control variables using the meta regression model, in order to drive a final conclusion on whether one bank type outperform the other. Notice here that there is no way to include in the comparison conventional banks which offer Islamic windows due to the lack of data. Among the 35 primary studies, only two papers present estimates of the efficiency for windows, Abdul-Majid et al. (2011) for Turkey, and Hafez and Halim (2019) for Egypt. According to the most common characteristics found in the 35 primary studies, the control variables are classified into three groups. The first group is what we call banking model variables. It includes some warnings suggested by some banking scholars on the variability of the definition of the efficiency scores in constructing the frontier model itself. For instance, we include dummies variables for studies which measure profit, cost, X efficiency and also a dummy for studies which estimate a meta frontier. Number one is the sensitivity of the results due to the specification of the inputs and the outputs, Table 6 in the appendix shows a high heterogeneity in the definition of the inputs and the outputs where different proxies for prices are employed. For example, most of the primary studies retain conventional outputs and inputs, 97.22% of the studies use loans as an output, 66.67% other earning assets as a second output, but less consensus is reported in the selection of the other outputs, only 22.22% of the studies consider off balance sheet activities as an additional output, 11.11% consider income as an output, among other cases. Much more heterogeneity in the input selection is observed. Among the large package of the 9 inputs considered in the primary studies, the authors employ a proxy for labor input measured by salaries and book values for physical capital, in 72.22% and 75% of the studies respectively, but much more heterogeneity in the definition of the other inputs is observed. 52.78% of the studies consider deposit as an input, only 17.65% consider equity as an input. This heterogeneity in the inputs and outputs definition, has also an important impact in constructing their respective prices, where proxies for output and input prices are employed in quite most of the studies. This issue is particularly important when authors estimate efficiency using behavioral models and employ nonparametric method because there is no way to take into account for noise coming from measurement errors in prices linked to the employed proxies with DEA models. Moreover, there is also another heterogeneity linked to the definition of the bank production process itself in the primary studies, this is common to most of the empirical literature on bank efficiency. As we have noticed in the first section, there is the intermediation approach and the production approach, this last approach has never been employed in the selected 35 primary studies due mainly to the availability of the data. Notice here that most of the studies, 27 used exclusively Bankscope data, 5 a mixed of Bankscope data and other sources like banks website or annual reports, but only 3 studies have used only annual bank's reports. We have noticed that most of the surveyed studies employ either the intermediation approach or a hybrid form where deposit is retained as an output among the other conventional outputs in the intermediation approach (loans, other earning assets, investments). Number two is whether off balance sheet activities should be included or not as an output. Earlier studies warned researchers evaluating bank efficiency that omitting off balance sheet activities such as customers irrevocable lines of credit or other credit commitments for example, may understate the evaluation of bank cost revenue and profit efficiency, see Rogers (1998) for the US case. To our knowledge, there is no comparative study on bank efficiency in MENA region which compared the efficiency using a standard model with only traditional bank activities and another one with off balance sheet activities as an additional output. Number three is whether the model used takes into account for risk or not. As mentioned by Berger and Mester (1997) some banks may be more

risk averse than others which may impacts on their behavior, cost or profit efficiency. They suggest to account for this phenomenon by adding equity or equity to total assets as a control variable in the frontier, some authors include equity as an additional input. The second group of variables is much more linked to the sample construction across the selected studies. Number one, is the sampled countries retained in the comparison. Some studies compare bank's performance at the national level by using just one country with very limited number of IB banks in the samples, Bader et al. (2007). Others use much larger samples of countries and consider specific region, the GCC, MENA, or a much larger countries sample including Asian countries. Number two is whether Iran should be included or not in the sample. Beyond those studies which compare the efficiency of IB and CB for one country or the GCC, the authors of studies including MENA region does not usually agree to include Iran in the sample. Some researchers use the argument that this country has an exclusively Islamic banking system so it should be excluded in the comparison, others who support its inclusion, argue that this country is one of the most important in the region in terms of banking assets and accounts for about 46.6% of the assets in the GCC according to the ICD-Thomson report 2017. Number three, is the data structure used, i.e. panel data or cross sectional data. Notice here, some authors who have panel data and employ nonparametric DEA method estimate the frontier by year because constructing a common frontier would consider the same bank observed for several years as a different production unit. It means that they estimate the efficiency favoring the cross section dimension and ignore the potential correlations between the efficiency scores across banks. This is not the case with SFA models where there is specific methodologies to construct the frontier using panel data (The true fixed effect model Greene(2005), Battese and Coelli (1995), Cornwell et al. (1990)). In the third group, we include other characteristics commonly used in meta studies, a variable called Hindex, measured by the H index (SJR) of the journal in which the paper has been published, to take account for the quality of the study. This variable is usually included in any meta regression analysis, Aiello and Bonnano (2016), (2018) and Irsova and Havranek (2010). We also add a dummy variable which takes the value of 1 when the author mention that the monetary variables have been deflated and 0 if not. This issue is important in particular when comparing banks at the international levels over years, for countries with high instability in inflation rate. Finally the sample size measured by the logarithm of the total number of observations is important since it may characterize the precision of the reported efficiency estimates.

The meta regression equation is the following:

$$Eff_{ij} = f(Islamic, Bank \text{ characteristics}, \text{Sample characteristics}, \text{Other controls}) + u_j + \varepsilon_{ij}, \quad (1)$$

$$i = 1,2,...,N_j \text{ observation}, \; j = 1,..35 \text{studies}$$

Eff is the average efficiency score reported in each j study by bank type, Nj is the total number of estimates reported by study. Due to the bounded nature of the efficiency score, we employ the Tobit estimation method. We also employ the ordinary least squares method, OLS for comparison. For both methods, we use in addition the heteroscedasticity correction to take into account the potential heterogeneity of the variance of the reported estimates. To sum, we have 20 potential covariates for the efficiency measures. To address the model uncertainty, as we have 2^{20}=1048576 regressions, called the whole model space, to be conducted in order to select the final model specification. It is quite impossible to select the best model within these cases. To deal with the model specification uncertainty, we employ the Bayesian model

averaging (BMA), to select the best one in the space of plausible models[9]. We follow earlier studies employing BMA in meta regression by Irsova Z., Havranek T. (2013) for foreign direct investment spillovers. In the spirit of Bayesian inference, the procedure search the most probable regressions in the model space. Each model is given a weight called a posterior probability, and the parameter estimates of the selected model are averaged across all possible combinations of models estimated by OLS. The inclusion of a specific variable in the final model is based on the posterior probability of inclusion (PIP) which conditional on the data, provide a probability for an independent variable to be included in the model. A variable with at least 30% PIP has been retained in the final specification, so for all the variables with lower values of PIP will not be considered as important in explaining the variations of the efficiency estimates. The model selected by BMA constitutes a first step to specify the model which will be estimated by OLS and Tobit method in a second step. The discussion of the results will then be discussed for the model selected by BMA.

Table 3: Meta regression parameter estimates for mean efficiency

	BMA		OLS	Tobit
Variables	Post-Mean	Pip		
Constant	0.955	1.00	0.935***	0.939***
	(0.041)		(0.045)	(0.044)
Islamic	-0.011	1.00	-0.013	-0.012
	(0.011)		(0.010)	(0.010)
Param	0.053	1.00	0.036	0.038*
	(0.024)		(0.023)	(0.023)
Cost	-0.056	1.00	-0.054***	-0.054***
	(0.015)		(0.018)	(0.018)
Profit	-0.104	1.00	-0.103***	-0.104***
	(0.017)		(0.018)	(0.018)
GCC	0.230	1.00	0.009	0.010
	(0.020)		(0.022)	(0.021)
MENA	0.098	1.00	0.089***	0.092***
	(0.024)		(0.023)	(0.023)
MENAASIA	0.043	1.00	0.027	0.029
	(0.023)		(0.023)	(0.023)
GCCASIA	-0.063	1.00	-0.073*	-0.072*
	(0.031)		(0.038)	(0.038)
Intermediation	0.013	0.36	0.037*	0.036*
	(0.021)		(0.020)	(0.020)
Off-balance sheet	0.068	1.00	0.068***	0.068***
	(0.015)		(0.016)	(0.016)
Iran	0.090	1.00	0.085***	0.084***
	(0.019)		(0.017)	(0.017)
SJR	0.077	1.00	0.072***	0.072***
	(0.015)		(0.017)	(0.017)
Size	0.055	1.00	-0.051***	-0.051***
	(0.009)		(0.009)	(0.009)
Meta	0.068	0.97	0.062***	0.063***
	(0.023)		(0.018)	(0.018)
Panel	0.000	0.04		
	(0.004)			
Risk_Control	-0.001	0.06		
	(0.006)			
Deflated	0.001	0.05		
	(0.007)			
Meta*Islamic	-0.008	0.17		
	(0.020)			
Cost*Islamic	-0.000	0.05		
	(0.003)			
Profit*Islamic	-0.003	0.09		
	(0.013)			
Observations	484		484	484
R-squared	-		0.370	

Robust standard errors in parentheses for OLS and Tobit
*** p<0.01, ** p<0.05, * p<0.1

[9] We also used stepwise regression method which provide the same final specification, results could be obtained upon request.

The most important question addressed in this paper is whether Islamic banks are more or less efficient than conventional banks. Islamic dummy variable which takes the value of 1 for Islamic banks and 0 for conventional banks is introduced in equation (1) to test this assumption. Table 3 below presents the results and shows that the two estimated methods, OLS and Tobit provide similar results. The dummy variable Islamic is negative but not significant in all regression cases which suggests that IB are as efficient as CB whatever is the model used to compare bank's performance. Most of the significant variables are those mainly linked to the methodology, the model used and what we previously called banking variables characteristics. For instance, the dummy variable Param is positive and significant (with a p-value of the t-test equal to 0.118 for OLS) which suggests that parametric frontier model, here SFA method yields on average around 3.8% higher efficiency scores than non parametric model using DEA models. This result can be explained by the fact that most of the estimates based on nonparametric behavioral models related efficiency scores are not directly comparable to those obtained from SFA, for example the scores derived from non standard profit frontier may differ with those obtained from a DEA model estimating profit efficiency since the behavioral model is not exactly the same. Furthermore, let me notice that we only found two studies among the 35 which compared the two methods on the same sample. Mobarek and Kalonov (2014) found that nonparametric models provide higher score in 2004 but the reverse for all the other years, 2005 to 2009. Doumpos et al. (2017) report average lower levels of efficiency of DEA models compared to SFA. These two examples, show that using the same samples SFA models depicts higher efficiency scores than DEA. The dummy variables, Cost and Profit are significant, (the excluded variable for this group of dummies is the efficiency derived from non behavioral models, i.e. X-efficiency). It suggests that there is a difference in the results obtained by behavioral models compared to non behavioral model. Interestingly, the results show that banks have more difficulties to control profit and costs than in controlling their overall production process. However, the high negative sign for profit dummy -10.3.% means that the potential for making much more profit by more likely making higher revenues is greater than the potential for doing so by reducing bank's costs or by improving technical efficiency. In other words, to increase their efficiency the bankers in the studied regions should mainly target: following this order, on increasing their profit, reduce their costs, instead of focusing on higher X-efficiency. Moreover, when we cross the cost and profit dummies with Islamic, the combined effect prove to be non significant. This result suggest no significant differences in profit and cost efficiency between IB and CB. The geographical dimension of the studies is also important explaining the heterogeneity of the efficiency measures. Only MENA and GGC and Asia groups regional dummies are significant, the excluded regional dimension being the studies based on a single country. The positive sign associated coefficient for MENA means that the efficiency score in MENA region is 7%-8% higher compared to studies based on a single country. By contrast, the GCC banks group being the most homogeneous group, the related dummy coefficient is not significant compared to single country studies, while the GCC with Asian countries group is less efficient compared to one country studies. This would imply that both IB and CB are much more efficient in MENA compared to the GCC.

The coefficient on the dummy Intermediation is positive and significant and suggests that the studies which consider the hybrid model, in particular when authors omit some inputs or outputs under estimate the efficiency of banks, or when they include deposits as an input. However, studies which consider off balance sheet activities as an additional output provide higher efficiency scores. This result is on line with the one obtained by Lozano and Pasiouras (2010) when they compared cost and profit efficiency using two models with and without off balance sheet. In addition, incorporating risk as an additional input or as a control in the model has no significant impact on the efficiency measure. It means that not controlling for

risk in construction the frontier has no impact on the efficiency of banks according to these studies. This result could be explained by the heterogeneity of the studies which include this variable, in some studies equity is considered as an input while in others it is incorporated in the behavioral models as a control variable. Due to the few specific cases, we are not able to distinguish them in the meta regression model.

The other sample characteristics variables, comparing banking efficiency using panel data, or deflating the monetary variables has no significant impact on the reported efficiency measures. The size variable measured by the logarithm of the total number of observations has a negative and significant impact on efficiency measure. A possible explanation, is since more than half of the efficiency estimates are coming from nonparametric methods 48%, it is well known that DEA estimates are higher with small samples, in particular when the estimates are based by year. So the higher is the sample size the lower would be the efficiency scores. In addition it is found that including Iran banking system, provides significant and positive impact on the efficiency measure, which suggest that this country should be included in any study comparing IB to CB at the international level, (MENA).

The dummy variable META, which takes the value of 1 for studies employing meta frontier models, is positive and significant suggests that meta frontier methodology provide 6% much higher efficiency scores compared to standard frontier models. This could be explained by the method itself, in a first step the banks are projected onto their own frontiers, while in the second step, the inefficiency is calculated as the difference between each group frontier and the meta frontier. Finally, the quality of the study, measured by the Scientific Journal Index, SJR is positive and significant which suggests that the journal ranking associated with a more likely presence peer reviewed system contributes to increase the efficiency estimates. One possible explanation of this result, efficiency measurement reported in highly indexed journals usually favor publications using improved methodologies and models with associated advanced techniques. This is the case for example for the recent studies of Johnes et al. (2014), Safiullah and Shamsuddine (2019) and Chaffai and Hassan who employ meta frontier techniques, or Abdulmajid (2010) and Alexakis et al. (2019) who employ output distance functions to estimate X-efficiency.

While the previous estimates did not find any evidence of the superiority of conventional banks system over their counterparts, we may have double suspicions that (i) some authors omit to conduct a deep comparison on the efficiency scores by comparing the efficiency distributions by bank type in the primary studies because they do not want to prove that that one banking system is statistically more/less efficient (ii) while those who do that, may want to show that one banking system outperform the other and the reviewers may favor such findings (iii) not providing the comparisons is not important with regard to the objective of the paper which is not mainly focused on the comparison of the efficiency of the two banking systems. Among them, 19 studies found that CB outperform IB with a significant difference in efficiency +3.8%, while for the other 18 studies which do not report such test, we found that IB outperform CB with a difference 1.3%, but this difference is not statistically significant, see Table 2. The question is whether such omission in comparing the two efficiency distributions is subject to a potential publication bias in some studies. To check this assumption, we re-estimated the meta regression models by distinguishing the two subsamples according to whether the authors report mean difference tests of the efficiency scores by bank type or not[10].

[10] To save space we just report the results for Model 3, the main conclusion regarding Islamic bank type remain robust for the Tobit models, results could be obtained upon request.

Table 4: Meta regression parameter estimates for mean efficiency by subsample

Variables	OLS (1) with t-test	OLS (2) without t-test	Tobit (3) with t-test	Tobit (5) without t-test
Constant	0.594***	1.237***	0.594***	1.242***
	(0.098)	(0.118)	(0.096)	(0.116)
Islamic	-0.038***	0.017	-0.038***	0.019
	(0.010)	(0.015)	(0.009)	(0.015)
Param	0.033	0.230***	0.033	0.231***
	(0.036)	(0.066)	(0.035)	(0.064)
Cost	0.008	-0.208***	0.008	-0.209***
	(0.023)	(0.040)	(0.023)	(0.039)
Profit	-0.053**	-0.339***	-0.053**	-0.340***
	(0.021)	(0.048)	(0.021)	(0.046)
GCC	0.064	0.154***	0.064	0.155***
	(0.040)	(0.053)	(0.039)	(0.052)
MENA	-0.042	0.156***	-0.042	0.161***
	(0.041)	(0.031)	(0.040)	(0.030)
MENAASIA	-0.047		-0.047	
	(0.033)		(0.032)	
GCCASIA	-0.042	0.105**	-0.042	0.107**
	(0.037)	(0.050)	(0.036)	(0.049)
Intermediation	0.095***	0.004	0.095***	0.004
	(0.026)	(0.034)	(0.026)	(0.033)
Off-balance sheet	0.178***	-0.035	0.178***	-0.036
	(0.041)	(0.036)	(0.040)	(0.035)
Iran	0.061***	0.228***	0.061***	0.225***
	(0.019)	(0.062)	(0.018)	(0.061)
SJR	0.016	0.191***	0.016	0.191***
	(0.027)	(0.053)	(0.026)	(0.051)
Size	0.007	-0.122***	0.007	-0.123***
	(0.014)	(0.035)	(0.014)	(0.035)
Meta	0.090***	0.036	0.090***	0.036
	(0.027)	(0.041)	(0.026)	(0.041)
Observations	266	218	266	218
R-squared	0.521	0.566		

Robust standard errors in parentheses for OLS and Tobit, study dummies estimatesare not reported
*** p<0.01, ** p<0.05, * p<0.1

Overall, as shown in Table 4, IB are much less efficient -3.6% compared to CB from the reported primary studies when the authors compare the two efficiency distribution by conducting a mean difference test. However, when they do not compare the distributions, IB are more efficient, but the difference is not statistically significant. For the other control variables, we can find also some differences in the results, in particular with the regional dimension or the model used. This could be explained by the subsamples variability. By contrast, the variable SJR which measure the publication quality, is statistically significant and positive for the subsample of studies which compare the distributions, but not significant for the other subgroup. A results which suggests that the studies which are published in highly indexed journals are more vigilant, their referees may be more strict and may ask for more statistical details when the authors compare the efficiency scores by bank type.

5. Robustness checks

We conduct alternative estimates of the meta regression model to examine whether the previous results discussed previously are robust. Two additional cases are explored. First, since the number of collected estimates by author differs, we check the sensitivity of our results when we exclude the study of Bader et al. (2007)[11] which includes the largest number of estimates 28, in our meta selection primary studies, and represents 11.57% of the total sample. In addition, this study considers the case of 21 countries in MENA, Africa and Asia but the sample of banks retained is the lowest compared to other studies for similar countries,

[11] It is one of the most cited papers on the efficiency comparison of the two banking systems, it is cited 294 times in google on 24 November 2019.

see Table 1 (43 IB and 37 CB). The representativeness of Islamic banks in this sample could be fragile as it is the case for the conclusions reported. Table 5, column Robust 1, reports the OLS results for the full sample and also for the two subsamples of studies which conduct the mean difference t-test or not. We still confirm our main results that there is no difference in overall banking efficiency between IB and CB, the difference being only significant for the studies which also conduct mean difference tests but not the opposite case. For the other covariates, most of the variables remain significant and with the same sign, parametric, profit, cost off balance sheet, SJR Meta and size. The conclusion of the previous results remain qualitatively close with regard to the geographical dimension of the studies, MENA being the most efficient region.

Second, the number of estimates per author being different, the higher is the number of reported estimates per study, the higher is its weight in the meta regression. In order to take into account for the unobserved heterogeneity linked to each primary study, we re-estimate the models by adding study fixed effect, the estimator hereafter called fixed effect[12]. The results of these robustness are provided in Table 5, we just report the parameter estimates by ordinary least squares method called Robust 2, the Tobit method which provides very close conclusions are not reported for brevity purpose. Notice at this stand, that the variables which does not varies within studies are automatically eliminated, such as Parametric or Iran for the subsample of studies which does not provide t-test.

The dummy Islamic is now negative and significant for all the sample and suggest that on average IB are slightly 1.3% less efficient than CB, a result which contradicts the previous results, but the difference is very low. The conclusion remain qualitatively the same for some variables, Profit, Meta or banking characteristics, or the quality of publications but some differences are found in particular with the geographical dimension. MENA is no more the most efficient region in terms of banking efficiency, GCC group being the most efficient, but when we enlarge this group to Asian countries it become the less efficient. However, with respect the potential publication bias, the same conclusion remain, only studies which conduct the comparisons of the efficiency distributions provide significant coefficient for Islamic dummy.

This last robustness check of the results should be further investigated. In fact, considering that all the studies have the same weights may penalize those studies which use large samples of banks or countries compared to small sample studies. The best way should be to weight the estimates by their reported standard errors for the efficiency scores by bank type. Unfortunately, this information is provided for only 39.67% of the primary studies estimates. Estimating the model for this subsample will introduce an additional bias due to sample selection in this case, explaining why this approach has been shelved.

[12] Authors who use this estimator in meta regression analysis call it the Fixed Effect, which should not be confused with the panel data Fixed Effect estimator.

Table 5: Meta regression robustness checks of the results

Variables	Robust 1(One study omitted) All sample	with t-test	without t-test	Robust 2 (Fixed effect) All sample	with t-test	without t-test
Constant	0.937***	0.780***	1.237***	0.672***	0.506***	0.933***
	(0.042)	(0.165)	(0.118)	(0.096)	(0.145)	(0.064)
Islamic	-0.010	-0.039***	0.017	-0.013*	-0.038***	0.017
	(0.011)	(0.011)	(0.015)	(0.008)	(0.008)	(0.013)
Param	0.113***	0.086	0.230***	0.096*	0.039	
	(0.025)	(0.054)	(0.066)	(0.050)	(0.033)	
Cost	-0.123***	-0.032	-0.208***	-0.123***	0.019	-0.193***
	(0.024)	(0.032)	(0.040)	(0.035)	(0.034)	(0.042)
Profit	-0.177***	-0.062**	-0.339***	-0.163***	-0.055**	-0.206***
	(0.027)	(0.028)	(0.048)	(0.035)	(0.028)	(0.057)
GCC	0.034	0.017	0.154***	0.277***	0.022	0.142***
	(0.022)	(0.047)	(0.053)	(0.083)	(0.051)	(0.053)
MENA	0.141***	0.001	0.156***	0.007	0.029	0.370***
	(0.027)	(0.051)	(0.031)	(0.067)	(0.040)	(0.050)
MENAASIA	-0.028	-0.075**		-0.005	0.061	
	(0.023)	(0.035)		(0.094)	(0.044)	
GCCASIA	-0.108***	-0.083**	0.105**	-0.261***	-0.087**	0.259***
	(0.036)	(0.042)	(0.050)	(0.031)	(0.043)	(0.055)
Intermediation	-0.008	0.047	0.004	-0.089***	0.114***	0.032
	(0.019)	(0.049)	(0.034)	(0.033)	(0.026)	(0.072)
Off-balance sheet	0.047***	0.087	-0.035	0.416***	0.188***	0.062
	(0.017)	(0.075)	(0.036)	(0.074)	(0.066)	(0.062)
Iran	-0.000	0.017	0.228***	0.078***	-0.010	
	(0.024)	(0.040)	(0.062)	(0.024)	(0.031)	
SJR	0.111***	0.021	0.191***	0.250***	0.127**	0.130***
	(0.019)	(0.029)	(0.053)	(0.038)	(0.062)	(0.047)
Size	-0.048***	-0.015	-0.122***	-0.012	0.011	-0.064**
	(0.008)	(0.022)	(0.035)	(0.029)	(0.021)	(0.028)
Meta	0.064***	0.102***	0.036	0.118***		0.141***
	(0.018)	(0.029)	(0.041)	(0.025)		(0.053)
Observations	428	210	218	484	266	218
R-squared	0.383	0.460	0.566	0.663	0.684	0.693

5. Conclusions

In this paper we conduct a meta analysis based mostly on published empirical literature comparing the efficiency of IB and CB from 1993 to 2019 and using frontier models. We collect 484 efficiency scores from 35 primary studies and other variables which may explain the heterogeneity of the reported results. The main question addressed is whether one bank type outperform the other conditional on the characteristics of the model, the data or the inputs/outputs used. This issue was highly discussed by scholars and some of them have reported that one bank type outperform the other, while others have reported opposite conclusion. Controlling for several sources of the heterogeneity of the primary studies, our investigations reach a "verdict" and show that there is no significant differences in the average efficiency between Islamic bank and conventional bank whatever is the metric, i.e. cost, profit or technical efficiency. There is no need to separate the sample by bank type in conducting an efficiency analysis for countries with the two banking systems. Furthermore, knowing that most of Islamic banking industry is mainly active in the GCC countries, Southeast Asia region, or in MENA, our meta analysis shows that MENA region banking system is much more efficient compared to other regions. Other characteristics prove to have an important impact on the efficiency measures, particularly the importance of inputs and output selection. For example using an hybrid model while selecting the inputs and the outputs in the bank production model, ignoring off balance sheet activities (in conducting international comparisons) may underestimate the efficiency of banks. Including Iran which has only Islamic banking system is important in any study covering the MENA region. However, using

larger size with highly heterogeneous banking systems may lead to lower efficiency scores. We also found that authors who estimate meta frontier provide higher efficiency scores compared to standard frontier models. Finally, the quality of the study has a positive impact on the efficiency measures, which may be explained by the editorial board policy vigilance for indexed journals. All these characteristics should be taken into account when evaluating a study on the efficiency of banks in the studied regions. Another interesting finding in this meta analysis linked to a potential publication bias has been evidenced. When we distinguish the studies into two authors groups, those who report a comparison of the efficiency distributions and those who do not, we find some differences suggesting potential publication bias. The results show that CB outperform IB, with a significant difference of 3.8% for studies which compare the efficiency distributions by bank type, but no difference for those authors which do not conduct the tests.

To conclude, we show the importance of banking and sample characteristics which may affect the efficiency measures in any study aiming to compare banking efficiency of IB and CB in the studied regions. Comparing the efficiency distributions by using statistical tests is highly recommended as we have shown a suspicion of potential bias. Putting aside the question of ownership structure and efficiency in the MENA or the GCC region, the meta regression analysis find evidence that the banks have more difficulties to increase their profits than to reduce costs than to control their technical efficiency. The region banking system is much less profitable than it should be and it is costly. This issue is particularly important for policy makers in the region who need to reinforce bank competition by for example deregulating their markets or by allowing more entries should be the real challenge in the future. Finally, we have shown the fragility of the conclusions based on the comparison of the efficiency of the two banking systems based on the experience of one single country. Policy makers for the issue of bank ownership structure and performance should be warned from the experience of a single country.

References

Abdul-Majid, M., Saal, D.S., Battisti, G., (2010) Efficiency in Islamic and conventional banking: an international comparison. Journal of Productivity Analysis, 34, 25–43

Abdul-Majid, M., Saal, D.S., Battisti, G., (2011) The impact of Islamic banking on the cost efficiency and productivity change of Malaysian commercial banks. Applied Economics, 43, 2033–2054

Abdul-Majid M., Falahaty M., Jusoh M. (2017) Performance of Islamic and conventional banks: A meta-frontier approach. Research in International Business and Finance, 42, 1327-1335

Abedifar P., Ebrahim S. M., , Molyneux P., P., Tarazi, A. (2015) Islamic banking and finance : Recent empirical literature and directions for future research. Journal of Economic Surveys, Vol 29, No 4, 637-670

Aigner D. J., Chu S. F. (1968) On estimating the industry production function. American Economics Review, 58:4, 826-839

Alexakis C., Izzeldin M., Johnes J., Pappas V. (2019) Performance and productivity in Islamic and conventional banks: Evidence from the global financial crisis. Economic Modelling, 79, 1-14

Al-Jarrah I., Molyneux P. (2006) Cost efficiency, scale elasticity and scale economies in Arab banking. Banks and Bank Systems, Vol 1, 3, 60-89

Al-Muharrami S. (2008) An examination of technical, pure technical and scale efficiencies in GCC banking. American Journal of Finance and Accounting, Vol 1, 2, 152-166

Alqahtani F., Mayes D. G., Brown K. (2017) Islamic bank efficiency to conventional banks during the global crisis in the GCC region. Journal of International Financial Markets, Institutions & Money. 51, 58-74

Amel D., Barnes C., Panetta F., Salleo C. (2004) Consolidation and efficiency in the financial sector: A review of the international evidence. Journal of Banking and Finance, 28, 2493-2519

Ariss, R.,T., (2007). On the rise of Islamic banking among giant commercial banks: A performance and efficiency analysis. Journal of International Business and Economics, 7(1), 70-83

Asmild M., Kronborg D., Mahbub T., Matthews K. (2018) The efficiency patterns of Islamic banks during the global financial crisis: The case of Bangladesh. The Quarterly Review of Economics and Finance, forthcoming, (Available online 12 April 2018)

Assaf G., Barros G. P., Matousek R. (2011) Technical efficiency in Saudi banks. Expert Systems with Applications, 38, 5781-5786

Azad M. A., Munisamy S., Masum A. M., Saona P., Wanke P. (2017) Bank efficiency in Malaysia: A use of Malmquist meta-frontier analysis. Eurasia Business Review, 7: 287-311

Bader, M., K., Shamsher, M., Ariff, M., Taufiq, H. (2007). Cost, revenue and profit efficiency of conventional versus Islamic banks: Financial ratios approach. Review of Islamic Economics, 11(1), 89-106

Batir T. E., Volkman D. A., Gungor B. (2017) Determinants of bank efficiency in Turkey: Participation banks versus conventional banks. Borsa Istanbul Review, 17-2, 86-96

Battese, G., Coelli T. (1995) A model for technical inefficiency effects in a stochastic frontier production function for panel data. Empirical Economics 20, 325-332

Bauer P. W. A., Berger A., Ferrier D., Humphrey D. B. (1998) Consistency conditions for regulatory analysis of financial institutions: A comparison of frontier models. Journal of Economics and Business, 50:2, 85-114

Beck, T., Demirgüç-Kunt, Merrouche, O., (2013) Islamic vs. conventional banking: Business model, efficiency and stability. Journal of Banking and Finance, 37, 433-447

Berger and De Young (1997) Problem loans and cost efficiency in commercial banks. Journal of Banking and Finance, 21, 849-870
Berger, A. N., and Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? Journal of Banking and Finance 21, 895-947
Bitar, M., Hassan, M.K., Pukthuanthong, K., and Walker, T. (2018a) The performance of Islamic vs. conventional banks: Evidence on the suitability of capital ratios, Open Economies Review, Vol 29, 5, 1003-1038
Bos, J.W.B., Koetter, M.(2009) Handling losses in translog profit models. Applied Economics, 43, 307-312
Bravo-Ureta, B. E., Solis D., Moreira Lopez V. H., Maripani J. F., Thiam A., Rivas E. T. (2007) Technical Efficiency in Farming: A Meta-Regression Analysis. Journal of Productivity Analysis 27(1) 57-72
Chaffai, M.E. (1998) Estimation des inefficiences techniques et allocatives des banques de dépôts Tunisiennes : Une frontière de coût fictif, Economie et Prévision, 5,117-129
Chaffai M., Hassan K., (2019) Technology gap and managerial efficiency: A comparison between Islamic and conventional banks in MENA. Journal of Productivity Analysis, 51, 39-53
Chaffai M. E. (2019) Technical efficiency and stability to shocks: A comparison between Islamic banks and conventional banks in MENA region. Global Finance Journal, forthcoming (available online, 19 July 2019)
Cornwell C., Schmidt P., Sickles R. (1990) Production frontiers with cross-sectional and time-series variation in efficiency levels. Journal of Econometrics 46,185-200
Doumpos M., Hasan I., Pasiouras F. (2017) Bank overall financial strength: Islamic versus conventional banks. Economic Modelling, 64, 513-523
Economist (2008) Savings and souls: Islamic finance. September 6. www.economist.com
Färe R. , Primont D. (1995), Multi-output production and duality: Theory and applications, Kluwer Academic Publisher, Boston, Massachusetts
Gonzales L. O., Razia A., Bua M. V., Sestayo R. L. (2019) Market structure, performance and efficiency: Evidence from MENA banking sector. International Review of Economics and Finance, 64, 84-101
Greene W.(2005) Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. Journal of Econometrics 126, 269-303
Hafez H. M., Halim M. (2019) The efficiency of Islamic banks versus conventional banks: An empirical study of an emerging economy. Banks and Bank Systems, Vol 14, 2, 50-62
Hassan M. K., Aliyu S. (2018) A contemporary survey of Islamic banking literature. Journal of Financial Stability, 34, 12-43
Humphrey, D. B., and Pulley, L. B. (1997). Banks' responses to deregulation: Profits, technology, and efficiency, Journal of Money, Credit, and Banking, 29, 73-93
ICD Thomson Reuters Islamic Finance Development Indicator (2017)
Irsova Z., Havranek T. (2013) Determinants of horizontal spillovers from FDI: Evidence from a large Meta analysis. World Development, 42, 1-15
Johnes J., Izzeldin M., Pappas V. (2009) The efficiency of Islamic and conventional banks in the Gulf Cooperation Council (GCC) countries: an analysis using financial ratios and data envelopment analysis. In: LUMS Working Papers Series 2009/023. Lancaster University Management School
Johnes J., Izzeldin M., Pappa V., (2014). A comparison of performance of Islamic and conventional banks. Journal of Economic Behavior & Organization, 103, S93-S107
Kamarudin, F., Sufian F., Nassir A. M. (2015) Does country governance foster revenue efficiency of Islamic and conventional banks in GCC countries? EuroMed Journal of Business, Vol 11, 2, 181-211

Kamarudin, F., Nordin B. A. A., Muhammad J., Abdul-Hamid M. A. (2014) Cost, Revenue and Profit efficiency of Islamic and conventional banking sector: Empirical evidence from Gulf Cooperative Council countries. Global Business Review, 15(1), 1-24
Khan, F., 2010. How Islamic is Islamic banking? Journal of Economic Behavior & Organization. 76, 805–820.
Lozano Vivas A., Pasiouras, F. (2010) The impact of non-traditional activities on theestimation of bank efficiency: international evidence. Journal of Banking and Finance, 34,1436-1449
Miah M. D., Uddin H. (2017) Efficiency and stability: A comparative study between Islamic and conventional banks in GCC. Future Business Journal, 3, 172-185
Mobarek A., Kalonov A. (2014) Comparative performance analysis between conventional and Islamic banks: empirical evidence from OIC countries. Applied Economics, 46, 3, 253-270
Mohanty S. K., Lin H. J., Aljuhani E. A., Bardesi H. J. (2016) Banking efficiency in Gulf Cooperation Council (GCC) countries: A comparative study. Review of Financial Economics, 31, 99-107
Olson D., Zoubi T. A. (2011) Efficiency and bank profitability in MENA countries. Emerging Markets Review, 12, 94-110
Narayan P. K., Phan D. H. (2019) A survey of Islamic banking and finance literature: Issues, challenges and future directions. Pacific-Basin Finance Journal, 53, 484-496
Rettab B., Kashani H., Obay L., Rao A. (2010) Impact of market power and efficiency on performance of banks in the Gulf Cooperation Council Countries. International Research Journal of Finance and Economics, 50, 190-203
Rogers K.E. (1998) Non-traditional activities and the efficiency of US commercial banks. Journal of Banking and Finance, 22, 467-482
Rozzani N., Adul Rahman R. (2013) Determinants of bank efficiency: Conventional versus Islamic. International Journal of Business Management. Vol 8, 14, 98-109
Saeed M., Izzeldin M. (2016) Examining the relationship between default risk and efficiency in Islamic and conventional banks. Journal of Economic Behavior & Organization, 132, 127-154
Safiullah Md., Shamsuddin A. (2019) Risk-adjusted efficiency and corporate governance: Evidence from Islamic and conventional banks. Journal of Corporate Finance, 55, 105-140
Sealey C. W., Lindley J. T. (1977). Inputs, outputs, and theory of production cost at depository financial institutions. Journal of Finance, 32, 1251–1265
Shaban M., Duygun M., Anwar M., Akbar B. (2014) Diversification and banks' willingness to lend to small businesses: Evidence from Islamic and conventional banks in Indonesia. Journal of Economic Behavior & Organization, 103, S39-S55
Simar L., Wilson W.P., (2008) Statistical inference in non-parametric frontier models. Ed. by Fried O.H., Lovell C.A.K., Schmidt S.S. The measurement of productive efficiency and productivity growth. Oxford University Press, Oxford: New York, 421-521
Srairi S. A., (2010) Cost and profit efficiency of conventional and Islamic banks in GCC countries. Journal of Productivity Analysis, 34, 45-62
Yilmaz A., Gunes N. (2015) Efficiency comparison of participation and conventional banking sectors in Turkey between 2007-2013. Procedia - Social and Behavioral Sciences, 195, 383-392

Appendix

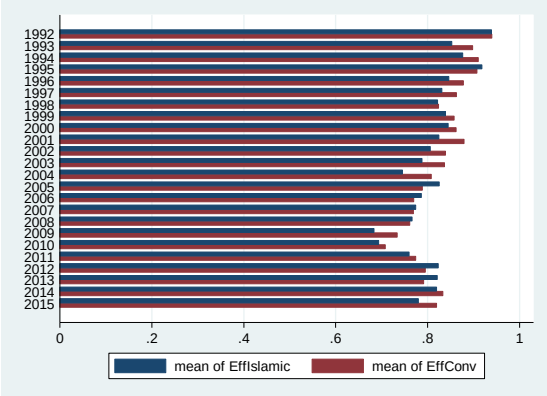

Figure1: Primary studies average efficiency scores by year

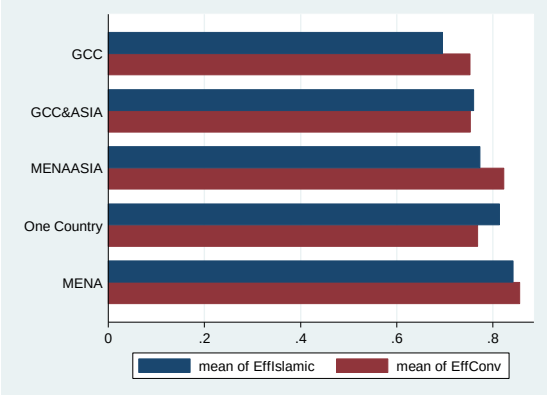

Figure1: Primary studies average efficiency scores by region

Table 6: Inputs and outputs definition in primary studies in %

Inputs		Outputs	
Numbers of employees	5.56	Loans	97.22
Salaries	72.22	Other earning assets	66.67
Book value (capital)	75.00	Off-balance sheet	22.22
Interest expenses	44.44	Investments/securities	16.67
Operating expenses	19.44	Income	11.11
Equity	16.67	Balance sheet earning	2.78
Loan loss provision	2.78		
Total assets	2.78		
Deposits	52.78		