Journal of Stock & Forex Trading
ISSN: 2168-9458

Li, J Stock Forex Trad 2014, 3:4
DOI: 10.4172/2168-9458.1000135

Research Article Open Access

The Impact of Non-interest Income on the Efficiency of China's Banking Sector

Li Li*

Assistant Professor, Ph.D. in Accounting, School of Management, Marist College, Poughkeepsie, NY 12601, USA

Abstract

This paper investigates the impact of non-interest income on bank efficiency based on data from China banking sector during the period 1996~2010 by establishing DEA model and Panel-Tobit model. The efficiency levels of China banking sector are estimated by employing traditional DEA model, which only considers loans and investments as the output variables, and alternative DEA model, which considers non-interest income as an additional output variable. The results of parametric and non-parametric univariate tests on the efficiency scores show that there are no significant differences in mean and median efficiency calculated from traditional and alternative DEA models. In other words, the inclusion of non-interest income in output vector does not have a statistically significant influence on the efficiency of China banking sector.

Additionally, we normalize each bank's efficiency score under these two DEA models in order to avoid potential estimation bias due to the fact that the alternative DEA model has one more output variable than the traditional DEA model, and the findings suggest that only a small proportion of banks present an increase in efficiency level with inclusion of non-interest income, while no significant changes are seen on most banks' efficiency levels. Also, further analysis by establishing Panel-Tobit regression model finds that the relationship between the share of non-interest income to the net operating revenue and the bank efficiency score is not significant, which suggests that the bank efficiency doesn't increase significantly with the increasing non-interest income share. Furthermore, the bank efficiency also does not present a significant increase with the time. Overall, our findings suggest that the inclusion of non-interest income does not significantly increase the efficiency level of China banking sector.

Keywords: Bank efficiency; China banking sector; Non-interest income

Introduction

With the gradual deepening of financial reform and opening of financial market, especially the implementation of a more stringent financial supervision policy in recent years, Chinese commercial banks have stepped into a transitional path from extensive operation to intensive one and gradually adjusted revenue structure in order to increase the proportion of non-interest incomes after having established modern corporate governance structure. Although traditional interest income is still the main source of revenue till now, as evidenced by the fact that the net interest income of China's banking sector accounts for 66% of after-tax profits by the end of 2011[1], increasing proportion of no-interest income and improving revenue structure has become a common consensus among domestic commercial banks.

In a deeper sense, external pressure and internal motive are dual sources of power that drive the China's banking sector to pay more and more attention to and promote vigorously the growth of non-interest income. The external pressure is mainly derived from stringent supervision and ability to make profit in the future. Chinese regulators are actively promoting the implementation of Basel III in China and intend to launch more stringent new regulatory tools. The China's banking sector has to face a real problem: how to promote the growth of income under more and more stringent regulatory requirements, especially the capital adequacy ratio requirements. As the nontraditional business generating non-interest income consumes less economic capital than the traditional business generating interest income, it has become an inevitable trend for domestic commercial banks to shift gradually toward non-interest income under the capital constraint.

Meanwhile, complete liberalization of the interest rate is inevitable during the process of deepening financial system reform and domestic commercial banks have to compete in a free market environment. Based on the fact that the benchmark spreads have remained high by now in China, the interest margin will inevitably gradually decrease during the process of interest rate liberalization. As interest income is still the main source of revenue, domestic commercial banks have to face tremendous growth pressures in the future. Therefore, the nontraditional business generating non-interest income should be developed in order to reduce the impact of interest rate liberalization. From internal motive prospective, because the contribution of non-interest income to the net operating revenue is relatively low in China banking sector, there are diversification benefits of increasing the non-interest income share to some degree, that is, the growth of non-interest income can reduce bank risk in some extent [1]. As a result, domestic commercial banks have internal motive to promote the growth of non-interest income.

However, what shall be noted is that expanding into non-interest income business requires the bank to invest more resources, including technology, human resources and material resources. On the contrary, as to traditional activities generating net interest income, the only cost of an additional loan is the bank's interest expenses [2]. Therefore, the growth of non-interest income probably leads to an increase of the bank's total operational costs and the cost per unit of production, thus decreasing the efficiency level of the bank. Does non-interest

[1]Source: China Banking Regulatory Commission 2010 Annual Report.

***Corresponding author:** Li Li, Assistant Professor, Ph.D. in Accounting, School of Management, Marist College, Poughkeepsie, NY 12601, USA, Tel: 845-575-3000; E-mail: lyanlin2010@gmail.com

Received July 07, 2014; **Accepted** December 23, 2014; **Published** December 30, 2014

Citation: Li L (2014) The Impact of Non-interest Income on the Efficiency of China's Banking Sector. J Stock Forex Trad 3: 135. doi:10.4172/2168-9458.1000135

income increase the efficiency level of the bank? This question is a topic of considerable importance to both commercial banks in terms of operating strategies and regulators of noninterest income business, especially to Chinese banks and regulars who are actively promoting the growth of non-interest income. This paper uses Chinese banking industry data to examine the topic in depth in the hope of getting meaningful conclusions. This paper is structured as follows. Section 2 presents a literature review on the effect of non-interest income on bank efficiency. Section 3 presents the methodology and descriptive statistical analysis of the data. Section 4 conducts empirical study with models and analyzes the results and finally section 5 summarizes our finds and provides some concluding remarks.

Review of the Literature

With the increasing scale of non-interest income and further research on commercial banks, researchers tend to attach more and more importance to the impact of non-interest income on the bank efficiency. Based on current progress of research, extensive agreement has yet to be reached as to the impact of non-interest income on the bank efficiency.

Some researches hold that an increase in the share of non-interest income is beneficial to improvement of the bank's own profitability and efficiency. De Young [3] considers that large amounts of fee-based or non-traditional products or services improve the efficiency of US commercial banks in the 1980's and 1990's Siems and Clark [4] estimate bank profit efficiency measures that include OBS (Off-balance sheet) activities and find that failing to account for OBS activities has important statistical and economic effects on derived efficiency measures due to seriously understating bank output. Rogers [5] estimates cost, revenue and profit efficiency of US commercial banks by using Distribution Free Approach (DFA) model with and without OBS items, and finds that the bank efficiency is understated if employing standard model that omit OBS items.

Radecki [6] realizes the importance of income of payment revenues to the bank, especially to the bank holding companies, whose revenue from payment revenues accounts for over 7% of their total revenues. Stiroh [7] also finds that the efficiency estimates of bank holding companies over 1991-97 are particularly sensitive to output specification and profit efficiency is without inclusion of OBS activities leads Isik and Hassan [8] estimates the efficiency of Turkish banking sector during the period 1980~1990 by incorporating OBS as an output variable and finds that the efficiency of private and foreign banks tend to be improved slightly with inclusion of non-traditional activities, as evidenced by the result that the technical and pure technical efficiency of private bank increase by 3.5% and 6.0% respectively, and the technical and pure technical efficiency of foreign banks increase by 2.9% and 2.7% respectively.

They imply that non-traditional activities pose greater impact on the efficiency of private and foreign banks because these two kinds of banks have larger non-traditional business scale. In other words, they conclude that models that ignore such non-traditional outputs may penalize banks that are heavily involved in such activities. Sufian and Ibrahim [9] find that the inclusion of non-traditional activities results in an increase in the estimated productivity levels of Malaysian banks.

Similarly, Casu and Girardone [10] investigate how non-traditional activities impact the changes of bank's total factor productivity and find that the inclusion of non-traditional activities in the bank's output index improve the productivity level of European banking sector during the period from 1994 to 2000, but they conclude that such improvements should be attributed to technological change rather than efficiency change. Lieu et al. [11] investigate the impact of non-traditional activities on the cost efficiency of Taiwan banks and find that the exclusion of non-traditional activities from the bank's output results in an approximate 5% underestimation of the bank's efficiency level and large banks with higher cost efficiency present increased ability to develop non-traditional activities. Rachita Gulatia and Sunil Kumara [12] investigate the relevance of the inclusion of non-traditional activities in the specification of banks' output on the efficiency of Indian banks and find that the exclusion of non-traditional activities not only understates the cost, technical and allocative efficiencies of individual banks but also affects the ranking of ownership groups in the industry. Jean-Pierre Gueyie et al. [13] also conclude that Canadian banks' expansion into non-traditional activities had resulted into decreased risk and increased performance benefitting from income diversification.

However, some other researches hold that the bank efficiency will not benefit from an increase in the share of non-interest income benefit. De Young and Rice find that marginal increases of non-interest income are usually accompanied with higher profits, but meanwhile, greater fluctuations of income level and worsening of risk return trade-off.

Jagtiani et al. [14] investigate the impacts of Off-balance sheet (OBS) products during the period from 1988 to 1990 on the scale economies of U.S. banking sector and find that OBS products have little or no significant effect on the bank's scale economies and there is no evidence to show OBS products could reduce the bank's costs.

Pasiouras [15] uses DEA model to investigate the efficiency of the Greek commercial banking industry over the period 2000-2004, and find that the inclusion of loan loss provisions as an input increases the efficiency scores, but off-balance sheet items do not have a significant impact. Chortareas et al. [16] use DEA based Malmquist Productivity Index to investigate the impact of off-balance sheet items on Greek banking sector during the period from 1998 to 2003 and also find that the inclusion of OBS items seems to have no significant impact on the efficiency and productivity of Greek banking system. Kozo Harimaya [17] examines the impact of entering into the trust business on cost structure of Japanese regional banks by measuring economies of scale and scope during the period from 1994 to 2003, and finds that such nontraditional banking activities yield no cost reduction for Japanese regional banks. Sameh et al. [18] also find that the models with and without non-traditional activities are equivalent in terms of overall technical efficiency for banks of all size classes except for those of the smallest size.

As far as domestic literature is concerned, most researches concentrate on estimating the efficiency of the China banking sector. The previous studies focused mainly on the study of efficiency comparison among banks with different types of ownership. For example, Huang Wei et al. [19], Shujie Yao et al. [20], Zhixin Liu et al.[21], Chao Zhang and Feng Gu [22], Guotai Chi et al. [23] adopt different methods to investigate the efficiency level of domestic commercial banks and find that the efficiency of non-state-owned commercial banks is usually higher than that of state-owned ones. With further research on the efficiency of China banking sector, domestic scholars like Jianhua Zhang [24], Chuanzhan Xu et al. [25], Cong Wang et al. [26], Lanan Liu et al. [27] and Xiufeng Sun et al. [28] embark on further studies on influencing factors of domestic commercial banks' efficiency from ownership to others. However, it is difficult to find domestic literature on the impact of non-interest income on the bank efficiency, indicating how little attention this topic has received from Chinese scholars.

Although Xiyi Li et al. [29], Hantao Liu [30] and Wei Sun et al. [31] have already attempted to include non-interest income into output variables; they only estimate the bank efficiency but not analyze the impact of non-interest income on the bank efficiency. Furthermore, Guotai Chi et al. [32] estimate the interest income efficiency and non-interest income efficiency, and analyze the relationship between non-interest income share and total revenue efficiency, so as to get some meaningful conclusions. Overall, from the domestic literature, although Chinese scholars conduct deep analysis on the efficiency of China banking sector, the impact of non-interest income on the bank efficiency is ignored, consciously or unconsciously, or the analysis is not deep or comprehensive enough even if the topic is mentioned.

Methodology and Data

Methodology

At present, parametric and non-parametric methods are two methods usually adopted in literatures to measure the bank efficiency. The parametric method proves more adaptable for single-input and single-output or multi-inputs and single-output but less efficient in dealing with multi- inputs and multi-outputs , and it usually requires a larger number of sample observations because of more strict requirements on the quantity of samples, Considering limited sample data of domestic commercial banks and multi-inputs and multi-outputs adopted in the study of this paper, the non-parametric method will be used in this paper to measure the bank efficiency.

This paper employs the non-parametric efficiency frontier analysis method-Data Envelopment Analysis (DEA) model to calculate the technical, pure technical and scale efficiency score by using CCR model [33] with constant returns to scale (CRS) and BBC model [34] with variable returns to scale (VRS). The CCR model can be expressed as follows:

$$\begin{aligned} &\text{Min} \\ &\text{s.t.} \quad \lambda_i x_{ri} \le \theta_k x_{r0} && \text{r = 1, 2, …, m} \\ &\lambda_i y_{ji} \ge y_{j0} && \text{j = 1, 2, …, s} \\ &\lambda_i \ge 0 && \text{I = 1, 2, …, n} \end{aligned} \tag{1}$$

Where, θ_k is invariant scalar representing the technical efficiency score (overall efficiency score) of the kth decision making unit (herein referred as the kth bank), which is constrained between 0 and 1($0 \le \theta_k \le 1$). $\theta_k = 1$ indicates that the k^{th} decision making unit (DMU) is located on the efficiency frontier and it is the best-practice bank in the sample. λ_i is a vector of N×1 constant. x_{ri} is the r^{th} input of the ith DMU, y_{ji} is the j^{th} output of the i^{th} DMU. The value of technical efficiency (overall efficiency) for each DMU may be derived by solving n times of the linear programming represented by formula (1).

CCR model assumes constant returns to scale, which means the producers are able to linearly scale the inputs and outputs without increasing or decreasing efficiency. This assumption is too rigorous and proves not very consistent with the real world. To solve this problem, Banker, Charnes and Cooper [34] loosened the assumption of constant returns to scale and propose a BBC model under the assumption of variable returns to scale. By adding convexity constraint $\sum_{i=1}^{n} \lambda_i = 1$, CCR model with constant returns to scale can be modified into BBC model with variable returns to scale:

$$\begin{aligned} &\text{Min } \theta_k \\ &\text{s.t.} \quad \lambda_i x_{ri} \le \theta_k x_{r0} && \text{r=1, 2, …, m} \\ &\lambda_i y_{ji} \ge y_{j0} && \text{j=1, 2, …, s} \\ &\sum_{i=1}^{n} \lambda_i = 1 && \text{i=1, 2, …, n} \\ &\lambda_i \ge 0 \end{aligned} \tag{2}$$

It is very easy to prove that the convexity constraint $\sum_{i=1}^{n} \lambda_i = 1$ meets the assumption of variable returns to scale. In formula (2), θ_k represents pure technical efficiency of the k^{th} DMU.

The technical efficiency (TE) can be decomposed into two collectively exhaustive components: pure technical efficiency (PTE) and scale efficiency (SE), i.e. TE=PTE×SE, while the technical efficiency and pure technical can be calculated respectively by CCR model and BBC model. Therefore, the scale efficiency can be derived from the equation.

This paper calculates the efficiency scores of domestic commercial banks by employing the traditional DEA model, which does not consider non-interest income as an output variable, and alternative DEA model, which considers non-interest income as an additional output variable. By comparing the results derived from these two DEA models; this paper investigates whether the efficiency estimates of China's banking sector tend to be improved with the inclusion of non-interest income. Furthermore, this paper establishes the Panel-Tobit regression model to test the impact of non-interest income on the bank efficiency.

Data and specification of bank inputs and outputs

This paper uses annual data for15 Chinese commercial banks during the period from 1996 to 2010. All of these banks are listed except Guangdong Development Bank (GDB) and Ever-growing Bank[2]. At the end of 2010, the assets of these 15 commercial banks accounted for approximate 65% of the total of China banking sector. All data come from China's Financial Yearbook (1996~2007) and the Annual Report of each bank (2001~2010).

As the definition and measurement of inputs and outputs in the banking function doesn't still reach extensive agreements, this paper combines the production and intermediation approaches in selection of input and output variables used in the model. The input variables include (I1) Deposits, which include short term deposits, short-term saving deposits, fiscal deposits, outward remittance, amounts payable, long-term deposits, long-term saving deposits, short-term deposits of guarantee and long-term deposits of guarantee classified according to bank financial statements, and (I2) Net Book Value of Fixed Assets, which refer to the value of fixed asset minus accumulated depreciation.

The output variables include (O1) Loans, (O2) Investments and (O3) Non-interest Income. The (O1) Loans include short-term loans, medium and long term loans, inward and outward documentary bills and discount, while subtracting the loan loss provisions; The (O2)

[2]It is possible that the unlisted banks have a different level of efficiency due to the lower monitoring associated with being unlisted. However, if we eliminate the two unlisted banks, the sample data is so small that our results might have bigger bias than we incorporate the unlisted 2 banks into our sample. In addition, although there is a little bit different in call report of listed and unlisted banks because of more strict disclosure requirements for listed banks, our main data source come from official China's Financial Yearbook provided by China central bank and all of commercial banks must submit the uniform data to central bank. Under the situation, we keep the unlisted two banks incorporated with our sample this paper and we believe the impact on efficiency level of China's banking sector is very small.

Investment is the sum of short-term and long-term investments minus investment risk provisions; As there is no specified and clear agreement on the concepts and scopes of non-interest income in China, we use the method adopted by Li Li and Yu Zhang to define the (O3) Non-interest Income, which includes fee and commission income, exchange gains, investment revenue, and other income.

We will calculate firstly the bank efficiency score when the outputs only include loans and investments, and then the bank efficiency score when the outputs consist of loans, investments and non-interest income. Finally, we will and analyze the impact of the inclusion of non-interest income on the efficiency of domestic commercial banks. Table 1 show the summary statistics of the input and output variables.

Results

Efficiency with and without Non-interest Income

We employ traditional and alternative DEA model to calculate respectively the technical, pure technical and scale efficiency score of the sample commercial banks during the period 1996 to 2010 by including or excluding non-interest income in the output vector. For convenience, we refer the traditional DEA model without non-interest income variable as model I and the alternative DEA model with non-interest income output variable as model II.

Meanwhile, as the assets of Chinese five major state-owned commercial banks account for very large proportion of the total of the China banking sector, reaching 49.2% at the end of 2010 and accounting for 76.94% of the total of these 15 sample banks. To calculate the bank efficiency score more accurately and reflect the impact of asset size on the value of the bank efficiency, we further calculate the asset weighted efficiency score from 1996-2010 by using the proportion of each bank's asset in the total of sample banks as a weight value to multiply by its efficiency score to get an asset weighted efficiency score in a certain year. The results derived from the traditional DEA and alternative DEA are presented in Table 2.

Table 2 shows that the inclusion of non-interest income has resulted in a higher unweighted mean technical and pure technical efficiency, while the unweighted mean scale efficiency presents decreases during the period from 2000 to 2002 and increase in other years with the inclusion of non-interest income.

As to the asset weighted efficiency, we also find that technical and pure technical efficiency present an increase with the inclusion of non-interest income and similarly the scale efficiency presents an increase with the inclusion of non-interest income during the observation period except the period from 1999 to 2002. Therefore, the inclusion of non-interest income seems to result in higher efficiency score of China banking sector. Of course, this hypothesis needs to be further verified by statistical test.

Meanwhile, further analysis on the results of Table 2 reveals the U-shaped relationship between non-interest income and the efficiency of China's banking sector during the observation period. That is, the impact of non-interest income on the bank efficiency is gradually decreasing from the beginning of the observation period, reaching its bottom during the period from 2000 to 2003, and then gradually increasing afterward.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Inputs															
Deposits															
Min	37.23	31.74	57.14	67.65	84.46	104.22	113.96	135.03	194.14	278.27	427.60	652.65	851.37	1333.38	1723.97
Mean	3948.68	4582.00	5253.81	5988.14	6695.65	7653.97	9066.04	10757.27	13218.65	14993.85	17089.26	19218.33	22839.64	28748.54	33662.47
Max	19008.85	22510.50	26317.68	29823.78	32485.19	35804.70	40568.98	45681.64	51153.97	57368.66	63514.23	68984.13	82234.46	97712.77	111455.60
S.D	6110.28	7071.59	8276.02	9325.84	10076.70	11069.32	12548.31	14237.66	16453.38	18603.00	21072.01	22973.87	27091.80	32919.57	37381.47
Net Book Value of Fixed Assets															
Min	0.69	0.99	1.12	1.11	1.46	1.81	2.06	2.14	4.27	4.32	6.81	7.67	15.43	17.21	23.75
Mean	98.22	118.07	129.63	154.53	177.53	175.93	183.75	205.79	207.63	229.74	213.13	234.06	275.88	310.91	336.25
Max	403.52	541.24	566.24	665.07	726.15	636.75	695.08	711.50	725.56	1099.76	789.74	811.08	1042.85	1122.76	1235.68
S.D	160.07	190.30	204.44	241.72	275.86	256.31	265.29	284.84	276.97	322.60	271.23	307.56	369.01	414.61	445.70
Outputs															
Loans															
Min	20.43	28.63	31.90	33.76	49.59	52.14	72.03	91.34	124.05	240.61	355.72	455.37	650.34	929.67	1186.46
Mean	3432.39	3845.87	4564.58	4838.34	4875.44	5485.02	6487.87	7724.86	8651.97	9174.73	10376.01	12199.84	13590.74	18291.26	21710.28
Max	17874.95	19872.00	22794.55	24105.13	24024.77	26514.20	29451.39	33266.68	37077.48	32895.53	35339.78	39575.42	44360.11	55831.74	66233.72
S.D	5570.46	6187.22	7280.01	7629.58	7428.95	8057.03	9004.94	10161.38	11255.95	10824.19	11902.02	13585.69	14456.87	19034.43	22342.78
Investments															
Min	1.69	8.19	22.31	29.33	46.29	52.72	43.06	63.86	72.18	36.77	106.44	132.07	134.64	213.03	410.57
Mean	368.93	364.41	694.55	1052.24	1649.92	1913.74	2324.67	2668.29	3306.87	4740.30	4616.69	4449.95	4122.19	4992.53	6048.39
Max	1929.16	2005.81	2948.21	5003.05	7925.37	7944.52	9928.90	11699.48	11992.54	20582.43	19037.76	21719.91	21444.39	19084.48	23660.92
S.D	574.29	572.82	1031.14	1652.60	2657.80	2909.30	3405.30	3829.79	4485.71	6790.62	6639.14	6727.85	6149.92	6145.48	7836.40
Non-interest Income															
Min	0.11	1.31	0.02	3.56	3.53	2.16	2.56	1.64	1.08	2.10	2.91	5.79	10.72	1.44	8.21
Mean	42.57	40.21	36.48	23.17	27.04	37.42	47.02	78.90	101.67	117.53	108.99	180.07	151.20	198.88	234.99
Max	168.46	155.21	173.85	89.95	107.21	164.64	214.07	311.57	402.88	643.15	662.37	1120.40	674.70	733.17	828.55
S.D	57.75	55.50	56.00	23.73	28.96	44.48	56.45	103.31	137.79	183.46	191.68	314.25	208.57	261.31	302.70

Source: China's Financial Statistics Yearbook (1996~2007) and Annual Report of each banks (2001~2010).

Table 1: Summary Statistics of Input and Output Variables (1996~2010) (CNY 100 Million).

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Model																
Technical efficiency	Unweighted mean	90.33	86.72	79.66	79.56	78.78	84.93	89.82	91.67	94.24	90.71	95.25	92.63	91.24	92.19	95.62
	Weighted mean	97.79	95.43	84.57	85.32	83.59	86.99	87.03	88.63	97.65	95.24	90.00	89.89	84.50	86.21	93.85
	S.D	10.95	13.60	15.13	13.39	12.50	11.29	8.66	5.90	8.15	7.90	7.11	6.95	10.78	9.68	7.77
Pure technical efficiency	Unweighted mean	94.77	91.59	85.80	86.81	85.84	89.99	93.40	96.97	95.17	94.54	98.73	97.52	95.77	96.84	97.25
	Weighted mean	98.55	98.67	94.93	98.40	97.20	96.54	97.26	98.85	98.84	98.10	98.40	98.73	95.63	95.65	95.79
	S.D	7.96	11.70	15.10	13.42	13.16	11.09	8.26	3.93	7.35	6.58	2.36	4.23	6.25	7.10	6.42
Scale efficiency	Unweighted mean	95.31	94.74	92.87	91.67	92.09	94.53	96.33	94.57	98.95	95.93	96.49	95.05	95.14	95.21	98.23
	Weighted mean	99.22	96.72	89.42	86.81	86.17	90.25	89.63	89.67	98.78	97.03	91.59	91.05	88.19	90.22	97.78
	S.D	7.88	8.77	6.61	6.02	8.04	6.52	6.39	5.36	1.93	4.28	6.82	6.79	8.33	7.19	2.69
Model																
Technical efficiency	Unweighted mean	93.03	89.20	84.35	81.46	79.31	84.95	90.23	92.31	95.47	91.65	97.18	95.84	93.09	94.21	96.09
	Weighted mean	98.47	96.07	84.98	85.44	83.69	87.00	87.11	89.35	98.95	95.63	92.80	94.71	87.81	91.58	94.66
	S.D	10.38	13.50	14.30	14.15	12.24	11.25	8.56	5.74	8.27	8.04	6.70	5.64	10.49	8.48	7.76
Pure technical efficiency	Unweighted mean	95.89	93.88	88.60	88.67	88.24	90.49	94.75	97.37	95.90	94.54	99.73	98.31	95.89	96.92	97.42
	Weighted mean	98.63	98.86	95.18	98.56	97.74	96.68	97.57	99.40	99.06	98.10	99.91	99.59	95.69	95.68	95.86
	S.D	7.08	11.23	13.75	13.31	11.69	10.66	7.79	3.96	7.39	6.58	1.01	3.35	6.19	7.13	6.46
Scale efficiency	Unweighted mean	97.01	95.00	95.19	91.79	89.97	94.04	95.37	94.86	99.48	96.89	97.43	97.53	96.91	97.19	98.55
	Weighted mean	99.84	97.17	89.64	86.76	85.68	90.12	89.40	89.93	99.86	97.41	92.88	95.12	91.48	95.65	98.53
	S.D	7.51	8.10	6.26	6.42	7.85	7.32	6.35	5.35	1.39	3.59	6.46	5.32	7.42	4.85	2.55
Model minus Model																
Technical efficiency	Unweighted mean	2.71	2.48	4.69	1.90	0.53	0.02	0.41	0.64	1.23	0.95	1.93	3.21	1.85	2.02	0.47
	Weighted mean	0.68	0.64	0.41	0.12	0.11	0.01	0.08	0.72	1.30	0.39	2.79	4.81	3.32	5.36	0.81
	S.D	5.31	5.56	9.31	6.95	1.13	0.08	1.25	1.15	2.09	3.25	3.44	5.31	4.48	3.68	1.14
Pure technical efficiency	Unweighted mean	1.11	2.29	2.80	1.86	2.40	0.50	1.35	0.40	0.73	0.00	1.01	0.79	0.12	0.08	0.17
	Weighted mean	0.08	0.19	0.25	0.16	0.55	0.14	0.31	0.55	0.22	0.00	1.51	0.86	0.06	0.03	0.07
	S.D	2.92	4.85	7.32	5.13	5.01	1.94	3.27	0.85	1.61	0.00	2.27	1.51	0.35	0.31	0.65
Scale efficiency	Unweighted mean	1.70	0.26	2.31	0.11	-2.11	-0.49	-0.96	0.29	0.53	0.95	0.95	2.49	1.77	1.98	0.31
	Weighted mean	0.62	0.45	0.22	-0.05	-0.49	-0.13	-0.23	0.25	1.08	0.39	1.29	4.07	3.28	5.43	0.76
	S.D	3.83	4.37	4.66	2.71	4.90	1.88	2.19	1.19	1.53	3.25	2.19	4.67	4.43	3.70	0.99
No. Obs		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Table 2: Efficiency Estimates of China Banking Sector from 1996-2010.

One plausible explanation is that the proportion of non-interest income to the net operating revenue presented U-shaped pattern, which results in the U-shaped relationship between non-interest income and the bank efficiency. According to the study from Li Li and Yu Zhang [1], the contribution of non-interest income to the net operating revenue decreased from 1996 (30.23%) to 1999 (16.99%) and increased again in the first few years of the 2000s (27.34% in 2004) and then decreased after 2004 (20.76% in 2008). Chinese economics was in recession periods because of the shocks of the Southeast Asian financial crisis and of the subprime mortgage crisis in 1997-99 and 2008. In 1997-99, 2008 and 2009, Chinese GDP growth rates were 9.3%, 7.8%, 7.6%, 9% and 8.5% respectively, and the growth rates of both net interest income and noninterest income were also undergoing a downward phase. It seems that the economic cycle has an impact on the revenue of China's banking sector [1].

In order to test if the impact of non-interest income on the bank efficiency is significant, we use both parametric (t-test) and non-parametric tests (Wilcoxon-test) to examine the differences in the mean efficiency of the China's banking sector derived from the traditional and alternative DEA models[3]. In addition, we classify these 15 commercial banks into large banks with assets greater than CNY 4 trillion and small banks with assets below CNY 4 trillion, and then further employ use both t-test and Wilcoxon-test to examine the differences in the mean efficiency of large banks and small banks

[3]Because the set of bank efficiency probably doesn't meet the hypothesis of normal distribution, both parametric and non-parametric tests are performed in order to get robust test results.

	1996-2010		1996-2002		2003-2010	
	t-test	Wilcoxon-test	t-test	Wilcoxon-test	t-test	Wilcoxon-test
Technical efficiency	1.567	1.914	1.031	1.019	-1.500	1.919*
Pure technical efficiency	-1.170	1.306	1.104	0.977	-0.557	0.995
Scale efficiency	1.099	1.818*	0.118	0.466	-1.649	2.062**

Note: (1) The null hypothesis of parametric and non-parametric tests is that the mean between the two models is equal; (2) **, and * indicate statistical significance at the 95%, and 90% levels, respectively.

Table 3: Results of Parametric and Non-parametric Tests for Mean Efficiency.

under the traditional and alternative DEA models. The test results are presented in Tables 3 and 4.

From Table 3, We find that except the Wilcoxon-test results for the mean scale efficiency under the traditional and alternative DEA models during the period from 1996 to 2000, and the mean technical efficiency and scale efficiency under the traditional and alternative DEA models during the period from 2003 to 2010 are statistically significant at 90% levels or 95% levels, both t-test and Wilcoxon-test results for the mean pure technical efficiency during all observation periods and the mean technical and scale efficiency during other observation periods are not statistically significant. Furthermore, as time passed, we didn't observe the inclusion of non-interest income can result in the increase of the bank efficiency significantly.

From Table 4, we find that both t-test and Wilcoxon-test results for the mean efficiency of large banks or small banks during

	Large Banks		Small Banks	
	t-test	Wilcoxon-test	t-test	Wilcoxon-test
Technical efficiency	-1.114	1.329	-1.184	1.444
Pure technical efficiency	-0.225	0.383	-1.228	1.398
Scale efficiency	-1.223	1.355	-0.376	1.093

Note: (1) The null hypothesis of parametric and non-parametric tests is that the mean between the two models is equal; (2) **, and * indicate statistical significance at the 95%, and 90% levels, respectively.

Table 4: Results of Parametric and Non-parametric Tests for Mean Efficiency of Large Banks and Small Banks.

all observation periods are not statistically significant, indicating that there is no significant difference in the mean efficiency of large banks or small banks derived from the traditional and alternative DEA models. According to the test results from Tables 3 and 4, we can draw a preliminary conclusion that the inclusion of non-interest income doesn't result in the increase of banks efficiency significantly from a statistical perspective, that is, the non-interest income does not increase significantly the efficiency of China banking sector.

We believe that the main reason can be attributed to two aspects: Firstly, some false elements are incorporated into the components of non-interest income of domestic commercial banks. Because China's banking sector has not yet to realize comprehensive operation, that is, most China banks have not extended their commercial businesses to other businesses like security business, insurance business and so on, China banks only have very limited ways to obtain non-interest income. Under this situation, most banks intentionally transfer directly a certain proportion of interest income into non-interest income by whitewashing financial statement in order to show the balanced revenue structure to regulators and investors and further establish a good image in the market. Therefore, some of non-interest income belongs to interest income in essence and thus the non-interest income share is overestimated in some extent. As a result, no significant impact of non-interest income will be seen on the increase of the bank efficiency. Secondly, As mentioned by Ramona and Thomas [2], the development of non-interest income business will accordingly result in investing more resources for banks like technology, human resources and material resources, thus increasing the cost per unit of production and offsetting to some extent the positive impacts of non-interest income on the bank efficiency.

Furthermore, we note that although the number of the inputs adopted by the traditional DEA model and alternative DEA model is same (i.e. Deposits and Net Book Value of Fixed Assets), the number of outputs is different-the traditional DEA model employs two outputs (Loans and Investments) while the alternative DEA model employs three outputs (Loans, Investments and Non-interest income). Alam [35] points that as the number of variables increases, average efficiency rises because each firm has a greater and greater opportunity to be efficient in some dimension of production. Thus, when comparing average efficiency across studies, attention must be paid to the number of variables. That is, the efficiency scores under alternative DEA model with inclusion of an additional non-interest income output probably increase.

Consequently, because of more variables, a higher mean bank efficiency value probably is calculated from the alternative DEA model that includes additional non-interest income output. In order to solve this problem, we employ the traditional model and alternative model respectively to estimate the Panel bank efficiency scores and normalize each bank efficiency by dividing each bank Pane efficiency score by the its mean efficiency score during the observation period. The normalized efficiency reflects the relative position of each bank relative to its mean efficiency. On the basis of normalized efficiency value, we compare the changes of relative position of each bank under traditional DEA model and alternative DEA model in order to further analyze the impact of non-interest income on the bank efficiency. The results are presented in Table 5.

From Table 5, we find that with the inclusion of non-interest income output, 7 out of these 15 commercial banks present an increase in the relative position of technical efficiency and the proportion of the number of banks whose relative position decreases accounts for 47.67% of these 15 commercial banks, while 8 banks are observed no changes in their relative positions, accounting for 53.33%; 3 out of these 15 commercial banks present a decrease in the relative position of the pure technical efficiency, accounting for 20%,while 12 banks are seen no changes in the relative positions, accounting for 80%; 5 out of these 15 commercial banks witness an increase in the relative position of the scale efficiency, accounting for 33.33%, while 10 banks are found no changes in the relative positions, accounting for 66.67%.

Overall, although some banks present an increase in their relative positions of the technical and scale efficiency with the inclusion of non-interest income, the changing proportion is not more than 50%, while the pure technical efficiency either keeps unchanged or decreases. Therefore, we can draw a conclude that with the inclusion of non-interest income output, only a small proportion of banks are observed an increase in efficiency scores, that is, the efficiency levels of most banks don't show obvious changes.. The conclusion is consistent with our previous analysis.

Non-interest income's impact on bank efficiency based on panel-tobit regression

After examining the impact of the inclusion of non-interest income output in DEA model on the bank efficiency, we examine the link further between non-interest income and bank efficiency using Panel-Tobit regression[4]. The model is:

$$DTE_{it}(DPTE_{it}, DSE_{it}) = C + \beta_1 NONSH_{it} + \beta_2 \ln(A_{it}) + \beta_3 LEVERAGE_{it} + \beta_4 ROA_{it} + \beta_5 ROE_{it} + \beta_6 T_i + \varepsilon_{it} \quad (3)$$

Where DTE, DPTE and DSE are the dependent variables, representing respectively the technical efficiency difference, pure technical efficiency difference and scale efficiency difference between the efficiency score under alternative and the efficiency score under traditional DEA model. For example, DTE equals the technical efficiency score calculated from alternative DEA model minus the technical efficiency score calculated from the traditional DEA model. The calculation of DPTE and DSE is similar to that of DTE. NONSH is the non-interest income's share of the net operating revenue. A is the assets of the bank, LEVERAGE is the leverage ratio (the ratio of equity to t asset, E/A), ROA is the return on assets, ROE is the return on equity, T is time trend (T=1...15), i is bank i, t is year t, and is the residual. C is the constant, β1~6 are the coefficients. The estimation results are presented in Table 6.

From Table 6, in all regression equations, we observe that the relationship between NONSH and the dependent variables including DTE, DFTE and DSE is not significant; indicating that the non-interest income growth doesn't induce the increase of the technical efficiency, pure technical efficiency and scale efficiency of China banks, and the

[4]The dependent variables of the regression model are the differences of efficiency values with and without non-interest income i output. As the efficiency value falls between 0 and 1, the difference of the two values ranges from -1 to 1, thus the dependent variable is a limited dependent variable. Therefore, we establish Panel-Tobit model in this paper.

	Technical efficiency				Pure technical efficiency				Scale efficiency			
	Model	Rank	Model	Rank	Model	Rank	Model	Rank	Model	Rank	Model	Rank
ICBC	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1
ABC	***1.018***	***3***	***1.021***	***1***	1.013	1	1.012	1	***1.006***	***3***	***1.009***	***1***
BOC	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1
CCB	***0.941***	***8***	***0.941***	***7***	***0.972***	***4***	***0.971***	***5***	***0.969***	***7***	***0.969***	***5***
BOCOM	1.019	2	1.019	2	1.013	1	1.012	1	1.007	2	1.007	2
CMB	***0.996***	***6***	***0.996***	***5***	***0.988***	***2***	***0.987***	***4***	1.009	1	1.009	1
SDB	***1.006***	***4***	***1.006***	***3***	0.998	2	0.997	2	1.009	1	1.009	1
CNCB	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1
CGB	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1
CEB	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1
CIB	***0.905***	***9***	***0.905***	***8***	***0.934***	***5***	***0.933***	***6***	***0.970***	***6***	***0.970***	***4***
EB	***1.000***	***5***	***1.000***	***4***	1.013	1	1.012	1	***0.988***	***4***	***0.988***	***3***
SPDB	***0.958***	***7***	***0.958***	***6***	0.983	3	0.988	3	***0.975***	***5***	***0.970***	***4***
HXB	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1
CMBC	1.021	1	1.021	1	1.013	1	1.012	1	1.009	1	1.009	1

Note: (1) The black italics indicate the changes in relative position of the normalized bank efficiency;(2) ICBC-the Industrial and Commercial Bank of China, ABC-Agricultural Bank of China, BOC-Bank of China, CCB-China Construction Bank, BOCOM-Bank of Communication, CMB-China Merchants Bank, SDB-Shenzhen Development Bank, CNCB-China CITIC Bank,CGB-China Guangfa Bank, CEB-China Everbright Bank, CIB-China Industrial Bank, EB-Evergrowing Bank, SPDB-Shanghai Pudong Development Bank, HXB-Hua Xia Bank, CMBC-China Minsheng Bank Corp., Ltd.

Table 5: Relative Position Changes of Bank Efficiency.

	Dependent variables		
	DTE	**DPTE**	**DSE**
C	0.001 (0.012)	-2.225 (-0.358)	2.544 (0.311)
NONSH	0.141 (1.711)	9.310 (1.598)	5.186 (1.706)
LN(A)	-0.006 (-0.611)	0.034 (0.037)	-0.705 (-0.633)
LEVERAGE	0.044 (0.577)	8.767 (1.166)	-4.225 (-0.555)
ROA	1.158*** (2.296)	12.310 (0.293)	116.866*** (3.317)
ROE	-0.001 (-1.477)	-0.073 (-0.838)	-0.085* (-1.836)
T	0.003 (1.012)	-0.010 (0.054)	0.275 (1.020)
F-statistic	5.834	5.132	2.500
Adj-R^2	0.301	0.270	0.118
No. Obs of Cross-sections	15	15	
No. Obs of Samples	225	225	

Note: (1) t-value in parentheses; (2) ***, **, and * indicate statistical significance at the 99%, 95%, and 90% levels, respectively.

Table 6: Non-interest Income Share as Determinant of Bank Efficiency.

conclusion is consistent with our previous analysis. At the same time, the correlation between T and DTE, DFTE or DSE is also insignificant, indicating that the bank efficiency does not increase significantly with the time, and this is also consistent with the analysis result from Tables 2 and 3. Additionally, all other independent variables coefficients are insignificant except the correlation between ROA and DTE or DSE and the correlation between ROE and DSE.

Conclusions

This paper explores the impact of non-interest income on the bank efficiency based on the data for the China banks from 1996 to 2010. We calculate respectively the efficiency scores of Chinese commercial banks by using the non-parametric Data Envelopment Analysis (DEA) model with and without non-interest income output, and compare the efficiency scores under two different DEA model in order to examine whether the omission of non-interest income understates bank efficiency. Then, we further examine the impact of non-interest income on the bank efficiency by establishing Panel-Tobit regression model.

Under the traditional and alternative DEA models, we find that with the inclusion of non-interest income output, either technical or pure technical efficiency presents an increase during the sample period while scale efficiency also presents an increase except the period from 2000 to2002.

However, the results of parametric test (t-test) and non-parametric test (Wilcoxon-test) suggest that the exclusion of non-interest income output does not bias the efficiency estimates for China banks because of the insignificant difference in the mean efficiency scores under the traditional and alternative DEA models. That is, the inclusion of non-interest income does not result in a significant increase in the bank efficiency.

In order to avoid potential estimation bias incurred by including an additional variable to account for non-interest income in alternative DEA model, we normalize each bank's efficiency score under these two DEA models and analyze the relative position changes of its efficiency with and without non-interest income. As a result, we find that although some banks present an increase in their relative positions of the technical and scale efficiency with the inclusion of non-interest income, the changing proportion is not more than 50%, while the pure technical efficiency either keeps unchanged or decreases. In other words, only a small proportion of banks present an increase in efficiency scores and the efficiency levels of most banks don't show obvious changes by including the additional non-interest income output in DEA model.

Furthermore, We establish Panel-Tobit regression model to examine the impact of non-interest income on the bank efficiency, and the findings also suggest that the correlation between non-interest income share and the bank efficiency is not statistically significant, that is, the technical, pure technical and scale efficiency of China's banking sector don't present significant increase with the increase of non-interest income share. In addition, we also find that the bank efficiency does not increase significantly with the time.

Overall, this study shows that the inclusion of non-interest income does not significantly increase the efficiency level of China banking sector. This conclusion is in some extent same as the research from

Jagtiani et al. [14], Pasiouras [15] and Chortareas et al. [16], which show that the inclusion of non-interest income seems to have no significant impact on the efficiency and productivity of banking industry. For China's baking sector, the main reason may be attributed to two aspects: first, most domestic commercial banks intentionally transfer directly a certain proportion of interest income into non-interest income because of limited ways to obtain non-interest income thus the non-interest income share is overestimated in some extent. Secondly, the development of non-interest income business will accordingly result in investing more resources for banks, thus increasing the cost per unit of production and offsetting to some extent the positive impacts of non-interest income on the bank efficiency.

Of course, as this area of banking becomes more developed in China, the result could change in the future. For a longer period in the future, China's banking sector should attach greater importance on the increase of real non-interest income so as to increase their own efficiency levels. Meanwhile, great efforts should be made to lower the cost of non-interest income business so as to improve the output efficiency.

References

1. Li L, Zhang Y (2013) Are There Diversification Benefits of Increasing Noninterest Income in the Chinese Banking Industry? Journal of Empirical Finance 24: 151-165.
2. Busch R, Kick T (2009) Income diversification in the German banking industry. working paper.
3. DeYoung R (1994) Fee-based services and cost efficiency in commercial banks. Proceedings of Conference on Bank Structure and Competition, Federal Reserve Bank of Chicago.
4. Siems TF, Clark JA (1997) Rethinking Bank Efficiency and Regulation: How Off-Balance Sheet Activities Make a Difference. Financial Industries Studies, Federal Reserve Bank of Dallas.
5. Rogers KE (1998) Nontraditional activities and the efficiency of U.S. commercial banks. Journal of Banking and Finance 22: 467-482.
6. Radecki LJ (1999) Banks' payments-driven revenue. FRBNY Economic Policy Review 5: 53-69.
7. Stiroh KJ (2000) How Did Bank Holding Companies Prosper in the 1990s? Journal of Banking and Finance 24: 1703-1745.
8. Isik I, Hassan MK (2003) Efficiency, Ownership and Market Structure, Corporate Control and Governance in the Turkish Banking Industry. Journal of Business Finance and Accounting 30: 1363-1421.
9. Sufian F, Ibrahim S (2005) An Analysis of the Relevance of Off-Balance Sheet Items in Explaining Productivity Change in Post-Merger Bank Performance: Evidence from Malaysia. Management Research News 28: 74-92.
10. Casu B, Girardone C (2005) An Analysis of the Relevance of Off-Balance Sheet Items in Explaining Productivity Change in European Banking. Applied Financial Economics 15: 1053-1061.
11. Lieu PT, Yeh TL, Chiu YH (2005) Off-Balance Sheet Activities and Cost Inefficiency in Taiwan's Banks. The Service Industries Journal 25: 925-944.
12. Gulatia R, Kumara S (2011) Impact of non-traditional activities on the efficiency of Indian banks: an empirical investigation. Macroeconomics and Finance in Emerging Market Economies 4: 125-166.
13. Gueyie JP, Guidara A, Lai VS (2014) The Impact of Non-Traditional Activities on Risk, Performance and Capital of Canadian Banks Under Regulatory Changes.
14. Jagtiani J, Nathan A, Sick G (1995) Scale economies and cost complementarities in commercial banks: on and off-balance sheet activities. Journal of Banking and Finance 19: 1175-89.
15. Pasiouras F (2008) Estimating the technical and scale efficiency of Greek commercial banks: the impact of credit risk, off-balance sheet activities, and international operations. Research in International Business & Finance 22: 301-318.
16. Chortareas G, Girardone C, Ventouri A (2009) Efficiency and productivity of Greek banks in the EMU era. Applied Financial Economics 16: 1317- 1328.
17. Harimaya K (2008) Impact of nontraditional activities on scale and scope economies: A case study of Japanese regional banks. Japan and the World Economy 20: 175-193.
18. Sameh CK, Jamel EC (2013) Bank Size and Efficiency in Developing Countries: Intermediation Approach versus Value Added Approach and Impact of Non-traditional Activities. Asian Economic and Financial Review 3: 593-613.
19. Wei H, Wang L (2000) The non-parametric approach to the measurement of efficiency: the case of China commercial banks. Journal of Finance: 88-96.
20. Yao S, Feng G, Jiang C (2004) The Empirical Analysis of Efficiency of Chinese Banks. Economic Research Journal 8: 4-15.
21. Liu Z, Liu S (2004) The Research on Efficiency of Chinese Commercial Banks Based on DFA Model. Quantitative & Technica Economics: 42-45.
22. Zhang C, Gu F, Di Q (2005) A Literature Review on Foreign Bank Efficiency Measurements and Its Affected Factors. Foreign Economies and Management: 50-57.
23. Chi G, Sun X, Lu D (2005) The Empirical Analysis on the Cost Efficiencies of Chinese Commercial Bank. Economic Research Journal: 10-114.
24. Zhang J (2003) DEA Method on Efficiency Study of Chinese Commercial Banks and the Positivist Analysis from 1997 to 2001. Journal of Finance: 11-25.
25. Xu C, Qi S (2007) The Empirical Analysis on the X-Efficiency of Chinese Commercial Banks. Economic Research Journal: 106-116.
26. Wang C, Tan Z (2007) Influence of Macro Factors, Property Rights Institution and Market Structure over the Efficiency Structure of Chinese Commercial Banks. Economic Research Journal: 110-123.
27. Liu L, Wang B (2010) On the Threshold Effect, Deregulation and the Improvement of Bank Efficiency: Theoretical Hypothesis and Empirical Study from China. Journal of Financial Research: 67-79.
28. Sun X, Chi G (2010) The Empirical Analysis on the Endogenous Influence Factors of Chinese Commercial Bank Efficiencies. Forecasting: 5-12.
29. Li X, Ren R(2004) Efficiency Change and Trend Analysis of the State-owned Commercial Banks. China Soft Science: 57-65.
30. Liu H (2004) The estimates on the efficiency of Chinese Commercial banks: Use of DEA Method. Economic Science: 48-58.
31. Sun W, Wang Z, He B (2005) The Evolution of Performance of China's Commercial Bank and Its Mechanism. Journal of Finance 10: 53-63.
32. Chi G, Sun X, Zheng X (2006) Research on the relationship between income structure and income efficiency of China's commercial banks. Journal of Systems Engineering 21: 574-605.
33. Charnes A, Cooper WW, Rhodes E (1978) Measuring the efficiency of decision making units. European Journal of Operational Research 2: 429-444.
34. Banker RD, Charnes A, Cooper WW (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science 30: 1078-1092.
35. Alam IMS (2001) A nonparametric approach for assessing productivity dynamics of large US banks. Journal of Money, Credit, and Banking 33: 121–139.