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GLOBAL FINANCIAL CRISIS AND PRODUCTIVITY CHANGES OF BANKS IN UAE: A DEA-MPI ANALYSIS

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ABSTRACT

The primary objective of this research is to undertake in-depth evaluation and examination of the productivity change of the Emirati Banking sector for a balanced panel which covers 10 banks operating in UAE for the period 2006-2010, by estimating a non-parametric approach Data Envelopment Analysis. Input-oriented Malmquist indices of productivity change are estimated with DEA to measure total factor productivity (TFP) change. The TFP changes are decomposed into the product of technological change and technical efficiency change (catch-up). The era of our sample is very rich with many aspects that influenced the UAE banking system which cover the global financial crisis era. The empirical results are obtained by running an input-oriented DEA model using the software package, DEAP Version 2.1 (Coelli, 1996). Our results reveal that the banking sector in UAE shown a decline after the financial crisis in 2008.

Keywords: Two Stage Data Envelopment Analysis; UAE Banks; Malmquist Productivity Indices; Total Factor Productivity; Global Financial Crisis.

1. INTRODUCTION

Financial system stability in any country is important for both the overall economic development and the effectiveness of the central bank monetary policy. Over the last two decades, the UAE government has undergone consistent and remarkable transformation from a socialist to a capitalist economy. These changes were introduced mainly to improve the economic efficiency of UAE banking system especially after the global financial crisis. The banking industry in the United Arab Emirates is one of the major, and arguably the most important, industry in the United Arab Emirates after the oil and gas industry. This is mainly due to its role as an intermediary and facilitator for the better allocation of assets in a country that is seen as the regional hub for international finance, a free zone and international trade hub, a leader in the development and sale of real estate mega-developments and centre for a large concentration of net worth individuals with large multibillion dollar conglomerates.

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All of these key industries in the United Arab Emirates require the presence of banks in order to allow the right allocation of funds through financing the key projects and industries of the country.

In 2010 the UAE banking sector comprising of some 23 local and 26, the banking sector in the UAE has for quite some time benefitted from being in a very sound and robust position. In the UAE, four types of banks are seen to be operating simultaneously. They are conventional, Islamic and foreign banks. Moreover, some commercial banks have started opening Islamic windows and Islamic units for those clients who do not want to indulge in interest-based transactions. This conviction created an increased demand for Islamic products in the field of financing, and gave birth to a market where only Islamic products are acceptable. Thus, banks working under Islamic windows are established to provide an additional service to Muslim clients or to offer a variety of products for general clientele.

The UAE was the first country in the world to establish an Islamic bank, namely Dubai Islamic Bank, in 1975. Islamic banking is one of the fastest-growing segments in the financial sector globally. Assets of UAE's Islamic banks reached $73.1bn at the end of 2010 according to UAE Central Bank governor. Islamic banks in the UAE target all categories to broaden their reach, through innovative product offerings including Islamic personal finance, Islamic credit cards and Islamic auto finance, Shari'a-complaint mortgages, and a growing range of investment funds.

UAE bank shares were slammed by a bear market amid an epic fall in oil prices, a rise in the US dollar and an exodus of global capital from emerging/frontier markets. The scale of selling on the Dubai Financial Market and the Abu Dhabi Securities Exchange has eerie echoes with the autumn of 2008, when Lehman's failure led to a seizure in the global interbank and wholesale funding markets, a $100 a barrel drop in Brent crude, panic flows into the US dollar and a free fall in Gulf property markets.

The global financial crisis in autumn of 2008 has affected many countries globally and in particular effect UAE economy in general. The UAE made various actions after the crisis to save their economy from any impact may affect their economy. Firstly, UAE banks have vastly boosted their capital cushions since 2008 and Basel Tier one capital for the banking sector is now 16.7 per cent, at least 500 basis points higher than on the eve of Lehman's failure. Secondly, six years of frenetic loan growth had made loan/deposit ratios in UAE banking excessive at 108 per cent in fall 2008. Banking sector leverage has also fallen to 7.6, 100 basis points lower than in 2008. Three, UAE banks have also successfully raised the non-performing loan coverage ratios in the banking system to 113 per cent, far higher than the coverage ratio during the 2008 global credit crisis. Fourth, the UAE banking sector was dependent on fickle global wholesale funding markets, which froze after Lehman's failure triggered an epic crisis of confidence in the international interbank market.

With the above information we should shed the light on measuring the productivity change of the banking sector during the global financial crisis era, especially the domestic banks, to assess how each bank performs during and after the global financial crisis. Measuring the efficiency of the United Arab Emirates banks significant as the UAE has developed rapidly comparing with other Middle Eastern countries and this will be important for analysts, practitioners and policymakers to be able to understand the relative performance of banks benchmark the efficiency of the banks against each other. (Jemrić and Vujčić, 2002).

The primary objective of this paper is to undertake and in-depth evaluation and examination of the productivity growth in the UAE banking sector. Input-oriented Malmquist indices of productivity

change are estimated with DEA to measure total factor productivity (TFP) change using a balanced panel data containing 10 banks operating in UAE for the period 2006-2010. The study compares the productivity change between the domestic banks during the sample period. The empirical results are obtained by running an input-oriented DEA model using the software package, DEAP Version 2.1 (Coelli, 1996).

The rest of the paper is organised as follows. To put the study in perspective. Section 2 presents a brief overview of existing literature on productivity changes in the banking industry. Section 3 presents the Malmquist Productivity Index (MPI) Measurement. The Data and the choice of variables presented in Section 4. The drivers of productivity change are analysis in Section 5. Sections 6 summarises and brings together the main findings.

2. LITERATURE REVIEW

The literature on efficiency and productivity change of banks and how productivity influenced by changes in regulations, innovation and technological processes and differences of productivity across countries is vast. Various studies conducted in the US, Europe, Asia and a few in Africa have measured efficiency and productivity change in banking sector.

Ferrier and Lovell (1990) and Grabowski et al. (1994) used the DEA approach to assess the productive performance of US banks relative to the best practice frontier, and found that overall the efficiency of the US banking industry ranges from 65% to 90%. Following this, Richard et al. (2002) used the DEA model to evaluate the productive efficiency of US commercial banks from 1984–1998. Strong and consistent relationships between efficiency and independent measures of performance were found. Seiford and Zhu (1999) examined the performance of the top 55 US commercial banks using DEA. They used a two-stage [1] production process to measure profitability and marketability, with inputs and outputs in each stage consisting of eight factors. Their results indicated that relatively large banks exhibited better performance on profitability, whereas smaller banks tended to perform better with respect to marketability.

The Middle East studies on measuring efficiency and productivity change of banks are limited. However, that are a few studies on measuring productivity and efficiency on the Middle East area. For example, Al-Tamimi and Lootah (2007) investigated the operating and profitability efficiency of 15 branches of UAE-based commercial bank utilizing the DEA method. The results indicate that the profitability efficiency appears to be higher than operational efficiency. Regarding the financial ratios analysis, a consistent effect cannot be obtained and it cannot be determined which branch has an overall position in terms of higher performance. In addition, management should consider major operational improvement efforts to reduce employees' expenses and other operating expenses combined with an increase in the total loans portfolio. Moreover, both interest and non-interest revenues require improvement to increase profitability efficiency of the whole branch network.

Using the data from the annual reports of individual banks published by Emirates Banks Association for 1997- 2001, Al–Tamimi (2008) focussed on identifying the relatively best performing banks and relatively worst performing banks in the United Arab Emirates (UAE). The study used DEA and some traditional financial ratios such as returns on assets, returns on equity, ratio of loans to deposits and ratio of loan to total assets to investigate efficiency of banks. The DEA model used interest expense and non-interest expense as input variable; interest revenue and non-interest revenue as

output variables. The study revealed that most of the UAE Commercial Banks were inefficient. The national banks were relatively more efficient than the foreign banks. Two traditional ratios namely, loans to deposits and loans to total assets indicated that the UAE Commercial Banks somehow did not use the available resources efficiently.

Al-Muharrami (2007) used DEA techniques to estimate technical, pure technical, and scale efficiency, using an input orientation for GCC banks for ten years. He highlighted several interesting findings: First, smaller banks exhibited superior performance in terms of overall technical efficiency than did larger ones. Second, big banks proved to be more successful in adopting the best available technology, while medium banks proved to be more successful in choosing optimal levels of output. Third, Islamic banks were more successful in both the adoption of the best available technology and choosing optimal levels of output. Fourth, banks in Bahrain, Qatar, Oman, UAE, Kuwait and Saudi Arabia ranked first to sixth, respectively, in terms of technical efficiency.

Miniaoui and Tchanetchan (2010) assessed technical efficiency of 44 top GCC banks over the period 2005-2008 using DEA approach. The results show that only 14 banks are rated as efficient under CRS and/or VRS assumptions, and indicate that Islamic banks perform slightly better than the other types of banks (conventional and windowing).

In a more recent , Al Suwaidi (2013), applied DEA method to evaluate and analyze the efficiency of the national commercial banks in the United Arab Emirates by defining and using different approaches of Data Envelopment Analysis in order to identify the relatively efficient and relatively less efficient national commercial banks. This study concentrates on the main approaches of the operating efficiency and the financial intermediary role efficiency. Through this study they observed that over the period of 2008 – 2012 that (i) A general and consistent level of high operational efficiency can be observed in the United Arab Emirates banking Sector; (ii) A general and consistent level of high intermediary role efficiency can be observed in the United Arab Emirates banking Sector with the presence of efficiency fluctuations in some banks; (iii) The age of individual banks had little or no effect on the relative efficiency of the bank; (iv) Compared to previous studies we can observe a general raise in operating efficiency levels among banks.

To the best of our knowledge, none of these studies have evaluate and analyse the productivity growth covered pre and post global financial crisis era for the UAE banking sector. The present study overcomes this limitation by encompassing the entire financial liberalisation period and investigating the drivers of productivity change in UAE banks. The global financial crisis brought about significat changes in practices of UAE banks from 2006 to 2010. The study undertaken in this paper will provide a new perspective about the banking sector of UAE.

3. THE MALMQUIST PRODUCTIVITY INDEX (MPI): DECOMPOSITION AND MEASUREMENT

The Malmquist TFP index was first introduced in two very influential papers by Caves, Christensen and Diewert (1982a, 1982b). These authors define TFP index using Malmquist distance functions; hence the resulting index is known as Malmquist TFP index or simply (MPI). One of the important features of these distance functions is that these allow description of a multi-input, multi-output production technology without the need to specifying a behavioural objective such as cost minimisation or profit maximisation. Distance functions are of two types: the input distance functions

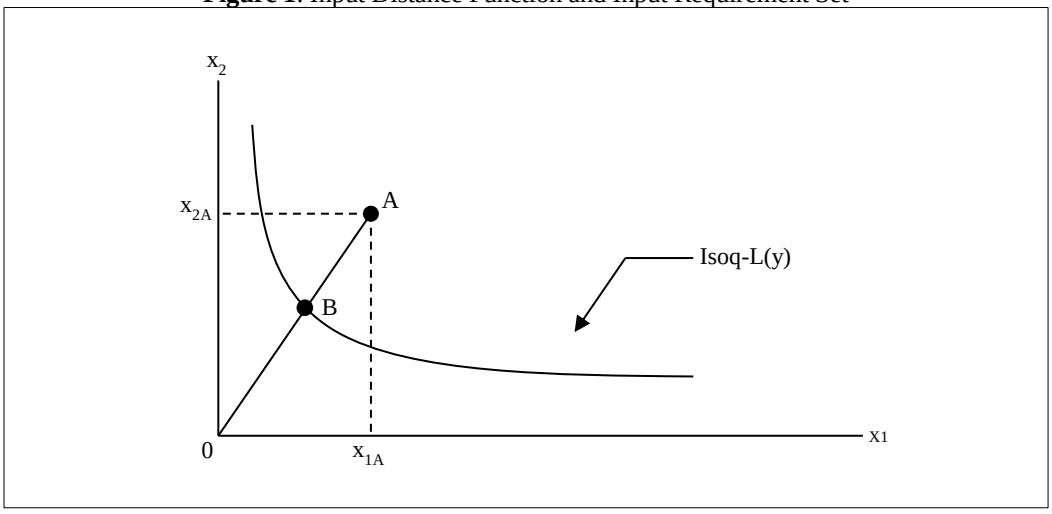
and the output distance functions. Input distance functions look for a minimal proportional contraction of an input vector, given an output vector; and output distance functions consider the maximum proportional expansion of output with a given set of inputs. Since the banks have better control over the inputs, we adopt an input-orientated approach for computing TFP.

Let $y_t \in R_+^M$ denotes an (Mx1) output vector, $x_t \in R_+^N$ an (Nx1) input vector, and L(y) denote the input requirement set representing the set of all input vectors, x, which can produce the output vector, y. Then the input distance function, which involves the scaling of input vector, is defined on input set, L(y), as:

$$d_i^t(y_t, x_t) = \max\{\rho_t : (x_t / \rho_t) \in L(y)\} \qquad (3)$$

where the subscript 'i' indicates 'input oriented' measure. The notation $d_i^t(y_t, x_t)$ stands for the distance from the period t observation to the period t technology. In other words, this distance function represents the largest factor, ρ_t, by which an input vector (x_t) is deflated to produce the output vector under period t technology. Similarly, $d_i^s(y_t, x_t)$ would indicate distance from period t observation to period s technology. An input distance function can be illustrated using an example where two inputs, x_1 and x_2, are used to produce a given output vector, y. For a given output vector, the production technology is represented by the isoquant, L(y) in figure 1. The value of the distance function for the point, A, which defines the production point where the firm uses x_1 of input 1 and x_2 of input 2, to produce the output vector y, is equal to the ratio ρ = OA/OB.

Figure 1: Input Distance Function and Input Requirement Set



Source: Coelli et. al (2005).

Based on input distance functions, the Malmquist TFP index can be constructed to measure productivity change between periods s and t, based on period t technology,

$$m_i^t(y_s, x_s, y_t, x_t) = \frac{d_i^t(y_t, x_t)}{d_i^t(y_s, x_s)}. \qquad (4)$$

A similar output oriented Malmquist index can be obtained based on period s technology as follows,

$$m_i^s\left(y_{s,}x_s,y_{t,}x_t\right)=\frac{d_i^s\left(y_t,x_t\right)}{d_i^s\left(y_{s,}x_s\right)}. \tag{5}$$

Clearly, Equations (4) and (5) imply that estimation of TFP change between the two periods could depend on the choice of technology. In order to avoid the effect of any arbitrarily chosen technology, Färe et al (1994) suggests to estimate the output oriented TFP as the geometric mean of the indices based on periods t and s technologies as given by equations (4) and (5), respectively. Hence we have

$$m_i\left(y_s,x_s,y_t,x_t\right)=\left[\left\{\frac{d_i^s\left(y_t,x_t\right)}{d_i^s\left(y_s,x_s\right)}\right\}\left\{\frac{d_i^t\left(y_t,x_t\right)}{d_i^t\left(y_s,x_s\right)}\right\}\right]^{\frac{1}{2}}. \tag{6}$$

When the value of m_i exceeds unity this indicates a positive TFP growth from period s to period t and a value of the index less than one indicates a decline in TFP growth. The Equation (6) can be re-written as

$$m_i\left(y_s,x_s,y_t,x_t\right)=\frac{d_i^t\left(y_t,x_t\right)}{d_i^s\left(y_{s,}x_s\right)}\left[\left\{\frac{d_i^s\left(y_t,x_t\right)}{d_i^t\left(y_{t,}x_t\right)}\right\}\left\{\frac{d_i^s\left(y_s,x_s\right)}{d_i^t\left(y_{s,}x_s\right)}\right\}\right]^{\frac{1}{2}}. \tag{7}$$

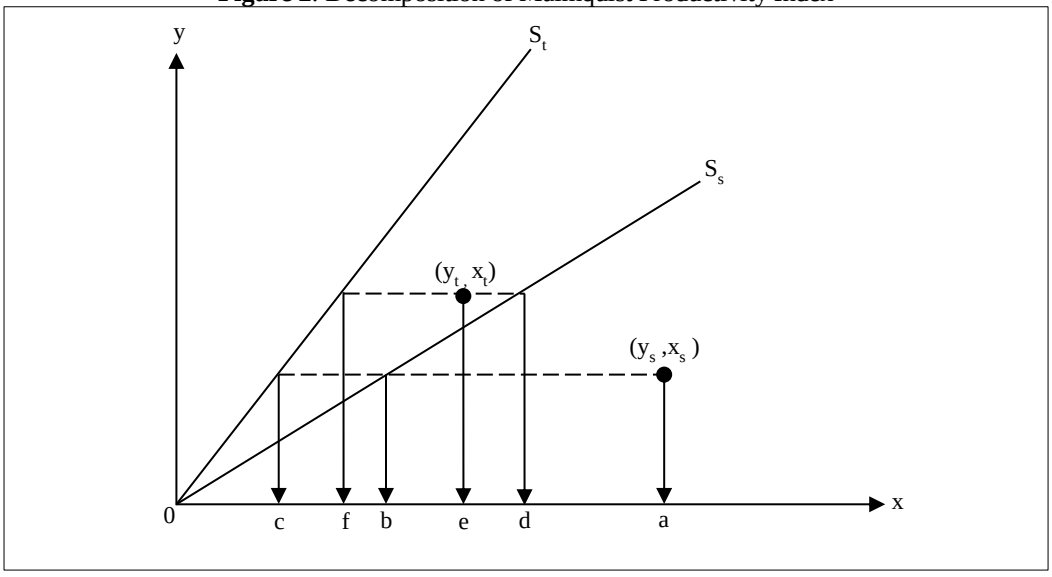
The ratio outside the square brackets measures the change in the input-oriented measure of technical efficiency between periods, s and t. This efficiency change is equivalent to the ratio of the Farrell technical efficiency in period t to the technical efficiency in period s. The remaining part of the index indicates the shift in technology between the two periods. Thus, the Malmquist TFP index given by equation (7) reveals shows that productivity change is the product of technical efficiency change (catch-up) and technological change (shift in frontier). The fig. 2 below illustrates the decomposition.

The technologies for period t and period s (t >s) are represented by S_t and S_s showing technological progress from period s to t. Both observations (y_t, x_t) and (y_s, x_s) are inefficient with respect to their own frontier and (y_t, x_t) does not belong to (y_s, x_s). Our formula (7) of the Malmquist index can be expressed in terms of distances along the x-axis. Thus we have

$$m_i\left(y_s,x_s,y_t,x_t\right)=\frac{oe/of}{oa/ob}\left[\left\{\frac{of}{od}\right\}\left\{\frac{oc}{ob}\right\}\right]^{\frac{1}{2}} \tag{8}$$

To measure Malmquist TFP change between any two periods as defined in equation (7), four distance functions have to be calculated. The decomposition of technical efficiency change into changes in scale efficiency and pure teachnical efficiency components would requires the calculation of the distance functions with VRS technology. The values obtained with CRS and VRS technology can be used to calculate the scale efficiency change residually. The mathematics underlying the estimation procedure is outlined in Fare and Grosskopf (1990) and Coelli et al (2005).

Figure 2: Decomposition of Malmquist Productivity Index



Source: Färe et al (1990)

4. THE DATA AND THE CHOICE OF VARIABLES

The choice of input and output variables for the banking sector is very controversial. In the literature one comes across three distinct approaches that are used for selecting inputs and outputs. These are: the production approach, the intermediation approach, and the value-added approach. The first approach views financial institutions as producers who use labour and capital to generate deposits and loans. This approach is used, among others, by Sathye (2001) and Neal (2004). The intermediation approach views financial institutions as intermediaries that convert and transfer financial assets from surplus units to deficit units. In an another conceptualization of the intermediate approach, Paul and Kourouche (2008) use interest expenses and non-interest expenses as inputs and interest income and non-interest income as the outputs. Hence, in our paper we follow the paper done by Paul and Kourouche (2008). The data used in this study covers 2006–2010 period and are taken from, auditing annual report of individual banks in UAE. The data were collected from 10 banks operating in UAE. We use the intermediation approach in which banks are viewed as financial intermediaries employing inputs such as total deposit and labour to produce outputs such as total loans and other investments. The variables are listed in Table 1.

Table 1: List of Inputs and Outputs

Inputs	Outputs
Interest Expense on Customer Deposits (X1)	Interest Income on Loans (Y1)
Other Interest Expense (X2)	Other Interest Income (Y2)

The definitions of the variables used in DEA model are as a follows. Inputs are defined as interest expenses and non-interest expenses. Interest expenses include expenses for deposits and other borrowed money. Non-interest expenses include service charges and commissions, expenses associated with fixed

assets and general management affairs, salaries and other expenses. Outputs are defined as interest income, and non-interest income. Interest income includes interest on loans and securities. Non-interest income includes service charges on loans and transactions, commissions and other operating income.

The major limitations or obstacles faced by this study are the general lack of information available to the public. Firstly, we faced the lack of publicly available information of the foreign banks as there are no separate financial statements available to researches or investors for the United Arab Emirates' activity. This means that all foreign banks had to be omitted from the study. To overstep these limitations we concentrated on the study on the national banks without including the few national banks with missing/no information. As the 10 national banks included in this study include the majority of major banks in the United Arab Emirates banking industry we believe that they are sufficient to show a clear picture of the banking industry as a whole.

A year by year analysis of the year end financial data provided from the Bank Scope Database was used. The data were collected from 10 domestic banks operating in UAE. The banks studied here are listed in Table 2. Based on their total assets size in 2010 measured in dirham.

Table 2: Assets of Domestic Banks in UAE, 2010

Bank Name	City	Total Assets AED
National Bank of Abu Dhabi	ABU DHABI	2,112,833,714
Emirates Bank International PJSC	DUBAI	1,887,078,501
Abu Dhabi Commercial Bank	ABU DHABI	1,781,498,424
First Gulf Bank	ABU DHABI	1,406,621,794
Mashreqbank	DUBAI	8,478,804,145
Commercial Bank of Dubai P.S.C.	DUBAI	384,849,836
Bank of Sharjah	SHARJAH	2,060,366,456
Arab Bank for Investment & Foreign Trade-Al Masraf	ABU DHABI	1,342,215,668
National Bank of Umm Al-Qaiwain	UMM AL-QAIWAIN	132,262,901
National Bank of Fujairah	FUJAIRAH	1,290,780,706

Source: Bankscope.

5. EMPIRICAL RESULTS

We have used non-parametric data envelope approach to compute the input oriented Malmquist indices of productivity change based on the panel data for 10 banks for the period 2006-2010. The computer software DEAP (Coelli, 1996) is used to calculate these indices. The value of the MPI (i.e. TFP) greater than one indicates positive productivity growth or productivity progress while a value less than one productivity decline or productivity regress. Percentage change in productivity is given by (productivity change – 1) x 100. Where mean aggregate indices are reported for the different groups of banks, these are weighted geometric means using the shares of individual banks in the group output as weights. Similarly, the indices aggregated over the period are also weighted geometric means, where shares of yearly outputs in the total output for the period are used as weights.

As mentioned earlier the our approach is the same approach used by Paul and Kourouche (2008). The sample period mean of TFP change and its components of technical efficiency change, pure technical efficiency change, scale efficiency change and technological change indices for each bank are presented in Table 3. The results reveal that the all the banks in our sample have shown productivity

improvements over the years. The highest mean TFP growth per annum has been shown by Mashreqbank 9.86% and lowest by the National Bank of Umm Al-Qaiwain. The observed improvement in mean TFP is largely attributable to technological progress.

Table 3: Estimates of Malmquist TFP Change and its Components, UAE Banks

Bank	TEC	TC	PTEC	SEC	TFPC
1	1.000	1.306	1.000	1.000	1.306
2	1.025	1.482	1.000	1.025	1.520
3	1.034	1.095	1.000	1.034	1.132
4	1.000	1.602	1.000	1.000	1.602
5	1.317	1.508	1.089	1.209	1.986
6	0.846	1.257	1.000	0.846	1.064
7	0.962	1.450	1.000	0.962	1.395
8	1.000	1.293	1.000	1.000	1.293
9	1.000	1.055	1.000	1.000	1.055
10	1.089	1.303	1.105	0.986	1.419

Source: Authors' calculations.

Notes: TFP denotes total factor productivity, TEC is the technical efficiency change, PTEC is the pure technical efficiency change, SEC is the scale efficiency change and TC denotes technological change.

The results reveals that TFP growth in the banking sector over the years from 2007 till 2010 presented in Table 4. In 2007 it can be observed that there was a decline TFPC for the ours ample data. However, in 2008 the banking sector have shown progress in TFP and that improvement before the global financial crisis appear which started in late 2008. The banks TFPC have experienced a decline in TFP growth in 2009 comparing with earlier year but still having progress in TFP. The reason may be due to several factors affecting the banking performance, in particular, due to the global financial crisis. The banking sector in UAE continue growing and having progress in TFP for the year 2010.

Our results reveal that the banking sector in UAE shown a decline after the financial crisis in 2008 and then they start improve their productivity for the year after, as the UAE government took action for supporting their financial and banking sector. In addition, our results, consists with other study done by (Al Suwaidi, 2013), as his study found decline in the efficiency and productivity for the banks in UAE in 2009 and then having progress for the year after.

Table 4: Yearly Malmquist Indices of Productivity Change, 2006–2010

Year	2007	2008	2009	2010	Mean
TFC	1.016	0.944	1.142	1.022	1.028
TC	0.844	1.243	0.986	1.324	1.082
PTEC	0.996	0.985	1.028	1.019	1.007
SEC	1.021	0.958	1.111	1.003	1.022
TFPC	0.858	1.174	1.125	1.353	1.113

Source: Authors' calculations.

Notes: TFP denotes total factor productivity, TEC is the technical efficiency change, PTEC is the pure technical efficiency change, SEC is the scale efficiency change and TC denotes technological change.

6. CONCLUDING REMARKS

This paper has used DEA model to estimate input-oriented Malmquist indices to examine TFP changes in the UAE banking sector during the global financial crisis era 2006-2010. The TFP changes

were decomposed into the product of technological change and technical efficiency change (catch up). The technical efficiency change is further decomposed into product of pure technical efficiency change and scale efficiency change. To the best of our knowledge, this is the first attempt to examine TFP changes in the UAE banking sector during the entire crisis era, not encompassed in the earlier studies. The results reveals that over the sample period for the UAE banking sector as a whole shows a productivity progress which is largely due to the technological change. Our results reveal that the banking sector in UAE shown a decline after the financial crisis in 2008 and then they start improve their productivity for the year after, as the UAE government took action for supporting their financial and banking sector. In addition, our results, consists with other study done by (Al Suwaidi, 2013), as his study found decline in the efficiency and productivity for the banks in UAE in 2009 and then having progress for the year after.

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APPENDICES

Table A-5: Malmquist Indices of Productivity Change for Banks, Year 2007

Bank	**TEC**	**TC**	**PTEC**	**SEC**	**TFPC**
1	1.000	0.606	1.000	1.000	0.606
2	0.727	0.877	0.771	0.943	0.637
3	0.821	0.763	1.000	0.821	0.626
4	1.364	0.886	1.000	1.364	1.208
5	1.169	1.136	1.000	1.169	1.328
6	1.000	0.843	1.000	1.000	0.843
7	1.000	0.691	1.000	1.000	0.691
8	0.917	0.953	1.000	0.917	0.874
9	1.000	1.016	1.000	1.000	1.016
10	1.345	0.797	1.243	1.082	1.073
Mean	1.016	0.844	0.996	1.021	0.858

Table A-6: Malmquist Indices of Productivity Change for Banks, Year 2008

Bank	TEC	TC	PTEC	SEC	TFPC
1	0.763	1.103	1.000	0.763	0.841
2	0.680	1.205	0.678	1.003	0.820
3	0.929	1.143	1.000	0.929	1.062
4	0.707	1.149	1.000	0.707	0.813
5	0.845	1.297	1.000	0.845	1.096
6	1.000	1.635	1.000	1.000	1.635
7	0.915	1.215	1.000	0.915	1.112
8	1.521	1.446	1.000	1.521	2.199
9	1.000	1.180	1.000	1.000	1.180
10	1.401	1.149	1.270	1.103	1.610
Mean	0.944	1.243	0.985	0.958	1.174

Table A-7: Malmquist Indices of Productivity Change for Banks, Year 2009

Bank	TEC	TC	PTEC	SEC	TFPC
1	1.311	1.171	1.000	1.311	1.535
2	2.744	0.793	1.913	1.434	2.175
3	1.026	0.988	1.000	1.026	1.014
4	1.414	1.035	1.000	1.414	1.463
5	0.899	0.990	0.918	0.979	0.890
6	1.000	0.675	1.000	1.000	0.675
7	1.092	1.182	1.000	1.092	1.291
8	1.000	0.987	1.000	1.000	0.987
9	1.000	0.915	1.000	1.000	0.915
10	0.734	1.276	0.748	0.981	0.936
Mean	1.142	0.986	1.028	1.111	1.125

Table A-8: Malmquist Indices of Productivity Change for Banks, Year 2010

Bank	TEC	TC	PTEC	SEC	TFPC
1	1.000	1.306	1.000	1.000	1.306
2	1.025	1.482	1.000	1.025	1.520
3	1.034	1.095	1.000	1.034	1.132
4	1.000	1.602	1.000	1.000	1.602
5	1.317	1.508	1.089	1.209	1.986
6	0.846	1.257	1.000	0.846	1.064
7	0.962	1.450	1.000	0.962	1.395
8	1.000	1.293	1.000	1.000	1.293
9	1.000	1.055	1.000	1.000	1.055
10	1.089	1.303	1.105	0.986	1.419
Mean	1.022	1.324	1.019	1.003	1.353

Source: Authors' calculations.

Note: TFP denotes total factor productivity, TEC is the technical efficiency change, PTEC is the pure technical efficiency change, SEC is the scale efficiency change and TC denotes technological change.