Performance and Productivity in Islamic and Conventional Banks: Evidence from the Global Financial Crisis

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Abstract

We assess the performance and productivity of Islamic and conventional banks using financial ratios, a two- and a four-component meta-frontier Malmquist productivity index (MPI). We focus on the relatively homogenous GCC region over the 2006-2012 period that covers the global financial crisis. We find that Islamic banks exhibit worse cost and profit performance but are on a par with regards to revenue performance compared to the conventional ones. The components of the meta-frontier MPI suggest that the technology of conventional banks improves markedly in years leading to the financial crisis and declines thereafter. Islamic banks show a similar but more muted pattern. By contrast, the pronounced within-Islamic bank group variation in technical efficiency and technology suggest that Islamic banks are quite heterogeneous as a group. Overall, the MPI analysis suggests that the two bank types are more aligned following the global financial crisis. Policy implications are subsequently discussed.

Keywords: Performance, Banking sector; Financial ratios; Meta-frontier Malmquist productivity analysis; Gulf Cooperation Council

JEL Classification: C14; G21

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Highlights

Islamic and conventional banks are distinctive based on cost and profit ratios

The Malmquist productivity index (MPI) shows little productivity gain 2006-2012

We advance the MPI to a 4-component decomposition using the bank type groups

This decomposition suggests distinctions between the two bank types

Banking operations have aligned following the global financial crisis

1. Introduction

The 2007 global financial crisis directed attention to the Islamic banking system which emphasises transparency and avoids undue risk and appears to have been more insulated from the crisis than conventional banks (Hamdan 2009; Willison 2009; Warde 2010). Islamic banking is distinct from conventional banking. The former is guided by *Shariah* principles whereby interest (riba) is forbidden, money is not treated as a commodity, there is prevalence of justice, and uncertainty (gharar) is prohibited (Hamdan 2009). As a consequence, Islamic banks use profit-and-loss sharing (PLS) instruments that do not guarantee a pre-determined profit to depositors and do not force borrowers to repay a pre-determined amount. In addition, Islamic banks offer fee-based services. These characteristics are thought to have positive implications on economic growth and stability. Many studies of Islamic banking focus on various aspects including efficiency (Johnes et al. 2014; Saeed and Izzeldin 2014), stability (Čihák and Hesse 2010; Pappas et al. 2016), loan default rates (Baele et al. 2014), credit risk (Abedifar et al. 2013) and accounting practices (Elnahass et al. 2014). Research has also focused on Islamic equity markets, with several studies investigating equity market integration and volatility spillovers (Majdoub and Mansour 2014), integration of conventional and Islamic equity indices (Majdoub et al. 2016), and predictability dynamics of the two types of indices (Sensoy et al. 2015).

The aim of this paper is to compare and contrast the financial performance and productivity of Islamic banks and conventional banks in the GCC group of countries during the global financial crisis. Consequently, this study fits with the established literature comparing the two banking models. However, our study seeks to improve upon certain sample selection deficiencies that studies in this field suffer from. In particular, in an attempt to boost the sample size, a customary practice is to feature a number of disparate countries, where banks can be expected to face different economic conditions, banking and accounting regulations. This can be particularly relevant for studies dealing with efficiency/productivity issues.[2] A remedy might be to have a single country case-study; however, data limitations could be even harder to surmount.[3] As such, our choice of the homogeneous GCC serves, perhaps, as a fine balance between the aforementioned issues.[4]

We contribute to the growing literature on Islamic and conventional banking with respect to performance and productivity measurement. First, we observe the relative performance of Islamic and conventional banks using two distinctive but complementary methods. Second, we explore the sources of productivity change in a meta-frontier framework, which is novel in this context. Here, the two- and four-component Malmquist Productivity Index (MPI)[5] analysis allows us to examine efficiency and technological change relative both to the meta-frontier[6] and to the distinctive bank-type frontiers.

As a preview of our findings, we find Islamic banks to be worse on cost performance but share equal revenue performance with the conventional ones. A poorer profit performance is evidenced in Islamic banks with the gap closing by the end of the study period. The meta-frontier MPI and its two-component decomposition show little gain in productivity across the sample period, although with some interesting fluctuations. In particular, the technology of conventional banks improves markedly in years leading to the financial crisis and declines thereafter, while a similar, yet more muted pattern is observed for the

[2] See Johnes et al., (2017) for a study on efficiency convergence that highlights the issues of mixing different countries.
[3] Some single-country studies in the efficiency/productivity literature are: El-Gamal and Inanoglu (2005) for Turkey, Abdul-Majid et al., (2008) for Malaysia, Matthews (2014) for Pakistan, Matthews (2017) for Bangladesh.
[4] The GCC countries - Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE) - share similar economic, market structure, financial and regulatory characteristics (Al-Hassan, Khamis and Oulidi, 2010).
[5] We use a number of acronyms in this paper and these are defined in the appendix.
[6] In the efficiency context, a (non-parametric) meta-frontier envelops *all* the observations in a data set regardless of the sub-group each observation belongs to.

Islamic banks. This is further corroborated by the four-component decomposition, suggesting that the two banking systems become more aligned after the global financial crisis. In addition, the pronounced variation within the Islamic bank group in terms of technical efficiency and technology seem to suggest that Islamic banks are not as homogenous a group as might be expected. Policy implications are subsequently discussed.

The paper is in six sections of which this is the first. A brief literature review is presented in section 2, while section 3 describes the methodological approaches used in the subsequent empirical analysis. Sample data are described in section 4 and results are presented and interpreted in section 5. Conclusions and policy implications are discussed in section 6.

2. Literature review

There is a considerable literature on the efficiency of banking institutions (reviews of which can be found in Berger and Humphrey 1997; Berger and Mester 1997; Casu *et al.* 2001; Brown and Skully 2002).[7] A minority of studies focus on Islamic banking, or on banking within the GCC countries and an even smaller number compares these two banking models within the GCC countries. In this section we provide a brief review of the studies that have compared Islamic and conventional banks performance, both generally and within the GCC context. *A priori* there are two main reasons that might impair Islamic bank performance: i) the restrictive nature of *Shariah* rules in terms of operational freedom; ii) the lower utilization of assets commensurate with the need for high liquidity and capitalisation reserves and the Islamic banks' limited access to capital and interbank markets (Ali 2011).

Due to the fast growth and projected future growth of Islamic banking, several economic aspects – including productivity – have been investigated in academic research. For example, Zins and Weill (2017) investigate how the implementation of Basel II standards affects the risk gap between Islamic and conventional banks. Their results suggest that Basel II standards enlarge the risk gap between the two bank types at the expense of Islamic banks. The contribution of Islamic banks in economic development of the host countries has been analysed in Imam and Kpodar (2016). Their results suggest that Islamic banking is positively associated with economic growth, even after controlling for key growth determinants. The operational performance of Islamic banks has been examined from different angles. Recently, Jawadi et al. (2017) use principal component analysis to show that the performance of Islamic banks varies across geographic regions. Furthermore, the geographic environment affects the operations of Islamic banking, suggesting the importance of externality effects, while the quantile specification used attests to the nonlinearity of the environmental factors' contributions to the Islamic bank performance.

Studies which use financial ratio analysis (FRA) do not always confirm the hypothesis of poorer performance amongst Islamic banks, though, and find that Islamic banks perform better than conventional banks in terms of profitability (Olson and Zoubi 2008; Parashar and Venkatesh 2010; Hasan and Dridi 2011; Olson and Zoubi 2011), resource use, cost effectiveness, asset quality, capital adequacy and liquidity ratios (Hassan and Bashir 2005). Doumpos, Hasan and Pasiouras (2017) compare Islamic, conventional and banks with an Islamic window with the use of a bank overall financial strength index. The results suggest that banks differ significantly in terms of individual financial ratios; however, the difference in the overall financial strength between Islamic and conventional banks is not statistically significant. At a regional level they find that conventional banks outperform both the Islamic banks and the banks with Islamic window in the case of Asia and the Gulf Cooperation Council; however, Islamic banks perform better in the MENA region.

[7] A summary of banking efficiency studies by country context can be found here http://www.lancaster.ac.uk/lums/golcer/ecajj/

Results of studies which measure performance using frontier estimation methods are also mixed. Some studies (two of which are in the GCC context) find that Islamic banks are significantly less efficient than conventional ones (Mokhtar *et al.* 2007; 2008; Srairi 2010; Kamarudin *et al.* 2014; Mobarek and Kalonov 2014), while other studies (two of which are in the GCC context) suggest that Islamic banks are significantly more efficient than conventional banks (Al-Jarrah and Molyneux 2006; Al-Muharrami 2008; Olson and Zoubi 2008). The vast majority of frontier studies, however, find no significant difference between the two bank types (El-Gamal and Inanoglu 2005; Grigorian and Manole 2005; Mokhtar *et al.* 2006; Bader 2008; Mohamad *et al.* 2008; Hassan *et al.* 2009), or else the significance of the difference between the two bank systems is not tested (Hussein 2004; Al-Jarrah and Molyneux 2005; Ahmad and Luo 2010; Said 2012). However, caution is needed regarding some studies where either the sample size - particularly the number of Islamic banks - is small or a variety of countries with markedly economies has been utilised; thus, making the isolation of an "Islamic banking" effect difficult.

Methodologically, many of the studies investigating efficiency differences assume that the two bank types share a common production function, which might lead to biased conclusions. More recent work, however, recognises this drawback and opts for a dual production function setup, often termed as meta-frontier[8], see for example (Abdul-Majid *et al.* 2008; 2010; 2011a; 2011b; Johnes *et al.* 2014).[9] The main advantage of the meta-frontier analysis is its ability to disentangle inefficiencies arising from managerial incompetency (i.e., net efficiency) and those pertaining to the business model itself (i.e., type efficiency). Efficiency meta-frontier studies conclude that managerial efficiency is not inferior in Islamic banks (Abdul-Majid *et al.* 2008; 2011a; 2011b; Johnes *et al.* 2014). Conversely, the Islamic banking model is inferior, in efficiency terms to the conventional one (Abdul-Majid *et al.* 2008; 2011a; 2011b;Johnes *et al.* 2014), which may not be surprising given its business and financial restrictions. However, if a meta-frontier framework is not used, then the conclusion is markedly different. In that case the overall efficiency score cannot differentiate between managerial and business type practices; hence the Islamic banking sector would falsely appear as of lower efficiency (Abdul-Majid *et al.* 2008; 2011a; 2011b; Johnes *et al.* 2014) and attributed to the lower quality of managerial personnel. Economic implications of such conclusion would be completely different.

Productivity in banking (as measured by the Malmquist productivity index[10]) and its components has been featured in several studies (Worthington 1999; Sanyal and Shankar 2011).[11] However, little work has been done on comparing productivity in Islamic and conventional banks. We review some of these studies next. Productivity in Malaysia has increased over the period 1996 to 2002, primarily as a consequence of technology rather than technical efficiency improvements, and the pattern of productivity change is similar for both conventional and Islamic banks (Abdul-Majid *et al.* 2008). In

[8] The incomparability of performance in different groups, which leads to the introduction of the meta-frontier concept dates back to Hayami (1969) and Hayami and Ruttan (1970, 1971). The meta-frontier in an efficiency context stems from the work of Cooper et al., (1981).

[9] These are a mix of single and multiple country studies, which give a reassurance over our previous criticism, particularly to the methodological nature of the issue we subsequently describe.

[10] The Malmquist productivity index (MPI) has been widely used for productivity growth measurement in banking (Portela and Thanassoulis 2010; Chang, Hu, Chou and Sun, 2012; Bassem, 2014; Kevork, Pange, Tzeremes and Tzeremes, 2017; Li, Crook and Andreeva, 2017) and a large variety of contexts, such as the health sector (Chowdhury et al. 2011), agriculture (Xu 2012) and transportation (Pires and Fernandes 2012) among others. See Afsharian and Ahn (2015) for an extensive review. Its wide application stems from the following merits: i) computational ease as it is an extension of a DEA analysis; ii) it does not require information on cost or revenue shares, making it less data-demanding; iii) decompositions of MPI can identify the sources of productivity growth such as efficiency change and/or technological progress (Chang and Luh, 2000). A further advantage, relevant to our context is that the MPI does not assume profit maximisation for the underlying banks compared to, for example, the Luenberger index which does (Boussemart et al., 2003).

[11] Applications of the Malmquist productivity index are not limited to the banking sector; see for example Zheng *et al.* (2003), Zaim and Taskin (1997) and Johnes (2008) for applications in Chinese, Turkish and UK organisations respectively.

the GCC, productivity evidence is mixed. In particular, one study finds that productivity has risen between 2000 and 2004 (Ramanathan 2007), while another finds that productivity has fallen over the period 1999 to 2004 (Ariss *et al.* 2007). Both studies find the technology change to have declined across the years, suggesting that any productivity differences are governed by technical efficiency change.

Several important remarks are in order here. First, neither of the two GCC studies has compared the Islamic and conventional banks. Second, although Abdul-Majid *et al.* (2008) implements a meta-frontier framework for the efficiency estimation, this is not carried over to the productivity analysis and it could be problematic for the interpretation of the results, as explained earlier. Third, the stark differences between these three studies (and more specifically about the two GCC ones) regarding the productivity dynamics and the relevance of the productivity components necessitates further analysis. The economic intuition is that the bank has more control over technical efficiency change that relates to the improvement of its managerial staff. By contrast, technology change is beyond the direct control of a single bank reflecting the availability of financial products and practices (EY, 2017), which is a key differentiating factor of the two bank types examined here. Fourth, none of the studies above has covered the global financial crisis, despite the fact that technology change is noted to surge ahead of financial crisis events (Sánchez 2010; Martin-Oliver and Salas-Fumás 2012). Our meta-frontier productivity analysis aims to fill these research gaps.

3. Methodology

The analysis of banking performance can be done in two ways: (i) by using financial ratio analysis (FRA); (ii) by using frontier estimation methods, such as data envelopment analysis (DEA) and stochastic frontier analysis (SFA). The first approach measures performance using ratios constructed from annual accounting statements. The second uses estimates of the technical (or X-) efficiency of banks. Financial ratios are easy to calculate and interpret (Hassan and Bashir 2005); but a single ratio cannot capture the performance over the breadth of banking activities as there is no criterion for selecting a ratio that is relevant to all stakeholders (Ho and Zhu 2004). In addition, the use of financial ratios assumes that banks are interested in cost minimisation, profit maximisation, or revenue maximisation; in the context of Islamic banking these may not be the most pressing objectives (Abdul-Majid *et al.* 2010). Efficiency measures calculated from SFA or DEA are less easy to understand and can be distorted by misspecification errors or the presence of outliers. Meta-frontier DEA has the advantage that its piece-wise linear frontier that envelops the data allows Islamic banks to pursue objectives other than cost minimisation or profit maximisation, which conventional banks typically do, without being penalised. The frontier estimation methods can also be extended when panel data are used to permit examination of productivity change using a Malmquist productivity approach.

3.1 Financial ratio analysis

We use six financial ratios across three categories: i) cost performance; ii) revenue performance; iii) profit performance (see Table 1).[12] Cost performance is proxied by *Cost to Income (CTI)* and *Non-Interest Expenses to Average Assets (NIE)* ratios. The first ratio is a widely used indicator of cost performance (see, for example, Beck *et al.* 2013). The second is more attuned to Islamic banks which are likely to have additional standing costs to cover, for example, the *Shariah* supervisory boards. *Net Interest Margin (NIM)* and *Other Operating Income to Average Assets (OOI)* are proxies for revenue

[12] Islamic banks do not charge interest or engage in interest bearing activities, but it is standard practice in certain financial ratios to include the term 'interest' as in, for example, *Net Interest Margin* (Olson and Zoubi 2008; Beck *et al.* 2013). This is merely a naming convention which includes the revenues or costs associated with equity-based financial products (such as *Mudarabah* and *Musharakah*). We maintain the generally accepted financial ratio names for maximum compatibility with other studies.

performance. The former captures the capacity of the bank to generate revenues through interest-based (or, in the case of Islamic banks, profit-sharing-based) financial products, while the latter indicates the capacity of the bank to generate revenues from fee-based financial products. *Return on Average Assets (ROA)* and *Return on Average Equity (ROE)* are well-established proxies for profit performance, see for example Olson and Zoubi (2008; 2016) and Rosly and Abu Bakar (2003) among others. We test for differences in financial ratios between the two banking systems using conventional significance tests. Given evidence in the literature of mixed results possibly deriving from use of small samples, we check the sensitivity of our results to sample size using the bootstrap procedure of Desagné *et al.* (1998).

[Table 1 here]

3.2 Malmquist productivity

Productivity changes can be measured using the Malmquist productivity index derived from the well-known distance function approach (Coelli *et al.* 2005). In the general situation where multiple outputs are produced from multiple inputs, the distance function provides a measure of a bank's technical efficiency and from this we can derive information about productivity change over time. The distance function and hence Malmquist productivity can be estimated using parametric or non-parametric methods. For reasons presented earlier we use DEA, a non-parametric approach, to estimate the distance function and derive the Malmquist productivity indexes.

The meta-frontier approach is relevant when the data can be split into g groups ($g = 1, \dots, G$) and makes a distinction between the distance function derived from the entire data set (the meta-frontier) which we will denote by $D_O(x, y)$, and the distance function derived for each group which we will denote by $D_O^g(x, y)$. Thus $D_O(x, y)$ represents *gross efficiency* (i.e. the efficiency measured relative to all DMUs), while $D_O^g(x, y)$ represents *net efficiency* (i.e. the efficiency relative to DMUs facing the same conditions). The technology gap ratio provides a measure of *type efficiency* and is defined as[13]

$$TGR^g(x, y) = \frac{D_O(x,y)}{D^g(x,y)} \quad (1)$$

When data are available over time the distance function methodology can be extended to derive productivity measures (Coelli *et al.* 2005). Let us assume time periods $t = 1, \dots, T$ and modify the earlier notation so that superscripts denote period. Thus $D_O^t(x^t, y^t)$ and $D_O^{t+1}(x^{t+1}, y^{t+1})$ represent the output distance functions for periods t and $t + 1$ respectively. The Malmquist productivity change index for time $t + 1$ relative to time t ($MPI_{t,t+1}$) is defined in full in Table 2. Values of the Malmquist productivity index above unity indicate that there has been an improvement in productivity between t and $t + 1$. Values less than 1 imply the converse. The index is made up of two components (see Table 2):

[Table 2 here]

- *Technical efficiency change* from period t to $t + 1$ ($TEC_{t,t+1}^*$) shows whether the DMUs are getting closer to their production frontiers over time. Values greater (less) than unity suggest improvement (deterioration). This component measures whether banks are using existing resources more efficiently (catching-up effect) and is particularly relevant for the bank's management by giving an indication as to whether the internal processes have been improved.
- *Technology change* from period t to $t + 1$ ($TC_{t,t+1}^*$) indicates whether the production frontier is shifting over time. Values of greater (less) than unity suggest improvement (deterioration) in technology. The idea here is that new technology that the bank adopts in the form of financial products, practices and/or procedures enables the bank to achieve higher productivity.

[13] This methodology is discussed in detail in a banking context in Johnes *et al.* (2014)

Moreover, this component can give an indication to the bank's management as to whether practices adopted by competitors can yield an advantage (innovation effect); thus, potentially the bank's management may consider expanding to such products/practices.

Oh and Lee (2010) provide the first meta-frontier productivity analysis application in a non-parametric context. A further extension of the meta-frontier Malmquist productivity index is offered by Chen and Yang (2011), in which four components are identified[14] that provide additional insights for data sets comprising groups ($g = 1, \dots, G$). The meta-frontier MPI is simply the original MPI calculated relative to all DMUs in the data set (the pooled sample), while the within-group MPI ($MPI^{g}_{t,t+1}$) is the MPI calculated relative to DMUs only within the same group. Following Chen and Yang (2011) the meta-frontier Malmquist productivity index is decomposed into four components (see Table 2 for additional details). The first two components are similar to those of the original Malmquist index but are now expressed as within-group, specifically:

- *Technical efficiency change* between periods t and $t+1$ relative to the group frontier ($TEC^{g}_{t,t+1}$). This is the catching-up effect in each of the identified groups.
- *Technology change* between periods t and $t+1$ relative to the group frontier ($TC^{g}_{t,t+1}$). This is the innovation effect in each of the groups.
- The third component, *Pure type catch-up* between periods t and $t+1$ ($PTCU^{g}_{t,t+1} = \frac{TGR^{g}_{t+1}}{TGR^{g}_{t}}$) measures how the effect of the business model (type) on efficiency changes over time (technology leading effect). Values of $PTCU^{g}_{t,t+1}$ greater (less) than 1 imply that business type is having less (more) effect on efficiency i.e. the effect of *modus operandi* is shrinking (increasing). In our case, an overtime diminishing type effect would be evidence that the practices between the two bank types become more aligned.

- The forth component, *Frontier catch-up* between periods t and $t+1$ ($FCU^{g}_{t,t+1} = \frac{TC^{*}_{t,t+1}}{TC^{g}_{t,t+1}}$) refers to the area lying between the meta-frontier and the group frontiers (leadership effect). It captures the speed of change of the meta-frontier relative to the group frontier: if $FCU^{g}_{t,t+1} < 1$ (> 1) then any outward (inward) shift of the group frontier is faster (slower) than that of the meta-frontier, suggesting that best practice within the group is improving faster (declining more slowly) than best practice in the whole sample causing the technology gap to shrink (expand).

4. Sample data, variables description and model specification

The sample data for both the FRA and the Malmquist productivity analysis are derived for banks in the 6 GCC countries from Bankscope over the period 2006 to 2012.[15] The market share of Islamic banking in the GCC is over 25%, suggesting that Islamic banks have become systemically important (Basu et al. 2015). Saudi Arabia, the UAE and Kuwait are considered to be three of the 'big 4' countries (along with Malaysia) in global Islamic finance (Ernst and Young 2013). By 2012, assets of GCC Islamic banks were around 34% of the global assets of Islamic banks, making the GCC a global Islamic finance centre. In terms of consistency of financial reporting between the two bank types, conventional banks

[14] It is this which makes the Malmquist approach attractive in the context of this study compared to alternative productivity indexes such as that proposed by Färe and Primont (1995).

[15] For the categorization of Islamic banks, we rely on Bankscope but we cross-check with other databases (e.g., Zawya, World Database for Islamic Banking and Finance, Central Banks) and individual banks' websites.

follow the practices established by the International Accounting Standards Board (IASB), while the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) is the regulatory body that ensures the applicability of the conventional standards to Islamic banks. The two frameworks are generally compatible, although there may be more lax disclosure requirements imposed on Islamic banks (Olson and Zoubi 2008). Only banks which have a full set of values for all required variables (for the FRA and the DEA) for all 7 years of the study are included. This yields a sample of 19 Islamic and 43 conventional banks.[16] The sample period has been selected so to provide as long a time frame as possible during the global financial crisis whilst maintaining a good balance between the bank-year observations for each bank type.[17] All variables were converted to 2005 prices using appropriate deflators.[18]

With the focus of the Malmquist analysis on productivity of *banks*, rather than bank *branches*, we adopt the intermediation approach (Pasiouras 2008) in the distance function estimation whereby banks are assumed to perform an intermediary role between borrowers and depositors and hence accept deposits and other funds in order to provide loans and alternative investments. The choice of input and output variables is informed by previous literature (Casu and Giradone 2004; Casu *et al.* 2004; Abdul-Majid *et al.* 2008; 2010; Mobarek and Kalonov 2014) as well as by data availability. Thus the outputs of banks which undertake an intermediary role are defined here as: i) Total loans, ii) Other earning assets. It is well-known that Islamic banks do not offer loans in the same way as conventional banks, and so the choice of total loans and other earning assets as outputs might therefore be questioned. Conventional banks earn money from the spread between lending interest and borrowing interest rates, while Islamic banks do not have interest rates but have a similar spread which is defined in terms of profit share ratios between the entrepreneurs (borrowers) and the depositors (lenders).[19]

The inputs which comprise the funds from depositors as well as capital and labour employed by the banks are defined as: i) Deposits and short term funding, ii) Fixed assets, iii) General and administration expenses, iv) Equity. General and administration expenses are used as a proxy for labour input. While it may not be an absolutely accurate reflection of labour input, it is more easily available than better measures (e.g. employee numbers or expenditure on wages) and has been used in previous studies (Drake and Hall 2003) where it is argued that personnel expenses make up a large proportion of general and administration expenses. Equity is included as an input to reflect risk-taking in the banking sector. In the context of Islamic banking, one would expect a difference in risk-taking behaviour between Islamic and conventional banks, and so it is important to incorporate it into the model (Sufian 2006/2007). Charnes *et al.* (1990) suggest that an indicator of risk-taking should explicitly be incorporated into any model of banking efficiency by the inclusion of loan-loss provision as an input. Data on loan-loss provision are not widely reported, and the sample can be much reduced by its inclusion. We therefore include as an input an alternative measure of risk namely, equity. This easily obtainable variable has been included to reflect risk in previous studies (Alam 2001; Mostafa 2007;

[16] The resulting sample is representative in terms of market concentration in the GCC countries compared with findings from Al-Muharrami *et al.* (2006).
[17] It is well-documented that Islamic banks were affected later than the conventional banks when the financial crisis hit the real economy (Olson and Zoubi, 2016; Basu et al., 2015). Consequently, in the years 2011-2012, the recovery process of the IBs still lags behind (Olson and Zoubi, 2016; Basu et al., 2015).
[18] These were calculated from data in World Economic Outlook 2014
[19] Note that in Bankscope the term 'total loans' is a generic one which encompasses the equity financing products used by Islamic banks and can therefore be used without disadvantaging Islamic banks. A breakdown of banking activity into different banking products might be more satisfactory, but it would result in an unsatisfactory loss of observations.

Abdul-Majid *et al.* 2010). A more detailed discussion of these inputs and outputs can be found in Johnes *et al.* (2014).

Descriptive statistics for the variables used in the Malmquist productivity analysis are shown in Table 3. The upward trend in banking business is clear for both types of banks. Total loans, for example, have grown on average by over 63% (in real terms) over the 7-year period. For conventional banks the growth is around 60% and for Islamic banks it is 75%. The table also indicates that the average size of an Islamic bank (in terms of total loans) is around half the size of a conventional bank. Note, however, that Islamic banks have higher levels of mean fixed assets than conventional banks.

[Table 3 here]

5. Results

5.1 Financial ratio analysis

The evolution over time of cost, revenue and profit ratios for conventional and Islamic banks can be seen in Figure 1 and Table 4. Cost ratios (CTI and NIE) are generally higher for Islamic banks compared to conventional banks, and the difference is significant in the case of NIE when looking at the period as a whole as well as individual years. The results are expected given that Islamic banks are not known to be cost effective owing to associated costs that are peculiar to their business model. For example, in order to achieve *Shariah* compliance, Islamic banks incur additional payroll expenses for maintaining a *Shariah* Supervisory Board (SSB) board. The SSB works in parallel to the Board of Directors and is considered the "Supra Authority" in an Islamic bank (Choudhury and Hoque, 2006). The SSB governance is featured in all IBs and is particularly relevant for the GCC banks where all IBs maintain one with at least three members. The average salary of a SSB member is approximately a quarter of the CEO's salary (Matoussi, 2014). In addition, the development of what are essentially bespoke products is a highly labour-intensive process (Willison 2009). The higher complexity of such products commands high legal costs, particularly when legal ramifications for compliance of Islamic financial products with foreign laws are necessary. In addition, a low cost-performance ratio requires a critical size of a bank necessary for economies of scale and scope to emerge; Islamic banks tend to be smaller than conventional ones in terms of assets and the products they offer. Looking at Figure 1, it is particularly noteworthy that the CTI rises for both bank types in 2009 (when the global financial crisis hit the real economy of the region) and the rise is considerably more marked for Islamic banks compared to conventional ones.

[Figure 1 and Table 4 here]

Turning to the revenue ratios, there is generally no significant difference in OOI and NIM between Islamic and conventional banks. This is expected since both bank types compete for the same depositors/investors, without any significant evidence to suggest that the average Muslim client would avoid a conventional bank.[20] Evidence from Ongena and Şendeniz-Yüncü (2011) suggests that firms consider Islamic banks as an alternative means of financing, hence complementary to conventional banks, without any solid connection to religious criteria. Individuals may have their own perceptions on whether certain practices/products are *Shariah*-compliant or not, which may influence their choice. Even though, the religiosity criterion may be quite prominent in the GCC, market structure dynamics

[20] There is the argument that clients of Islamic banks can be willing to pay higher prices to have peace of mind (El-Gamal, 2009); however we believe that this may be more relevant for the high-net worth individuals.

(e.g., market share of either bank type (Al-Hassan et al. 2010)) suggest that the two banks complement each other. Moreover, Islamic banks maintain two types of reserves[21] to ensure a smoothed-out return payment to their investment account holders; thus staying competitive and reducing displaced commercial risk. The fact that no revenue efficiency differential exists between the two bank types ensures that there is no short-term demand threat to either bank type. In the wake of the global financial crisis, the results show a significant difference in the revenue ratios between the two bank types, which however is reduced as the crisis unfolds.

Another comparison is based on the ROA and ROE, which are the two most widely adopted profitability measures, often examined in tandem. Based on both ROA and ROE conventional banks are found to be more profit efficient than Islamic banks in the GCC when taken across the period as a whole. If considered alongside the cost and revenue ratios, we conclude that this is driven by the cost advantage exhibited by conventional banks. Prior to the global financial crisis, profitability of the two bank types is more aligned without significant differences (e.g., ROE). However, as the crisis hits significant differences in profitability between the two bank types emerge, and appear to be closing after 2011.

The profitability measures used in this study include the rate of return on assets (ROA) and the rate of return on equity (ROE). The rate of return on assets, ROA, is the most characteristic accounting measure of a bank's performance, defined as net income over total assets. The ROE, on the other hand, reflects how effectively a bank management is using shareholders' capital. ROE in accounting terms is defined as net income divided by shareholders equity. Nevertheless, Islamic and conventional banks view profitability differently. The prohibitions that exist in the Islamic banking model, most notably that of interest (no money for money) – place profitability lower in the hierarchy of their goals. The ethical reasoning is that interest does not allow the sharing of risk; a necessary condition for a fair distribution of income and wealth. The challenge here is the smooth operation of Islamic banks without some kind of predetermined financial reward, which in the conventional banking is manifested via the interest rate margin. Islamic banks replace the concept of interest payments by the profit and loss sharing (PLS) agreements that use the principle of risk sharing; most notably the *Mudarabah* and the *Musharakah*. Under *Mudarabah*, Islamic banks receive funds from the investing public and then they may use the funds in business activities according to decisions of the bank's management, under the restriction that these business activities are not forbidden by the Islamic Law. In a *Mudarabah* scheme the partner that receives the funds provides labour and business expertise and in return gets a reward. In the *Musharakah* agreement two or more partners combine their capital and services for the purpose of making a profit. In this sense, a *Mudarabah* is a special case of a *Musharakah* agreement. Thus, Islamic banks based on equity financing are in fact partners with both depositors and entrepreneurs as they share economic risk with both.

A look at the full sample period however, conceals year-on-year differences in performance. A closer inspection of the results indicates two main observations. First, Islamic banks profitability shows higher variability relatively to conventional banks. Second, the profitability patterns between Islamic and conventional banks switch during the period. Islamic banks have higher ROA during the years 2006 and 2007 (the years prior to the global financial crisis) than their conventional counterparts. But as the global financial crisis unfolds and hits both the GCC region and the real economy, profitability levels of Islamic banks fall below those of the conventional banks, and only show mild signs of recovery towards the end of the sample period.

There are various reasons for the observed ROA and ROE observed patterns. The larger variability in the ROA and ROE of Islamic banks compared to the conventional banks, also found elsewhere (see,

[21] Islamic banks maintain a profit equalization reserve (PER) and/or an investment risk reserve (IRR) both enabling the bank to forgo some of its profit share when it considered essential due to the commercial pressure (Mejia et al., 2014; Alzahrani and Megginson, 2017).

for example, Olson and Zoubi 2016; Basu et al. 2015), may be, in part, driven by the fact that the Islamic banking sector in the GCC is smaller and more heterogeneous than the conventional one, comprising both old/large and new/small banks.[22] There is therefore variability in the offered products, as well as in personnel expertise and knowhow. In addition, Islamic banks are known to utilise an equity type of financing (i.e. profit and loss sharing) that is known to underperform during prolonged periods of economic crises (Grassa 2012; Olson and Zoubi 2016). This is markedly evident in the dynamics of the non-performing loans (NPL) of the two banks, which – even similar on average – peak with a two-year delay in Islamic banks (in 2012 as opposed to 2010 of conventional banks) (Basu et al. 2015). In contrast, the almost flat ROA and ROE observed in conventional banks could be an indication of a profit-smoothing behaviour widely practised by these banks (Safieddine 2009; Elnahass *et al.* 2014; Abdelsalam *et al.* 2016). The persistence of a gap in profitability between the bank types is also evidenced in Basu et al. (2015), which seems, however, to be narrowing over time (Olson and Zoubi, 2016).[23]

5.2 Malmquist productivity analysis

The MPI is derived from meta-frontier DEA results[24] which we briefly summarise (full results are available on request). We find no significant difference between Islamic and conventional banks in terms of gross efficiency. However, *net efficiency* is 6 percentage points higher, on average, for conventional banks compared to Islamic banks. In terms of *type efficiency*, the Islamic banking business model is more efficient than the conventional one by nearly 5 percentage points in the GCC over the entire period. Thus, the similarity in performance of the two types of banks in terms of *gross efficiency* conceals interesting differences in *net* and *type* efficiency. The effect of the global financial crisis is also notable in the context of efficiency dynamics. In particular, both *net* and *type efficiency* estimates are significantly different between the two bank types before the crisis, but not during.

This higher *type* efficiency could be attributed to the fact that a dual banking system in these countries is well founded and supported (EY, 2016). Small banks that specialise in niche areas may be more flexible in capturing a certain need of the market than fully-fledged banks. In addition, new banks may be better suited to incorporate a certain technological innovation that might offer them an advantage over competition. For example, a new bank may invest in Financial Technology (FinTech) with the view to enhancing the user experience through simplified transaction flow, ease of use and increased choice (EY, 2017). By contrast, incumbents may not be eager to embark on such changes on the grounds that they may not receive explicit support from the regulator (EY, 2017). The majority of Islamic banks are small, while a substantial proportion are comprised of new banks. Moreover, the existence of strong competition between the two bank types incentivizes Islamic banks to maintain their market share by offering a competitive and diversified range of products. At the same time, Islamic banks need to abide by their special business model, which on the one hand protects them from possible (over-) exposure to debt instruments and complex derivatives that have been criticised during the global financial crisis. On the other hand, the lower *net* efficiency of Islamic banks suggests that there may be some scope for an improvement in the managerial competency.

[22] For example, the Dubai Islamic Bank (UAE) was established in 1975, while Noor Bank (UAE) only in 2008.
[23] However, the study periods and geographical areas covered are not comparable as Olson and Zoubi examine the Middle East, Africa, and Southeast Asia regions over the period 1996 to 2014.
[24] Note that constant returns to scale (CRS) are assumed, and we allow for time varying production conditions to account for market expansions and possible spill overs from global financial markets by performing the DEA for each year separately.

The MPI and its components ($TEC^{*}_{t,t+1}, TC^{*}_{t,t+1}, TEC^{g}_{t,t+1}, TC^{g}_{t,t+1}, PTCU^{g}_{t,t+1}, FCU^{g}_{t,t+1}$) are defined in section 3 and summarised in Table 2. Related results are presented in Table 5 and Figure 2. The indices are calculated for each consecutive pair of years over the 7-year interval 2006 to 2012.

[Table 5 and Figure 2 here]

Panel A of figure 2 (which displays the results of MPI, and its two-component decomposition: $TEC^{*}_{t,t+1}, TC^{*}_{t,t+1}$) shows occasional fluctuations, and only slight differences between the bank types. For instance, in 2007/08 (the years leading to the global financial crisis), productivity rises for conventional banks. The main driver behind this result is that positive technology change exceeds negative technical efficiency change during this period. The former can plausibly be explained by the surge of expansive business decisions and availability of financial products and practices that, *ex-post*, have been linked to the fuelling of the crisis e.g. housing market boom/bubble, securitisation products (Sánchez 2010; Martin-Oliver and Salas-Fumás 2012). When technology change is highly positive, a negative technical efficiency change is commonly observed. This is because of the outwardly-shifting frontier, which increases the gap between the most and least efficient banks. Islamic banks have also experienced positive technology change through the same period, but of lesser magnitude. Contributing factors include their lower exposure to complex financial products, relatively higher level of deposits and lower levels of asset utilisation (Ali 2011). In 2008/09, both bank types experience a fall in productivity, with conventional banks being more adversely affected than Islamic banks. The global financial crisis is likely to be linked to this drop in general banking productivity in the GCC banking sector, an observation which has received further support in the literature (Maredza and Ikhide 2013). The financial crisis seems to have a different impact in the GCC compared to elsewhere, and this may be for reasons pertaining to the different investment philosophies and market structure leading to sustained differences in risk measures of the two bank types in this period (Al-Hassan, Khamis and Oulidi, 2010; Olson and Zoubi 2016). Productivity in Islamic banks has reverted to pre-crisis levels sooner (in 2009/10) than in conventional banks (in 2010/11). This is not in line with the FRA profitability analysis reported in this paper and elsewhere (see Olson and Zoubi 2016). This is not surprising given that productivity (and efficiency) takes a more holistic approach to the bank's operations compared to FRA.

Panels B and C of Table 2 extend the commonly-adopted two-component to a four-component decomposition. The four-component decomposition further captures the within-group behaviour in the productivity context.[25] Interpretation of Panel B of Figure 2 (and columns (6) and (7) of Table 5) should be made in the context of overall productivity change – relative to the meta-frontier – which we already discussed and illustrated in Panel A. Observation of Panel B of Figure 2 shows that the trough in PTCU in conventional banks occurs in 2007/08 in tandem with the observed technological progress in the meta-frontier (see Panel A) and is indicative that the gap between the meta-frontier and the conventional bank frontier is widening at this time. Consequently, the conventional banking model is becoming more distinctive than the Islamic one, a consequence of the increased technology that takes place, which is only remotely shared by Islamic banks owing to their business model restrictions. This pattern is reversed in the later part of the sample, where the gap between the meta-frontier and the conventional banks' frontier narrows. This cycle could be the consequence of the increased regulatory restrictions that were introduced in the wake of the crisis. Our results are in line with the convergence in certain performance indicators between the two bank types following the financial crisis found elsewhere (Gohou and Miniaoui 2013; Olson and Zoubi 2016). The PTCU and FCU oscillations of Islamic banks appear more dampened relatively to those of conventional banks. Business model uniqueness aside, this

[25] However, since the values are calculated within groups, we issue a caveat: the results for Islamic banks are based on a smaller within-year sample (n=19) than the conventional bank results (n=43). Note, however, that a sample size of 19 with a DEA model with 4 inputs and 2 outputs is well within the acceptable norms for DEA applications recommended by Dyson *et al.* (2001).

might be because Islamic banks are predominantly local and more specialised in their operations compared to conventional banks. Hence, they are less prone to the fluctuations in international markets. In contrast, conventional banks comprise a mix of local and foreign banks[26] and are active in a larger variety of financial services and products, beyond the traditional deposit-taking/loan-making activities of the Islamic banks. Innovations and practices (positive and negative) of conventional banks could therefore diffuse more quickly amongst this group causing the conventional banking group frontier to outpace the meta-frontier.

Panel C of Figure 2 and columns (4) and (5) of Table 5 outline changes in technical efficiency and technology *within banking groups*. The results suggest that Islamic banks exhibit higher variation in the levels of TC and TEC. This can be, in part, attributed to the small size of Islamic banks, which makes them sensitive to changes in the financial environment. This in turn leads to substantial observed variation in managerial practices changes (reflected in TEC) and innovation (reflected in TC). A further reason may be traced in the heterogeneity of Islamic banks. Islamic banking is a relatively young industry, yet the GCC is home to some of the oldest and largest Islamic banks. For example, the Dubai Islamic Bank (UAE) was established in 1975, while Noor Bank (UAE) only in 2008. It is therefore expected that we have leaders and followers within the Islamic banking industry with regards to, for example, product innovation, availability of financial products and banking presence and status. In turn, this may lead to substantial variation in changing managerial practices changes (reflected in TEC) and innovation (reflected in TC).[27] The followers in Islamic banks are particularly adversely affected in the early years of the global financial crisis as revealed by the fall in TEC in 2007/08, which however picks up soon afterwards. TC, amongst Islamic banks, however, remains volatile throughout the period, suggesting that a fraction of the Islamic banks has been considerably more affected than others during the global financial crisis.

To conclude this section, we link the FRA and the MPI results from which further interesting insights can be drawn. The ROA and ROE results suggest that the gap between Islamic and conventional banking performance which unravelled in 2009 persists throughout the sample period. The productivity results, in contrast, suggest an alignment between the two bank types following the effects of the financial crisis. Two points are worth mentioning here. First, although the gaps between banks persist for ROA and ROE, these become visibly narrower as time progresses (see Figure 1). Second productivity measures are based on technical efficiency, which considers the full intermediation process that a bank is performing (with ratios capturing certain aspects of it). It might be, given more time, that the alignment of managerial and business practices of Islamic and conventional banks observed through the productivity analysis might feed into a continuing narrowing of the gap between the two bank types with respect to measures such as profitability (as verified in Olson and Zoubi, 2016) but also risk-related measures (which Olson and Zoubi, 2016 did not verify).

[26] Foreign bank entry has been shown to be beneficial to the host country through improved access to capital markets (Claessens *et al.* 2001); long term, the presence of foreign banks can benefit the bank supervisory, regulatory and legal framework in the host country (Süer *et al.* 2016).

[27] Across the whole period, the top two most technologically innovative banks (based on geometric mean technology change) are IBs: the Emirates Islamic Banks and the First Investment Company. The reasons for their superior technological performance are likely to differ. The former maintains close connections with universities (for example through the financing of 'The Innovation Challenge', a university-wide competition for innovative social media solutions with banking applicability) and offers innovative products and services to its customers through its award-winning use of information technology. In contrast, the latter specialises in real estate, oil drilling and related infrastructure projects, which were deemed to be highly profitable investments during this period.

6. Conclusion

The paper sets out to examine the relative performance and productivity of Islamic and conventional banks in the GCC region over the period 2006 to 2012. We have used a variety of approaches including financial ratio analysis, a meta-frontier Malmquist productivity index with the standard two-component decomposition, and where we have extended the latter with a four-component decomposition. This allows for finer details within the groups be identified and gaps between the meta-frontier and the bank type frontiers to be captured.

The comparison of the performance of the two banking systems via the approaches adopted shows interesting variations. Islamic banks have lower cost performance owing to increased costs associated with maintaining a *Shariah* Supervisory Board and the development of complex *Shariah*-compliant products. From a revenue perspective, we find no significant differences between the two bank types, which is indicative that the two bank types compete for depositors/investors, attesting to the complementarity of the two banking systems. Profit performance is relatively poorer in Islamic banks, while taking them long to align with profitability rates of conventional banks after the global financial crisis. A possible explanation lies within the earnings management and smoothing practices of conventional banks as well as specific attributes of equity type of financing utilised by Islamic banks.

The standard two-component Malmquist productivity index approach finds gains in productivity for both bank types over the 2006 - 2012 sample period. Measured in relation to the meta-frontier, the technology of conventional banks improves in years leading to the global financial crisis and declines thereafter. This may reflect the prevailing business environment, which determines both decision-making and the adoption of financial products. The more muted, yet similar pattern existing for Islamic banks may be attributed to their steering away from complex derivatives and financial product.

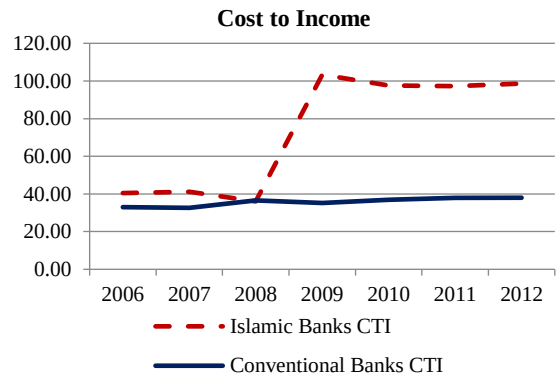
The four-component decomposition, which makes use of the within-group frontiers, identifies a widening gap between the meta-frontier and the conventional bank frontier, with the conventional banking model becoming more distinctive in the lead-up to the financial crisis relatively to the Islamic one. Post 2008/09, however, we observe a reversal of that pattern as conventional banking practices become less distinctive. Islamic banks show similar, but more muted, patterns. Variations in technical efficiency and technology are more pronounced for Islamic banks and an explanation may lie in the history of Islamic banks in the GCC. While the industry is relatively young, the GCC has some of the oldest Islamic banks and this mix is likely to be markedly different in terms of product innovation, clientele focus, range of financial products and status.

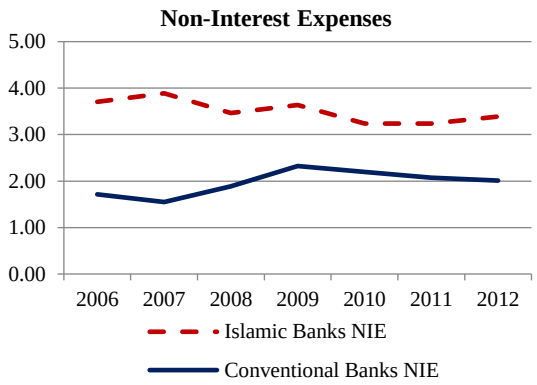
The period under study was a turbulent one for banking generally. The presence of both Islamic and conventional banks operating side by side in the GCC offers the diversity that is generally associated with a greater resilience to exogenous shocks. This might suggest that a dual banking system is one to be encouraged. Furthermore, policy makers and regulators should be wary of the important variations within the Islamic banking industry when setting up or implementing bank regulations. Hence, besides recognising the distinction between conventional and Islamic banks, a further distinction within Islamic banks, possibly in line of the specialisation and/or the range of offered products as this paper has evidenced, needs to be made. Therefore, it is important for Islamic banks as a whole to promote a brand image based on the principles of mutuality, transparency and cooperation, which is particularly topical given the EU (2018) policy "Financing a Sustainable European Economy", on sustainability (Maers and Hassanzedah, 2013; Mukhtar *et al.* 2018). To decrease operational costs Islamic banks could embrace the latest information technology financial applications (FinTech) and/or adopt a cost ceiling

policy for *Shariah* Supervisory Board costs, which would relate to the size, complexity and nature of business.

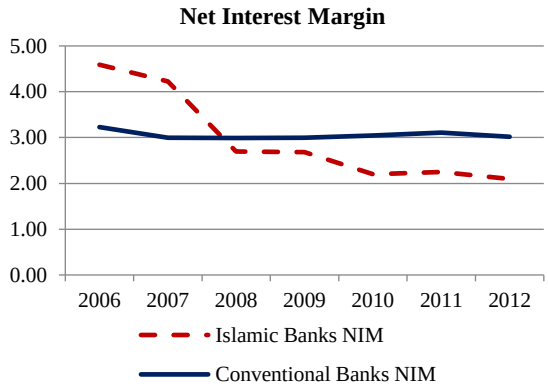
Figure 1: Evolution of financial ratios

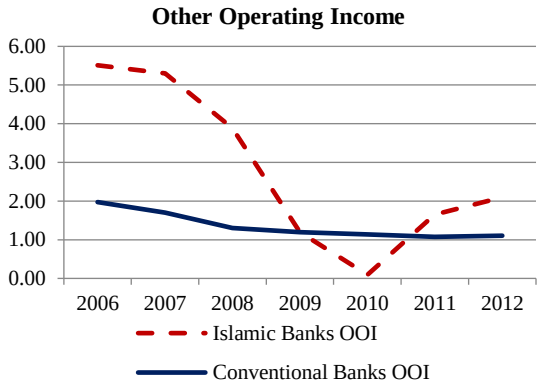
Panel A: Cost performance



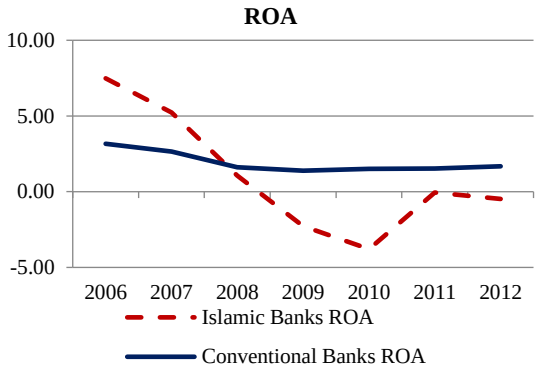


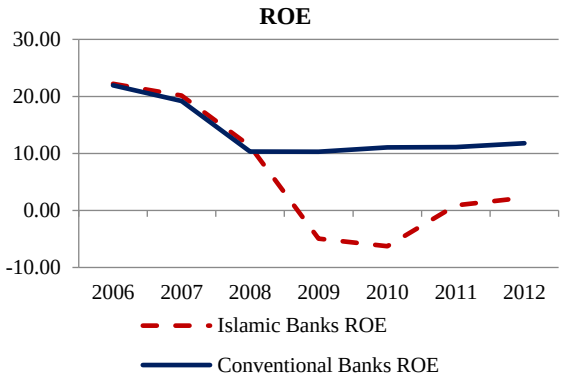
Panel B: Revenue performance





Panel C: Profit performance

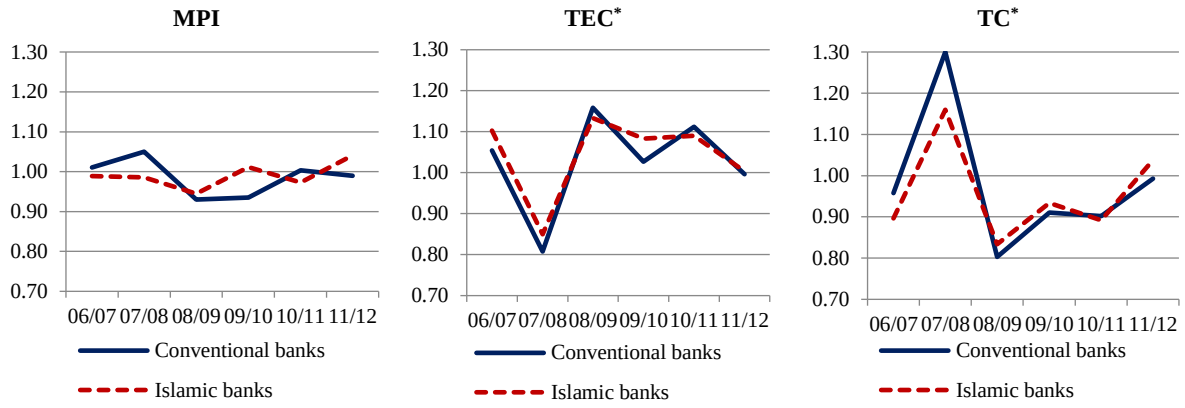




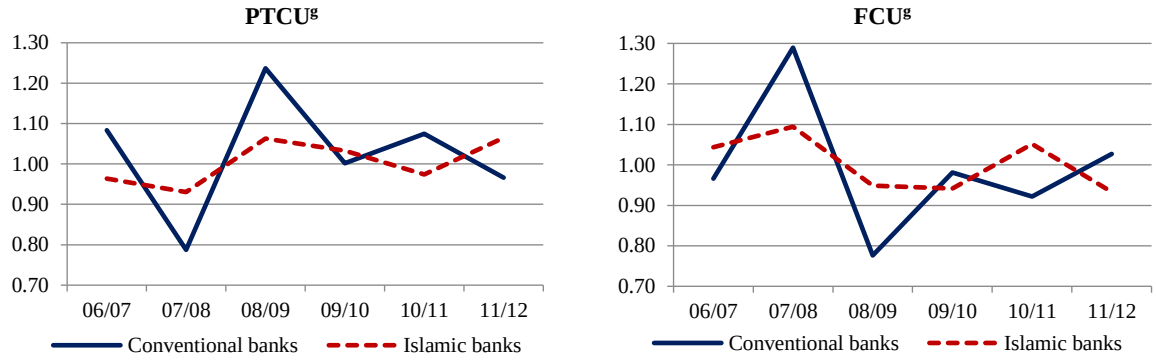
Notes: Cost performance is represented by cost-to-income (CTI) and non-interest-expenses (NIE). Revenue performance is represented by net-interest-margin (NIM) and other-operating-income (OOI). Profit performance is represented by ROA and ROE.

Figure 2: Meta-frontier decomposition of the MPI over time and by bank type

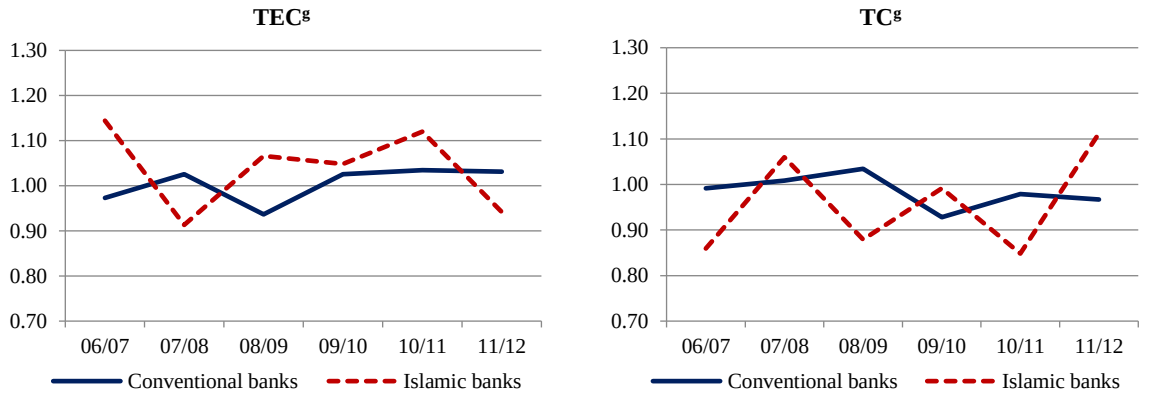
Panel A: MPI, technical efficiency change and technology change relative to the meta-frontier



Panel B: Pure type catch-up and frontier catch-up



Panel C: Technical efficiency change and technology change relative to the group frontier



Note: Panel A shows the two-component MPI decomposition while panels B and C show the four-component decomposition, both defined in Table 2.

Table 1: Definitions of Financial Ratios according to Bankscope

	Cost Performance Ratios
Cost to income (CTI)	Calculated as [Overheads/(Net Interest Margin + Other Income)]×100 where Overheads are mostly salaries
Non-interest expenses to average assets (NIE)	Calculated as [(Overheads + Loan Loss Provisions)/Average Total Assets] ×100
	Revenue Performance Ratios
Net interest margin (NIM)	Calculated as [Net Interest Margin/Average Total Earning Assets] ×100
Other operating income to average assets (OOI)	Calculated as [Other Operating Income/Average Total Assets] ×100
	Profit Performance Ratios
Return on average assets (ROA)	Calculated as [Net Income/ Average Total Assets] ×100
Return on average equity (ROE)	Calculated as [Net Income/ Average Equity] ×100

Table 2: Summary of the meta-frontier components in efficiency and productivity change

Meta-frontier Malmquist Productivity Index $\boldsymbol{MPI_{t,t+1}} = \left[\left(\frac{D_O^t(x^{t+1},y^{t+1})}{D_O^t(x^t,y^t)}\right)\left(\frac{D_O^{t+1}(x^{t+1},y^{t+1})}{D_O^{t+1}(x^t,y^t)}\right)\right]^{1/2}$

Note that $D_O^t(x^{t+1},y^{t+1}) = \min_\theta\{\theta: (y^{t+1}/\theta) \in P^t(x^{t+1})\}andD_O^{t+1}(x^t,y^t) = \min_\theta\{\theta: (y^t/\theta) \in P^{t+1}(x^t)\}$.

The meta-frontier Malmquist productivity index indicates changes in productivity calculated relative to the meta-frontier. Values in excess of 1 indicate an improvement in *productivity*.

Two-component decomposition of the Meta-frontier Malmquist Productivity Index : $MPI_{t,t+1} = TEC^*_{t,t+1} \cdot TC^*_{t,t+1}$

Meta-frontier technical efficiency change $\boldsymbol{TEC^*_{t,t+1}} = \left(\frac{D_O^{t+1}(x^{t+1},y^{t+1})}{D_O^t(x^t,y^t)}\right)$	**Technology Change** $\boldsymbol{TC^*_{t,t+1}} = \left[\left(\frac{D_O^t(x^{t+1},y^{t+1})}{D_O^{t+1}(x^{t+1},y^{t+1})}\right)\left(\frac{D_O^t(x^t,y^t)}{D_O^{t+1}(x^t,y^t)}\right)\right]^{\frac{1}{2}}$
Measures whether DMUs are getting closer to the meta-frontier over time holding technology constant, implying that banks are using existing resources more efficiently. Values greater (less) than 1 indicate improvement (deterioration).	Measures technology change and indicates whether the frontier is shifting (because of innovations such as new financial products, systems). Values greater (less) than 1 indicate improvement (deterioration).

Four-component decomposition of the Meta-frontier Malmquist Productivity Index : $\boldsymbol{MPI_{t,t+1} = TEC^g_{t,t+1} \cdot TC^g_{t,t+1} \cdot PTCU^g_{t,t+1} \cdot FCU^g_{t,t+1}}$

Within-group technical efficiency change ($\boldsymbol{TEC^g_{t,t+1}}$)	**Within-group technology change** ($\boldsymbol{TC^g_{t,t+1}}$)	**Pure type catch-up** ($\boldsymbol{PTCU^g_{t,t+1}}$)	**Frontier catch-up** ($\boldsymbol{FCU^g_{t,t+1}}$)
This measures the *technical efficiency improvement <u>within</u> group g*. It is calculated relative to the group frontier. Values greater (less) than 1 indicate improvement (deterioration).	This measures *technology improvements <u>within</u> group g*. It is calculated relative to the group frontier. Values greater (less) than 1 indicate improvement (deterioration).	This measures the TGR in period *t*+1 relative to the TGR in period *t*. If it exceeds 1 then the business banking model is having less effect (group managerial capabilities and scale are catching up with the meta-frontier), and *vice versa*.	If FCU is less than 1 then the group frontier is catching up with the meta-frontier; innovations at the meta-frontier level are diffusing quickly to the group frontier. Values greater than 1 indicate the converse. It can identify leader groups that implement certain practices to increase productivity.

Note: $MPI^g_{t,t+1} = TEC^g_{t,t+1}.TC^g_{t,t+1}$

Table 3: Descriptive statistics for the DEA input and output variables

	Conventional			Islamic			ALL		
	Mean	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
				2006					
Total loans	6250	4550	5419	2976	628	4723	5246	2982	5396
Other earning assets	3893	2315	4041	1455	481	1884	3146	1694	3684
Deposits & short-term funding	8618	6016	7652	3731	1096	5638	7121	3915	7407
Fixed assets	87	60	90	137	27	281	102	54	172
General & admin expenses	139	88	133	101	40	142	127	75	136
Equity	1361	1046	1173	872	359	1214	1211	752	1197
				2007					
Total loans	8075	5795	7563	3720	1153	5688	6740	4154	7282
Other earning assets	4745	2741	5198	1752	756	2329	3828	1775	4705
Deposits & short-term funding	11314	7544	10698	4655	1600	6703	9274	5415	10081
Fixed assets	111	81	110	153	43	292	124	70	184
General & admin expenses	158	108	148	126	61	157	148	101	150
Equity	1645	1356	1518	1064	422	1485	1467	915	1520
				2008					
Total loans	8863	6195	8283	4062	1711	5945	7392	4054	7915
Other earning assets	3848	2202	4007	1612	646	2009	3163	1583	3650
Deposits & short-term funding	11192	8159	10270	4860	1596	7042	9252	4914	9794
Fixed assets	121	87	121	153	48	325	130	75	204
General & admin expenses	175	100	197	124	53	156	159	86	186
Equity	1534	1154	1431	1019	410	1372	1376	808	1422
				2009					
Total loans	11004	7828	10559	5256	2181	7655	9242	5940	10059
Other earning assets	5011	2880	6070	2106	849	2680	4121	2025	5414
Deposits & short-term funding	13831	9282	13629	6228	2257	8923	11501	6695	12801
Fixed assets	154	124	144	191	57	417	165	87	257
General and admin expenses	214	137	222	164	86	215	198	111	219
Equity	2092	1421	1974	1267	617	1786	1839	1128	1942
				2010					
Total loans	10070	6635	9677	5198	1901	7327	8577	5439	9243
Other earning assets	4626	2563	5466	2093	798	2517	3850	2037	4881
Deposits & short-term funding	12846	8236	12860	6385	2141	8950	10866	6138	12104
Fixed assets	147	102	133	202	76	448	164	88	268
General & admin expenses	197	123	200	151	63	197	183	102	198
Equity	2083	1351	1945	1187	611	1646	1808	1100	1891
				2011					
Total loans	9423	5535	9526	4630	1789	6913	7954	4653	9030
Other earning assets	4181	2600	4968	1893	745	2578	3480	1711	4482
Deposits & short-term funding	11932	7729	12240	5894	1875	8756	10081	5629	11561
Fixed assets	124	87	118	174	54	371	139	80	225
General & admin expenses	183	118	179	147	57	194	172	94	183
Equity	2019	1341	1967	1070	503	1509	1728	965	1879
				2012					
Total loans	10028	6009	10379	5222	1729	7921	8555	4418	9883
Other earning assets	4085	2763	4622	1891	747	2450	3413	2024	4186
Deposits & short-term funding	12654	8000	13309	6521	1856	10070	10774	5310	12649
Fixed assets	121	84	116	169	61	334	136	71	207
General & admin expenses	186	115	184	152	53	201	176	98	188
Equity	2130	1311	2066	1093	481	1568	1812	941	1974
				All Years (2006-2012)					
Total loans	9102	6195	8963	4438	1711	6583	7672	4476	8574
Other earning assets	4341	2563	4927	1829	747	2322	3571	1770	4451
Deposits & short-term funding	11769	7955	11675	5468	1767	8016	9838	5436	11067
Fixed assets	124	84	121	168	48	350	137	75	219
General & admin expenses	179	111	182	138	60	179	166	93	182
Equity	1838	1237	1761	1082	470	1491	1606	929	1717

Notes: All values are in millions of US$ at 2005 prices.

Table 4: Financial ratio analysis by year

	CTI			NIE			NIM			OOI			ROA			ROE		
	All	**IB**	**CB**	**All**	**IB**	**CB**	**All**	**IB**	**CB**	**All**	**IB**	**CB**	**All**	**IB**	**CB**	**All**	**IB**	**CB**
All years (2006 – 2012)																		
Mean	46.76	73.54	35.73	2.43	3.50	1.96	3.03	2.96	3.06	1.80	2.82	1.36	1.66	1.03	1.93	11.47	6.50	13.67
p-value (t-test)	0.04**			0.00**			0.80			0.01**			0.22			0.00**		
Median	35.69	45.22	33.08	2.03	2.83	1.80	3.02	3.18	2.97	1.26	1.68	1.20	1.86	1.46	2.02	13.73	8.32	14.54
p-value (MW)	0.00**			0.00**			0.54			0.00**			0.01**			0.00**		
p-value (KS)	0.00**			0.00**			0.00**			0.00**			0.00**			0.00**		
2006																		
Mean	35.19	40.53	32.96	2.3	3.70	1.71	3.65	4.59	3.23	3.06	5.51	1.97	4.49	7.49	3.17	22.03	22.21	21.94
p-value (t-test)	0.06*			0.16			0.29			0.12			0.11			0.95		
Median	33.14	39.94	30.93	1.84	2.7	1.48	3.31	3.32	3.3	1.83	3.24	1.67	3.16	3.51	3.09	20.165	18.31	20.44
p-value (MW)	0.02**			0.00**			0.37			0.00**			0.10*			0.45		
p-value (KS)	0.03**			0.00**			0.00**			0.00**			0.02**			0.16		
2007																		
Mean	35.03	41.08	32.64	2.24	3.89	1.55	3.37	4.22	2.99	2.80	5.30	1.70	3.44	5.24	2.65	19.48	20.16	19.18
p-value (t-test)	0.11			0.03**			0.27			0.04**			0.07*			0.73		
Median	32.78	38.36	32.21	1.73	2.38	1.35	3.03	3.03	2.96	1.78	3.02	1.57	2.96	4.56	2.82	21.01	21.00	21.02
p-value (MW)	0.19			0.00**			0.38			0.00**			0.01**			0.57		
p-value (KS)	0.11			0.00**			0.06**			0.00**			0.00**			0.58		
2008																		
Mean	36.40	36.05	36.55	2.37	3.47	1.89	2.90	2.69	2.99	2.10	3.89	1.30	1.44	1.06	1.61	10.60	11.26	10.30
p-value (t-test)	0.92			0.02**			0.87			0.11			0.72			0.86		
Median	32.97	32.49	32.97	1.835	2.94	1.66	3.03	3.62	3.02	1.465	2.35	1.29	1.955	1.84	2.08	14.755	12.89	15.86
p-value (MW)	0.73			0.00**			0.16			0.00**			0.69			0.32		
p-value (KS)	0.97			0.00**			0.02**			0.00**			0.12			0.57		
2009																		
Mean	54.50	103.35	35.19	2.73	3.64	2.32	2.90	2.68	3.00	1.20	1.20	1.19	0.27	-2.27	1.39	5.63	-4.93	10.30
p-value (t-test)	0.38			0.02**			0.61			0.99			0.10*			0.03**		
Median	35.76	45.99	32.90	2.39	3.13	2.09	3.01	3.25	2.89	1.08	0.99	1.09	1.27	0.24	1.58	10.27	1.22	12.16
p-value (MW)	0.01**			0.01**			0.45			0.27			0.00**			0.00**		
p-value (KS)	0.00**			0.01**			0.19			0.09*			0.00**			0.00**		
2010																		
Mean	53.37	97.62	36.91	2.52	3.24	2.20	2.79	2.20	3.05	0.82	0.09	1.14	-0.11	-3.79	1.51	5.75	-6.27	11.06
p-value (t-test)	0.38			0.04**			0.16			0.27			0.15			0.03**		
Median	35.96	51.10	34.51	2.19	2.94	2.06	3.00	3.07	2.97	1.02	0.86	1.06	1.48	0.48	1.70	10.45	2.08	12.60
p-value (MW)	0.01**			0.01**			0.71			0.12			0.00**			0.00**		
p-value (KS)	0.01**			0.00**			0.10*			0.03**			0.00**			0.00**		
2011																		
Mean	56.10	97.31	37.89	2.43	3.24	2.07	2.85	2.25	3.11	1.25	1.65	1.08	1.04	-0.06	1.52	7.96	0.88	11.09
p-value (t-test)	0.23			0.01**			0.17			0.14			0.11			0.02**		
Median	39.85	53.54	33.85	2.04	2.76	1.96	3.02	3.12	2.99	1.08	0.91	1.08	1.46	0.71	1.70	10.41	3.24	12.51
p-value (MW)	0.00**			0.00**			0.48			0.95			0.00**			0.00**		
p-value (KS)	0.00**			0.00**			0.09*			0.17			0.00**			0.00**		
2012																		
Mean	56.60	98.67	38.00	2.43	3.39	2.01	2.74	2.10	3.02	1.41	2.10	1.11	1.02	-0.48	1.68	8.86	2.23	11.79
p-value (t-test)	0.38			0.04**			0.09*			0.19			0.14			0.03**		
Median	39.11	51.48	33.94	2.06	2.79	1.91	2.87	2.70	2.92	1.11	1.04	1.11	1.60	0.79	1.84	11.24	3.58	13.08
p-value (MW)	0.00**			0.00**			0.26			0.63			0.00**			0.00**		
p-value (KS)	0.00**			0.00**			0.01**			0.04**			0.00**			0.00**		

Notes: ** = significant at 5% significance level; * = significant at 10% significance level; t test tests the null hypothesis that the means of the two samples are equal (equal variances are not assumed)
MW is the Mann Whitney U test which tests the null hypothesis that the two samples are drawn from different distributions (against the alternative that their distributions differ in location); KS is the Kolmogorov-Smirnov 2-sample test which tests the null hypothesis that the two samples are drawn from different distributions (against the alternative that their distributions differ in location *and* shape)

Table 5: Geometric means derived from the meta-frontier Malmquist productivity index

	$MMPI_{t,t+1}$	$TEC^{*}_{t,t+1}$	$TC^{*}_{t,t+1}$	$TEC^{g}_{t,t+1}$	$TC^{g}_{t,t+1}$	$PTCU^{g}_{t,t+1}$	$FCU^{g}_{t,t+1}$
	(1)	(2)	(3)	(3)	(5)	(6)	(7)
				Conventional			
06/07	1.010	1.054	0.958	0.973	0.992	1.083	0.966
07/08	1.050	0.808	1.300	1.026	1.008	0.788	1.289
08/09	0.930	1.158	0.803	0.937	1.034	1.237	0.776
09/10	0.935	1.027	0.911	1.025	0.928	1.002	0.981
10/11	1.003	1.112	0.902	1.035	0.978	1.075	0.922
11/12	0.989	0.996	0.993	1.031	0.967	0.966	1.027
06/12	**0.985**	**1.020**	**0.967**	**1.004**	**0.984**	**1.016**	**0.982**
				Islamic			
06/07	0.989	1.103	0.896	1.144	0.859	0.964	1.043
07/08	0.985	0.850	1.160	0.913	1.060	0.930	1.094
08/09	0.945	1.133	0.834	1.066	0.879	1.063	0.949
09/10	1.011	1.083	0.934	1.048	0.992	1.033	0.942
10/11	0.973	1.090	0.892	1.120	0.848	0.974	1.052
11/12	1.041	1.003	1.038	0.942	1.112	1.065	0.933
06/12	**0.990**	**1.039**	**0.953**	**1.035**	**0.953**	**1.003**	**1.000**
				All			
06/07	1.004	1.069	0.939	1.023	0.949	1.045	0.989
07/08	1.030	0.820	1.255	0.990	1.024	0.829	1.226
08/09	0.935	1.151	0.812	0.974	0.984	1.181	0.826
09/10	0.958	1.044	0.918	1.032	0.947	1.011	0.969
10/11	0.994	1.105	0.899	1.060	0.937	1.043	0.960
11/12	1.005	0.999	1.006	1.003	1.009	0.995	0.997
06/12	**0.987**	**1.025**	**0.962**	**1.013**	**0.974**	**1.012**	**0.988**

Notes: The TEC^{*} and TC^{*} components refer to the two-component decomposition of the MPI, the TEC^{g}, TC^{g}, $PTCU^{g}$ and FCU^{g} to the four-component (more details in Table 2).

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Appendix

Table A1. Acronyms and their meanings.	
Term	**Explanation**
MPI	Malmquist productivity index
PLS	Profit-and-loss sharing
FRA	Financial ration analysis
DEA	Data envelopment analysis
SFA	Stochastic frontier analysis
CTI	Cost to income (see also Table 1 for more information on financial ratios)
NIE	Non-interest expenses to average assets (see also Table 1 for more information on financial ratios)
NIM	Net Interest Margin (see also Table 1 for more information on financial ratios)
OOI	Operating Income to Average Assets (see also Table 1 for more information on financial ratios)
ROA	Return on Average Assets (see also Table 1 for more information on financial ratios)
ROE	Return on Average Equity (see also Table 1 for more information on financial ratios)
IASB	International Accounting Standards Board
AAOIFI	Accounting and Auditing Organization for Islamic Financial Institutions
SSB	*Shariah* Supervisory Board
MW	Mann-Whitney test (see also Table 4)
KS	Kolgomorov-Smirnov test (see also Table 4)