

A Cross-Country Comparison of Operational Efficiency between Chinese and Pakistani Commercial Banking Industries

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Abstract

The objective of this paper is to make a cross-country comparative analysis on operational efficiency (OE), that is consisted of technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE), between the industries of Chinese and Pakistani commercial banks (CBs) for the year 2012 to 2016. To measure the OE score of a CB, we apply a non-parametric approach known as data envelopment analysis (DEA) method. From the previous studies on CBs, we adopt two models, i.e. Model A and Model B, with a different set of inputs and outputs variables to assess that does efficiency scores vary with change in a number of inputs and outputs. The empirical analysis finds that both Mean TE and PTE scores of Chinese CBs are always relatively higher than the corresponding scores of Pakistani CBs in the time period 2012-2016. However, Mean SE score of Chinese CBs obtained by using Model A is relatively lower than of Pakistani counterparts. It also finds that the Mann-Whitney U test shows that there is a significant difference between Mean TE scores of CBs in the commercial banking industries of both countries for the years 2012-2016.

Key words. : Data envelopment analysis, Commercial banks, China, Pakistan, Mann-Whitney U test.

1 Introduction

An organization basic goal is always to develop those kinds of strategies which could be implemented to get the desired results through effective use of available resources by applying management functions efficiently. A bank organized chiefly to handle the everyday financial transactions of businesses (as through commercial deposits and loans) is known as a commercial bank (CB). A banking industry plays a vital role in the development of a country's economy by providing services to customers.

The main theme of this research is to make a cross-country comparative analysis of operational efficiency (OE) between Chinese and Pakistani commercial banking industries by using the data envelopment analysis (DEA) method and Mann-Whitney U test. The DEA method that is a famous approach introduced by Charnes, et al. [4] is used to measure the technical efficiency (TE) of a set of decision-making units (DMUs) that have a variety of identical inputs to produce a variety of identical outputs. A comprehensive series of research work has been conducted to evaluate the performance of CBs of different regions of

the world, see Emrouznejad and Yang [8]. However, in our knowledge, so far no one has done the study measuring and comparing the performance of banking industries between China and Pakistan by using the DEA method and Mann-Whitney U test.

Both of China and Pakistan belong to developing countries in terms of per-capita gross domestic product (GDP). They are two neighboring countries in Asia and well-renowned friends on a global economic map. Following the previous scholar's research directions this paper provides a DEA comparative analysis of OE, that is consisted of TE, pure technical efficiency (PTE) and scale efficiency (SE) between China and Pakistan banking sectors for the time of 5 fiscal years (2012-2016), setting up two models with different inputs and outputs.

This paper consists of 5 Sections. In Section 2, a comprehensive review of the current situation of the banking industries of both countries is discussed. Section 3 discusses the methodology used in the research. Empirical analysis of DEA and Mann-Whitney U test and conclusion are presented in Sections 4 and 5, respectively.

2 An overview of the Chinese and Pakistani banking industries

China and Pakistan have strong bindings since 1949 after the independence of the People's Republic of China; both the countries are always committed to promoting the social, political and economic ties. The structure of this relationship is based on common interests in all sectors includes trade, agriculture, art, education, etc. At present, China and Pakistan are 1st and 6th largest populated countries of the world, respectively, with a population of 1.39 billion and 200.8 million people.

With every passing day, both countries are committed to strengthening their economic relations. For the economic development in Pakistan, China is progressively increasing its investments in all fields of life. In South Asia, Pakistan is the first country to have a free trade agreement with China. After the completion of the first five years of FTA China and Pakistan planned to extend the agreement for the next five years because it had positive impacts on Pakistan trade as exports increased gradually. Main sectors of cooperation are agriculture, economy, industry, energy, technology, communication, etc. In 2013 both governments signed different agreements through China -Pakistan economic corridor (CEPEC) with 46 billion US dollars should be invested in the infrastructure and energy projects in Pakistan.

At the end of 2016 China's GDP was recorded around RMB 74.41 trillion, according to statics of 2016 total numbers of Chinese incorporated institutions are 4,399 including 5 state-owned CBs, 12 joint stock CBs, 134 city CBs, 1,114 rural CBs, 39 foreign banks, 1125 rural credit cooperatives, 68 trust corporations, 236 financial companies, 56 finance leasing companies, 18 consumer finance firms, 1,443 town or village banks, 4 assets managing firms, 25 auto financing institutions, 5 money brokerage firms, 48 rural mutual cooperative institutes and 8 private sector banks. Furthermore, 4.09 million employees are working in this industry.

In 2016 the total assets of China's banking sector increased by 0.1% with a comparison to 2015 and recorded RMB 232.3 trillion. Similarly, there is an increase of 0.1% from

the previous year was noticed in liabilities, and the total amount was RMB 214.8 trillion. Statics shows us that by type of banking institution in total financial assets of the banking industry are as following, large CBs, joint stock CBs, city CBs, small- and medium-sized rural financial institutions, respectively, accounted for 37.3%, 18.7%, 12.2% and 12.9%. There is a continuous increase in profits of the Chinese banking industry. By the end of 2016, the total net profit of the Chinese banking sector was RMB 2.1 trillion with an increase of 3.6% from 2015. Among the 2.1 trillion CBs total net profit was 1.65 trillion. See China Banking Regulatory Commission [6].

In 2016, GDP of Pakistan was recorded \$278.91 billion US dollars. Pakistan banking industry has a vital part in the GDP. The industry mainly divided into local and foreign banks, further local banks include private, public and specialized banks. There are 6 public, 16 private banks, 13 Islamic, and 11 microfinance banks operating in Pakistan banking sector. Meanwhile, 7 foreign banks are also operational.

In 2016, the total value of the financial assets of Pakistan banking industry was PKR (Pakistani rupees) 15.98 trillion with an increase of 12.02% from the previous year. Similarly, an increase of 21.51% was noticed in the value of liabilities from the previous year, with total amount PKR 14.59 trillion. The overall growth of the banking sector was witnessed 11.32% increased in the balance sheet size of domestic banks. However, in 2016 the profit of Pakistan banking industry decreased by 1.01% after the tax deduction comparing with calendar year 2015. Foreign banks shared in the banking industry remain 2.45% with an increase of 9.53%. See State Bank of Pakistan [14].

3 Methodology

3.1 Data envelopment analysis

To measure the efficiency of DMUs, Charnes, et al. [4] introduced a nonparametric efficiency analysis known as DEA. This linear programming technique was initially used to measure the efficiency of DMUs. Sherman and Gold [13] were first researchers to apply DEA on the banking sector to calculate the relative efficiency scores of various DMUs.

Considering a set of J DMUs with n input and m output in T (t=1, . . . , T) periods. Suppose in time period t, decision-makers are using inputs $x^t \in R_+^n$, to produce outputs $y^t \in R_+^m$. Define the input requirement set in period t, which is:

$$L^t(y^t) = \{x^t : x^t \text{ can produce } y^t\}.$$

Assume that $L^t(y^t)$ is non-empty, closed, convex, bounded and satisfies strong disposability property of inputs and outputs $L^t(y^t)$ is bounded from below by the input isoquant (a constant returns to scale (CRS) production boundary), that is:

$$I_{soq}L^t(y^t) = \{x^t : x^t \in L^t(y^t), \lambda x^t \notin L^t(y^t) \text{ for } \lambda < 1\}$$

Define the input distance function of period t as follows:

$$D^T(y^t, x^t) = \sup_{\theta} \{ \theta : (x^t/\theta)L^t(y^t) \}$$

Hence, define the TE in period t as follows:

$$TE^t(y^t, x^t) = 1/D^t(y^t, x^t) \quad (1)$$

Usually, $TE < 1$, which indicates that a specific DMU is under assessment comparing with other DMUs, which shows us that this DMU is productively inefficient because it used the excessive inputs while $TE=1$ shows that DMU is fully efficient. Banker, et. al. (1984) described that TE could be further decomposed into PTE and SE:

$$TE = PTE \times SE. \quad (2)$$

In general, as TE, PTE or $SE < 1$, indicates that the DMU under assessment, comparing with other DMUs, is pure technically inefficient or scale inefficient. Emrouznejad, et al. [8] has theoretical studies and application following the above and other DEA models. In the current era, DEA method is very popular in performance measurement of the banking and finance sectors. For examples, Sherman, et al.[13], Avkiran [2], Sathye [12], Akhtar [6], Emrouznejad, et al. [7], Hada, et al. [10], Wanke et al. [15] and Zhu et al. [17],[19] applied the DEA models successfully in banking and financial sectors of different regions of the world.

3.2 Two input-output models and solving

To measure the productive efficiency of banks in Australia, Avkarin [2] used DEA method with two different Models, Model A and Model B with changed inputs and outputs. Following this direction Sathye [12] conducted the research on Indian banking industry by using Model A and Model B. Then, Zhu et al. [17],[19] measured the OE of Chinese CBs by using similar DEA approach of two input-output Models. Hada et al. [11] studied the OE between Nepal and China banking sectors for the years 2012 and 2013. Zhu et al. [16] conducted a cross-country research on the OE between Chinese and India banking sectors for the years 2012 and 2013.

In this paper, following the previous research work, two models, i.e., Model A and Model B, with different sets of input and output variables are selected and used, see Table 1.

Balanced panel data of all inputs and outputs for both of Chinese and Pakistani banking industries from the years 2012 to 2016 are collected from Bank Scope Database. However, some of the missing data are mainly collected through the annual reports of banks. We take a sample of total 126 CBs, including 101 Chinese and 25 Pakistani CBs. Chinese banks include 5 state-owned banks, 12 joint stock banks, 52 city banks, 16 rural banks and 16 foreign banks. Meanwhile Pakistani banking sample includes 5 state-owned banks, 14 private banks and 6 foreign banks. All of the financial data used in this paper are transformed into US dollars for comparing, in 2016, 1 USD=6.9370 RMB, 1 USD =104.79 PKR. The DEA evaluating problems are solved by using the computer software DEA-Solver. The OE given is calculated in the input-oriented measure.

Table 1. Model A and Model B

Model A		Model B	
Inputs		Inputs	
Interest expense	Non-interest expense	Deposits	Staff numbers
Outputs		Outputs	
Net interest income	Non-interest income	Net loans	Non-interest income

3.3 Mann-Whitney U test

The Mann-Whitney U is a nonparametric test that could be used instead of an unpaired t-test. When data is not normally distributed, the test could be used efficiently to test the null hypothesis that two samples came from the same population. See Freedman [9].

In this paper, the Mann-Whitney U test is used to check that is there any statically significant difference exist between the efficiency scores of both country banking industries. We use the mean/average efficiency scores (for the years 2012-2016) of all 126 CBs and separately calculate Mann-Whitney U test values for Model A and Model B. To test the difference for the time period of the years 2012-2016, we define the null and alternative hypothesis as follows: H_0 : There is no significant difference in Mean TEs of Chinese and Pakistani CBs. H_1 : There is a significant difference in Mean TEs of Chinese and Pakistani CBs. The Mann-Whitney U test is used to test the hypotheses. Software used is SPSS 20th version.

4 Empirical analysis

4.1 The application of DEA

Through the empirical analysis, Table 2 shows us the result output of Model A. 5 years Mean TE score of all 126 CBs is 0.6889; Mean PTE is 0.7553; and Mean SE is 0.9189. In detail, the results indicate that Mean efficiency scores (TE, PTE) for the years 2012-2016 of Chinese 101 CBs are relatively higher than of their 25 Pakistani counterparts as TE= 0.7162>0.5784 and PTE= 0.7873>0.6260. However, Mean SE score of Chinese CBs is relatively lower than of Pakistani counterparts as SE= 0.9160<0.9308.

Further elaborating the model a result we find that 5 years Mean TE and PTE scores of China 5 state-owned CBs, respectively, are relatively better than of all remaining 96 Chinese CBs, but the Mean SE score is relatively lower. The similar results were found by Zhu et al. [16]. The results in Table 2 also show that foreign CBs operating in China are least efficient in Mean TE and PTE categories of commercial banking including Chinese state-owned, joint-stock, city, and rural CBS.

Table 2. Model A Mean TE scores of both countries CBs.

2012-2016	TE	PTE	SE
Mean All 126	0.6889	0.7553	0.9189
Mean China 101	0.7162	0.7873	0.9160
Mean Pakistan 25	0.5784	0.6260	0.9308
Mean CH 5 state owned	0.7827	0.9602	0.8152
Mean CH 96 others	0.7128	0.7783	0.9213
Mean CH 12 joint-stock	0.6866	0.8705	0.7907
Mean CH 52 city	0.7297	0.7762	0.9433
Mean CH 16 rural	0.7559	0.8061	0.9396
Mean CH16 foreign	0.6344	0.6885	0.9294
Mean PK 5 state owned	0.4999	0.5707	0.8819
Mean PK 20 others	0.5981	0.6399	0.9430
Mean PK 14 private	0.5303	0.5464	0.9725
Mean PK 6 foreign	0.7564	0.8580	0.8743

Contrary Chinese CBs, 5 years Mean OE (TE, PTE and SE) scores of 5 state-owned Pakistani CBs are relatively lower than the 20 other Pakistani CBs as TE=0.4999;0.5981, PTE=0.5707;0.6399 and SE= 0.8819;0.9430. Adverse Chinese banking sector, in terms of TE and PTE, the foreign banks operating in Pakistan perform relatively better than the domestic (state-owned and private) banking industry as mean efficiency scores indicate in Table 2. Akhtar [1] also had similar results where foreign banks operating in Pakistan perform relatively better than domestic banks including public and private. However, in terms of SE, the foreign banks operating in Pakistan perform relatively worse than the domestic banking industry as SE=0.8743 ;0.8819 and 0.9725, see Table 2.

Figure 1 shows us the Mean TE scores (Model A) variation of both countries CBs from the year 2012 to 2016. The figure is clearly indicating that Chinese commercial banking industry performance is relatively better in all 5 years.

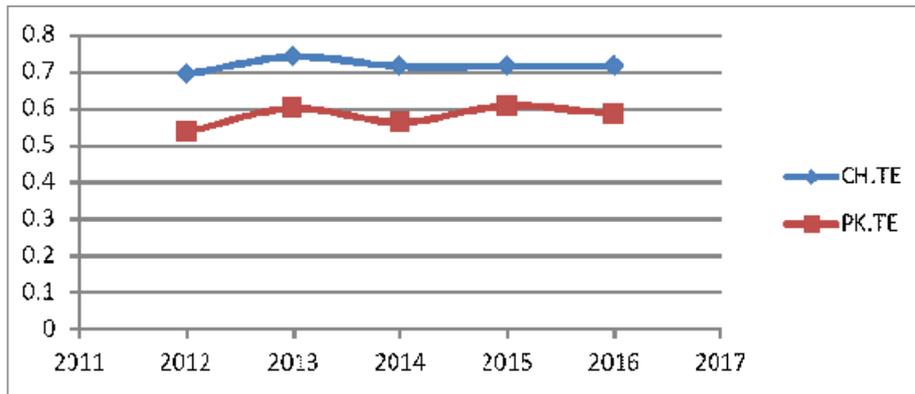


Figure 1. Mean TE scores (Model A) variation from the year 2012 to 2016.

Table 3 shows the result output of Model B. 5 years Mean efficiency scores of all 126 CBs are TE=0.6744, PTE=0.7328 and SE=0.9266. Results of Model B indicate that Mean efficiency scores for the years 2012-2016 of Chinese 101 CBs are also relatively higher than of their 25 Pakistani counterparts: TE=0.6987>0.5764, PTE=0.7499>0.6640 and SE =0.9379>0.8806.

Table 3. Model B Mean OE scores of both countries CBs.

2012-2016	TE	PTE	SE
Mean All 126	0.6744	0.7328	0.9266
Mean China 101	0.6987	0.7499	0.9379
Mean Pakistan 25	0.5764	0.6640	0.8806
Mean CH 5 state owned	0.7214	0.9587	0.7488
Mean CH 96 others	0.6976	0.7391	0.9479
Mean CH 12 joint-stock	0.8385	0.9199	0.9125
Mean CH 52 city	0.6565	0.6834	0.9637
Mean CH 16 rural	0.6795	0.7171	0.9474
Mean CH 16 foreign	0.7433	0.8063	0.9235
Mean PK 5 state owned	0.4926	0.5870	0.8667
Mean PK 20 others	0.5974	0.6832	0.8842
Mean PK 14 private	0.5459	0.6078	0.9041
Mean PK 6 foreign	0.7176	0.8593	0.8377

Further elaborating the model B result, we find that Mean TE and PTE scores of China 5 state-owned CBs, respectively, are better than of all 96 remaining Chinese CBs, but the Mean SE score is relatively lower. The similar results had been reported in Zhu et al. [16]. In Table 3, we also find that Mean TE and SE scores of Chinese 5 state-owned CBs are relatively lower than foreign CBs, but the Mean PTE is relatively higher.

Similar to Model A results, in Model B 5 years Mean OE (TE, PTE and SE) scores of 5 state-owned Pakistani CBs are relatively lower than the 20 other CBs as $TE = 0.4926 < 0.5974$, $PTE = 0.5870 < 0.6832$, and $SE = 0.8667 < 0.8842$. Foreign banks operating in Pakistan perform relatively better than domestic banking industry as Mean TE and PTE scores of Pakistani foreign banks are relatively better than the domestic CBs. However, in terms of SE, the foreign banks operating in Pakistan perform relatively worse than the domestic banking industry as $SE = 0.8377 < 0.8842$ and 0.9041 , see Table 3.

Figure 2 shows us the Mean TE (Model B) scores variation of both countries CBs from the year 2012 to 2016. Figure 2 is clearly indicating Chinese commercial banking industry performing relatively better.

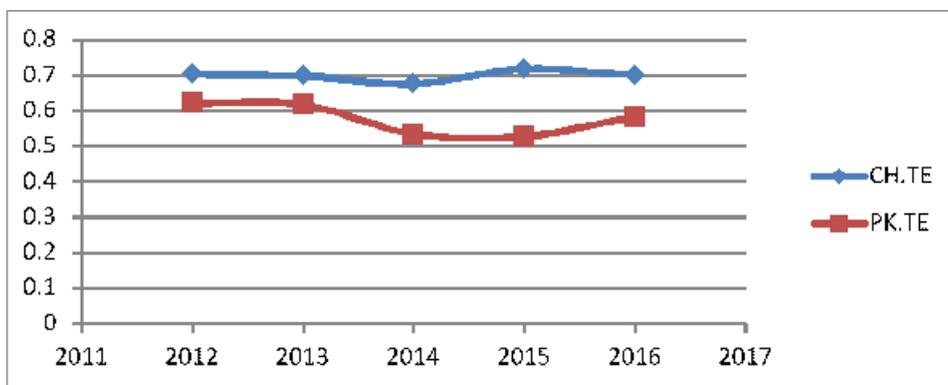


Figure 2. Mean TE scores (Model B) variation from the year 2012 to 2016.

4.2 The application of Mann-Whitney U test

Table 4 shows the result of Model A Mann Whitney U test with a sample of 126 in total included 101 Chinese and 25 Pakistan CBs with Mean Rank (TEs) of 69.99 and 37.28, respectively. Test statistics of Model A Mann-Whitney U test shows that z value is -4.010 and p-value is .000 which is less than .05 that indicates we can reject the null hypothesis and accept the alternative hypothesis given in Section 3.3.

Table 4. Model A, Mann-Whitney U Test for differences

Years	Banks	N	Mean Rank	Sum of ranks
2012-16	China	101	69.99	7069.00
	Pakistan	25	37.28	932.00
	Total	126		
Test statistics				
Years		2012-2016		
Mann-Whitney U		607.00		
Wilcoxon W		932.00		
Z		-4.010		
Asymp. Sig. (2-tailed)		.000		
a. Grouping Variable: Banks				

Table 5 shows us the result of Model B Mann-Whitney U test with a sample of 126 in total included 101 Chinese and 25 Pakistan CBs with Mean rank (TEs) of 69.74 and 38.28, respectively. Test statistics of Model B Mann-Whitney U test shows that z value is -3.857 and p-value is .000 which is less than .05 that indicates we can reject the null hypothesis and accept the alternative hypothesis.

Table 5. Model B, Mann-Whitney U Test for differences

Years	Banks	N	Mean Rank	Sum of ranks
2012-16	Chinese	101	69.74	7044.00
	Pakistan	25	38.28	957.00
	Total	126		
Test Statistics				
Years		2012-2016		
Mann-Whitney U		632.00		
Wilcoxon W		957.000		
Z		-3.857		
Asymp. Sig. (2-tailed)		.000		
a. Grouping Variable: Banks				

5 Conclusion

China and Pakistan have not only social, cultural and geographical bindings but also have strong economic ties and potential of growing trade and business. In this study, we conduct a cross-country comparative analysis on the OEs (TEs, PTEs and SEs) of China and Pakistan's commercial banking industry for the years 2012-2016. We use two models, Model A and Model B, to find does any variation occur in efficiency scores with changing the inputs and outputs.

After the empirical analysis, we have got the results that both Mean TE and PTE scores of Chinese CBs obtained by using either Model A or Model B are always relatively higher than Pakistani CBs for the years 2012-2016. However, Mean SE score of Chinese CBs of Model A is relatively lower than of Pakistani counterparts.

Chinese state-owned banks TE and PTE scores are relatively higher than Pakistani state-owned CBs in Models A and B; However, Pakistani foreign CBs perform better than the foreign banks in China's commercial banking industry except Mean TE score of China foreign CBs in Model B which is slightly better than its Pakistani counterparts. In terms of TE and PTE, Chinese state-owned CBs performance is relatively better than all remaining CBs operating in China in both Models A and B. Contrary to China, in terms of OE, Pakistani state-owned CBs underperform with a comparison to their Pakistani counterparts in both models.

In terms of TE and PTE, foreign banks operating in China are less efficient than domestic Chinese CBs in Model A. However, Mean TE and SE scores of the foreign CBs are relatively better than Chinese state-owned banks in Model B. In terms of TE and PTE, Pakistani foreign banks are more efficient than its private and public domestic CBs, and there is no changed occur while changing inputs and outputs of Models. However, in terms of SE, the foreign CBs perform relatively worse than the domestic banking industry in both Models A and B. Finally, the Mann-Whitney U test is used and the results for both Models A and B indicate that there is a significant difference between Mean TE scores of both countries CBs for the time period of the years 2012-2016.

The further research direction of this study is to collect more data from other south Asian countries like India, Bangladesh, and Nepal. Furthermore, we could use the DEA method and Malmquist productivity index to conduct cross-country comparisons of different banking industries to measure the efficiency (such as X-efficiency), efficiency change and total factor productivity change, reflecting banking industry's performance over time.

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