World Journal of Social Sciences
Vol. 1. No. 4. September 2011. Pp.95-106

The Relationship between Bank Efficiency and Stock Returns: Evidence from Chinese Listed Banks

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This paper examines the relationship between bank efficiency change and stock price returns. Our analysis consists of three parts. Firstly, we employ the Data Envelopment Analysis (DEA) Window Analysis method to estimate the efficiency of Chinese listed banks using seasonal data over the period 2008-2010. Secondly, we calculate the stock returns of the these banks for every quarter between 2008 and 2010. Thirdly, we regress the quarterly efficiency changes on stock returns. The results indicate a positive and robust relationship not only between technical efficiency change and stock returns but also between pure technical efficiency change and stock returns. However, we find no evidence that scale efficiency changes are reflected in stock returns. We also find that technical efficiency and pure technical efficiency better explains bank stock returns compared to ROE which is one of the traditional accounting profits measures. Overall, we conclude that both technical efficiency and pure technical efficiency measures include useful information for shareholders who wish to explain bank stock returns.

JEL Codes: G14, G21

1. Introduction

According to the efficient market hypothesis, stock prices incorporate all publicly available information (Fama, 1970). Studies on stock markets have found that stock prices do incorporate relevant publicly known information (Ball and Kothari, 1994). Kothari (2001), a review of capital market research in accounting, proposes that stock prices incorporate earnings information. However, Patel (1989) point out that the accounting information studies on how they affect stock price performance are applicable only under special economic settings and fail to consider the data of balance sheet. Berger and Humphrey (1997) and Bauer et al. (1998) state that efficient frontier approaches seem to be superior compared to the use of traditional financial ratios. The efficiency measures are estimated upon publicly available accounting information and they take into account simultaneously all inputs and all outputs each time (Beccalli et al., 2006). Thus, it may be expected that efficient banks perform better than inefficient ones and this will be reflected in market prices.

Only a few studies attempt to link the efficiency of banks to their stock price performance although quite lots of surveys exist in the literature to examine relationships between traditional accounting performance measures and stock prices changes (Beccalli et al. 2006).

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In this paper, we aim to extend the aforementioned literature by providing emerging markets evidences from China. By employing DEA window analysis, we provide a greater degree of freedom in order to avoid the limitations of using a small group of samples and which is a common drawback of earlier studies. Another important aspect of our study is that the most recent evidences of Chinese listed banks are provided.

The rest of the paper is structured as follows. Section 2 reviews related studies in the main literature. Section 3 presents the data and methodology used for the empirical analysis. Section 4 discusses the empirical results and Section 5 provides the conclusion of the study.

2. Literature Review

Banking efficiency studies are abounding in the literature. However, only a few studies have examined relationships between bank efficiency and its stock price. These include the country-specific studies on the U.S. (Eisenbeis et al., 1999), Singapore (Chu and Lim, 1998), Malaysia (Sufian and Majid, 2006), Australia (Kirkwood Nahm, 2006), and Greece (Pasiouras et al., 2007).

Using both DEA and SFA in explaining risk-taking behavior, Eisenbeis et al. (1999) estimated the cost efficiency of a sample of large US bank holding companies. They find that both methods produce informative efficiency scores, and recommend decision-makers to put more weight on the SFA estimates.

Using DEA, Chu and Lim (1998) estimated the cost and profit efficiency of six Singapore listed banks during the period 1992-1996. They find that changes in bank stock prices reflect the changes in profit efficiency rather than cost efficiency. Using DEA, Sufian and Majid (2006) investigated Malaysian banks that are listed on the Kuala Lumpur Stock Exchange (KLSE) during 2002-2003. Their conclusion is the same as Chu and Lim (1998) Employing DEA method, Kirkwood and Nahm (2006) evaluated cost efficiency of Australian banks in producing banking services and profit between 1995 and 2002. They find that changes in bank efficiency are reflected in stock returns.

Pasiouras et al. (2007) examined 10 Greece commercial banks listed on the Athens stock exchange. They find that there is a positive and statistically significant relationship between annual changes in technical efficiency (TE) and stock price returns. On the other hand, they find that changes in scale efficiency (SE) have no impact on stock price returns.

In summary, researches indicate that the changes in bank efficiency are reflected in stock price returns. And it can be concluded that changes in bank stock prices reflect the changes both in profit efficiency and cost efficiency. A decomposition of bank efficiency suggests that there was a positive and statistically significant relationship between annual changes in TE and stock price returns. On the other hand, it is found that changes in SE have no impact on stock price returns for Greece listed banks. Most of the literatures employed DEA model to estimate bank efficiency scores although Eisenbeis et al. (1999) highlight the method of SFA.

3. Data and Methodology

We employ DEA window analysis to estimate the efficiencies required for this study of all the 14 Chinese listed banks. Then we calculate their stock performance as represented by quarterly stock returns, calculated for each bank by adding daily returns. Finally, we regress each bank stock performance on the quarterly change of the efficiency measures in order to test if such a statistical link can be established to explain bank stock price changes.

3.1 Data

Our starting point consisted of the population of banks that are listed on the stock exchanges of China before 2008 so as to obtain many more samples with balance data. The sample includes 14 banks namely, Industrial and Commercial Bank of China (ICBC), China Construction Bank (CCB), Bank of China (BC), Bank of Communications Corporation (BCC), China Merchants Bank (CMB), Shanghai Pudong Development Bank (SPDB), China CITIC Bank Corporation Limited (CITIC), Industrial Bank Co. Ltd (IBC), China Minsheng Banking Corporation (CMBC), Hua Xia Bank (HXB), Shenzhen Development Bank Co. Ltd (SDB), Bank of Ning Bo (BNB), Bank of Beijing (BB) and Bank of Nan Jing (BNJ), including all of the state-owned and joint stock commercial banks listed on the Shanghai and Shenzhen Stock Exchange. The investigating period is from the first quarter of 2008 to the third quarter of 2010. Thus, the data for the inputs and outputs cover 11 quarters over the period. The dataset is balanced and consists of 154 seasonal observations.

We collected information from various sources. Some data are collected from their quarterly and annual financial statements. And some are from the database of quarterly and annual balance statements and profit sheets obtained from the website of sina. Daily and monthly stock prices were obtained from database of Northeast Security Company of China. All variables are measured in million of China RMB.

3.2 DEA Window Analysis

DEA window analysis which is that of a moving-average analysis was proposed by Charnes et al. (1985) in order to measure efficiency in cross sectional and time varying data. Each bank is treated as a different bank in a different period which can increase the number of data point. Therefore, small sample sizes problem can be solved. And another advantage of DEA window analysis is that the performance of a bank in a period can be contrasted against themselves and against other banks overtime (Asmild et al., 2004).

A brief DEA window analysis review is presented here. Following Asmild et al. (2004), consider N DMUs $(n=1,2,\cdots,N)$ observed in T $(t=1,2,\cdots,T)$ periods using r inputs to produce s outputs. Let DMU_n^t represent an DMU_n in period t with a r dimensional input vector $x_n^t=(x_n^{1t},x_n^{2t},\cdots x_n^{rt})'$ and s dimensional output vector $y_n^t=(y_n^{1t},y_n^{2t},\cdots,y_n^{st})'$. If a window start at time k $(1\le k\le T)$ with window width w $(1\le w\le t-k)$, then the metric of inputs is given as follows:

$$X_{kw}=(x_1^k,x_2^k\ldots,x_N^k,x_1^{k+1},x_2^{k+1},\ldots,x_N^{k+1},\ldots,x_1^{k+w},x_2^{K+w},\ldots,x_N^{k+w})'$$

And the metric of outputs as:

$$Y_{kw} = (y_1^k, y_2^k ..., y_N^k, y_1^{k+1}, y_2^{k+1}, ..., y_N^{k+1}, ..., y_1^{k+w}, y_2^{k+w}, ..., y_N^{k+w})'$$

The CCR model (constant returns to scales, CRS) of DEA window problem for DMU_k^t is given by solving the following linear program:

$$\begin{aligned} \min \quad & \theta \\ s.t. \quad & \theta' X_t - \lambda' X_{kw} \geq 0 \\ & \lambda' Y_{kw} - Y_t \geq 0 \\ & \lambda_n \geq 0 \ (n = 1, 2, \cdots, N \times w \end{aligned} \tag{1}$$

BCC model (Variable returns to scales, VRS) formulation can be obtained by add the restriction $\sum_{n=1}^{N} \lambda_n = 1$ (Banker et al., 1984). The objective value of CCR model is designated technical efficiency (TE), and the objective of BCC model is pure technical efficiency (PTE). The BCC model is illustrated as:

$$\begin{aligned} \min \quad & \theta \\ s.t. \quad & \theta' X_t - \lambda' X_{kw} \geq 0 \\ & \lambda' Y_{kw} - Y_t \geq 0 \\ & \sum_{n=1}^{N} \lambda_n = 1 \\ & \lambda_n \geq 0 \ (n = 1, 2, \cdots, N \times w \end{aligned} \tag{2}$$

Asmild et al. (2004) point out that there are no technical changes within each of the windows because all DMUs in each window are compared and contrast against each other and suggest a narrow window width should be used. Charnes et al. (1994) found that $w = 3$ or 4 tended to yield the best balance of informativeness and stability of the efficiency scores. In order to be sure that the results will be credible, a narrow window width must be used. Therefore, a 3 year window has been chosen in our analysis ($w = 3$).

In this paper, the first window contains the first, second and the third quarter of the year 2008 increasing DMUs from 14 to 42 ($n \times w = 14 \times 3$). Then the window moves on one quarter period. The procedure will be repeated and the analysis is performed to these DMUs. That is the data from period 1, 2, 3 forming the first window row, and the data from period 2, 3, 4 forming the second row, and so on. The procedure will be repeated 9 ($T - w + 1 = 11 - 3 + 1$) times to obtain all efficiency values in all windows. Subsequently, by applying a nine, three-year window, the number of DMUs of the sample would increase to 378 (i.e. $14 \times 3 \times 9$), thus providing a greater degree of freedom to the sample.

3.3 Variables Definition

In the banking theory literature, there are five main variables definition approaches namely, production approach, intermediation approach, asset approach, operating approach and revenue approach. It is commonly acknowledged that different choice of variables significantly affects the results of efficiency studies. However, studies on chinese banking usually choose variables according to their purposes and the data that can be obtained because some information cannot be obtained in China, especially for banks.

In this paper, we choose interest income (y_1) and non-interest income (y_2) as outputs according to the revenue approach because we want to link efficiency with stock price performance and bank's revenue ability is the main point stockholders concern. As the same time, we assume customer deposits and short term funding (x_1), fixed assets (x_2), and employee expenses (x_3) as inputs to employ items in balance statement in order to involving more information than usual accounting ratios. We employ the item of deposits and short term funding as an input to represent the capacity of bank's image in the public. The item of fixed assets is used as the proxy of bank's scale. And the item of employee expenses is employed as a measure of bank's management quality.

3.4 Panel Data Econometric Methods

The panel regression model we used is as below:

$$Y_{it} = \alpha_0 + \beta X_{it} + \sum_{j=1}^{6} \gamma_{jit} Z_{jit} + \varepsilon_{it} \tag{3}$$

Where $\varepsilon_{it} = \mu_{it} + v_{it}$; Y_{it} is the moving average of bank i's daily stock returns in window t; X_{it} is bank's mean quarterly percentage change in bank efficiency in window t including the technical, pure technical, and scale efficiency scores; α and β are the parameters to be estimated; $\varepsilon_{it} \sim i.i.d\,(0, \sigma^2)$ and it is assumed to be free from autocorrelation.

Z_{it} is an vector of bank specific factors. Z_{1it} is calculated as a natural logarithm of total bank deposits as a measure of bank's market power. Z_{2it} is calculated as the ratio of total loans to bank total assets as a measure of bank's loans intensity. Z_{3it} is measured as the natural logarithm of banks' total assets as the proxy of bank's scale. Z_{4it} is calculated as ratio of total noninterest expenses to total assets as a measure of bank's management. Z_{5it} is measured by the ratio of banks' equity to total assets as a measure of banks' leverage level. Z_{6it} is calculated as bank's profit after tax divided by total assets as a proxy measure for bank profitability.

For the panel regression analysis, individual banks' quarterly returns are calculated as the sum of daily stock returns for all sample banks. Daily returns have smaller standard deviations than do monthly returns.

In order to assure the regression model to be unbiased, several specification tests are performed. But we need not conduct assuming homogeneity because Baltagi et al. (2003) argues that homogeneous panel estimation may be more suitable for short sample. The panel data fixed effects estimation is chosen according to several specification tests namely, the likelihood ratio (LR) test, Breush-Pagan Lagrange

Multiplier (LM) test and Hausman test. In addition, the fixed effects estimation can account for unobserved factors which may affect stock price return, knowingly or not.

4. Findings

4.1 Efficiency of Chinese listed Banks

Employing DEA Window Analysis, we estimate the technical efficiency of Chinese 14 listed banks. The technical scores and its decomposition are listed in table 1.

It is observed from Table 1 that small banks exhibit the highest level of mean TE of 94.29% than do their larger counterparts. On the contrary, the big banks tend to report the lowest level of mean TE of 88.91%. According to the decomposition results, we find that the lowest mean TE of large banks might due to its lower mean SE.

table 1
Window Analysis and Decomposition of Technical Efficiency Scores

		TE		PTE		SE	
size	bank	mean	SD	mean	SD	mean	SD
big	ICBC	0.8700	0.0468	0.9993	0.0021	0.8706	0.0463
	CCB	0.8962	0.0586	0.9949	0.0036	0.9006	0.0578
	BC	0.9011	0.0714	0.9759	0.0192	0.9222	0.0625
	AVERGE	0.8891		0.9901		0.8978	
medium	BCC	0.8909	0.0579	0.9578	0.0327	0.9292	0.0325
	CMB	0.8419	0.0730	0.8819	0.0503	0.9525	0.0355
	SPDB	0.8720	0.0375	0.9136	0.0371	0.9537	0.0197
	CITIC	0.8874	0.0391	0.9177	0.0319	0.9665	0.0150
	IBC	0.9863	0.0206	0.9970	0.0057	0.9893	0.0214
	CMBC	0.9520	0.0402	0.9704	0.0257	0.9806	0.0246
	HXB	0.9393	0.0448	0.9539	0.0370	0.9847	0.0263
	AVERGE	0.9100		0.9418		0.9652	
small	SDB	0.9341	0.0422	0.9561	0.0294	0.9772	0.0283
	BB	0.9628	0.0261	0.9731	0.0221	0.9894	0.0092
	BNB	0.9241	0.0367	0.9775	0.0437	0.9461	0.0593
	BNJ	0.9506	0.0631	0.9802	0.0166	0.9695	0.0196
	AVERGE	0.9429		0.9717		0.9705	

notes: The banks are classified into three groups according to their size; The group of Large includes the banks whose assets larger than 1000 million RMB; Medium means that the assets of banks in this group are between 100 million and 1000 million RMB; Small is refer to those banks whose assets less than 10 million RMB; Mean is the average score for the thirteen quarterly period; SD is the standard deviation for the period; Averge is the mean efficiency of group.

Supporting the findings of Berger et al. (1993), it shows that large banks have higher mean level of PTE of 99.01% than do their smaller peers. While the medium banking group has reported the lowest mean PTE of 94.18%. And the differences among these groups are not significant.

On the contrary, it is clear from Table 1 that the large Chinese banks have exhibited the lowest mean SE compared to its medium and small group. The large banks have reported the lowest mean SE of 89.78% compared to their counterparts, which is consistent with some earlier bank efficiency studies (Miller and Noulas, 1996; Drake and Hall, 2003; Webb, 2003). And the results suggest that the small sized banks have exhibited the highest mean SE of 97.05% during the period of study.

4.2 Efficiency and Chinese Banks' stock Price Returns

If the markets of Chinese stock exchange are efficient, we expect changes in bank efficiencies would be reflected in stock returns even though short-term variations may not be explained by efficiency measures. By using bank efficiency scores as the independent variable against stock price return as the dependent variable, equation (3) is estimated. Panel regression model with fixed-effects is employed. Tables 2-4 present the regression results derived from estimating Equation.

It is observed from table 2-3 that the results are robust across various regression models with respect of other bank specific trait variables. The coefficients of bothTE scores and PTE scores are positive and significant just as we expected. However, it is obtained from table 4 that the coefficient of SE is insignificant, which is consistent with earlier studies (Chu and Lim 1998; Beccalli et al., 2006; Sufian and Majid, 2006).

The magnitude of the coefficient of TE is 2.07, significant positive, which implies that a 1% improvement in TE would lead to the improvement in their stock prices 2.07%. Likewise, the magnitude of the coefficient of PTE is 4.4525, also positive, significant higher, which implies that a 1% improvement in PTE would lead to the 4.45% improvement in their stock prices.

Another result of the regression models is that both TE and PTE provide more information than changes in ROE, because the coefficients of TE and PTE are significantly positive and obviously larger than the coefficients of ROA. The coefficient of TE is about 4.5 times of the coefficients of ROA. And the coefficient of PTE is almost 10.8 times of the coefficients of ROA. So it is concluded that PE and PTE better explains bank stock returns compared to ROE which is one of the traditional accounting profits measures.

5. Conclusion

Motivated by the limited research in Chinese banking, using the quarterly data from 2008 to 2010 of 14 listed banks, this paper examines the relationship between efficiency changes and stock returns of Chinese banks. The DEA Window Analysis methodology has been used to estimate three different types of efficiencies. The efficiency scores have been used to investigate the link between efficiency changes and stock returns.

The results show that large banks exhibit lower level of TE than their smaller counterparts, which due to their lower level of SE. On the other hand, the small and medium sized banks have a higher level of TE and SE compared to large peers.

The results of panel regressions suggest that changes in TE and PTE were statistically significant and positively related to stock returns. However, we find no evidence of the significant relationship between SE and stock returns. Thus, it seems that TE and PTE are incorporate helpful and important information for bank stakeholders and potential investors. In addition, we find that TE and PTE have advantages over ROE which is one of the acceptable traditional accounting ratios.

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Appendix

Table 1

Regression Results of Stock Price Return to Technical Efficiency

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-2.8928	0.7427	-3.8951	0.0002***
X	2.0772	0.6775	3.0661	0.0028***
Z1	-6.4956	2.3336	-2.7836	0.0064***
Z2	6.3325	1.3559	4.6703	0.0000***
Z3	6.5478	2.3413	2.7967	0.0061***
Z4	-0.6188	0.6027	-0.5010	0.0000***
Z5	0.7527	0.5394	0.6152	0.0002***
Z6	0.4615	0.8270	0.4035	0.0000***
Fixed Effects (Cross)				
_SDB	-0.1536			
_SPDB	-0.2483			
_CMBC	-0.0095			
_CMB	0.1340			
_HXB	-0.5133			
_BC	-0.1182			
_ICBC	0.5145			
_IBC	-0.3318			
_CCB	-0.1443			
_CITIC	-0.3810			
_BCC	-0.1443			
_BNB	0.6695			
_BNJ	0.8811			
_BB	-0.1550			
R-squared	0.7088			
Adjusted R-squared	0.6566			
F-Statistic	13.5786			
Log likelihood	-11.6025			

Notes: ***Statistically significant at the 1% level.

Table 2

Regression Results of Stock Price Return to Pure Technical Efficiency

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-5.1995	0.9318	-5.5799	0.0000***
X	4.4525	0.9031	4.9303	0.0000***
Z1	-6.2162	2.1722	-2.8617	0.0051***
Z2	6.5548	1.2411	5.2813	0.0000***
Z3	6.2581	2.1777	2.8737	0.0049***
Z4	-0.8907	0.3574	-0.7310	0.0000***
Z5	0.1178	0.0927	0.1148	0.0036***
Z6	0.4125	0.3173	0.3571	0.0000***
Fixed Effects (Cross)				
_SDB	-0.1585			
_SPDB	-0.1385			
_CMBC	-0.0313			
_CMB	0.3123			
_HXB	-0.4399			
_BC	-0.2020			
_ICBC	0.2721			
_IBC	-0.3330			
_CCB	-0.1807			
_CITIC	-0.2790			
_BCC	-0.1807			
_BNB	0.5904			
_BNJ	0.8657			
_BB	-0.0969			
R-squared	0.7421			
Adjusted R-squared	0.6959			
F-Statistic	16.0533			
Log likelihood	-3.9488			

Notes: ***Statistically significant at the 1% level.

Table 3

Regression Results of Stock Price Return to Scale Efficiency

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.6541	1.0538	-0.6207	0.5361
X	-0.0413	0.9851	-0.0420	0.9666
Z1	-5.2577	2.4314	-2.1625	0.0328**
Z2	7.4880	1.4087	5.3155	0.0000***
Z3	5.2626	2.4392	2.1575	0.0332**
Z4	-1.1322	0.7266	-0.5094	0.0000***
Z5	0.1641	0.0813	0.1329	0.0002***
Z6	-0.6541	1.0538	-0.6207	0.5361
Fixed Effects (Cross)				
_SDB	-0.2517			
_SPDB	-0.3621			
_CMBC	-0.0640			
_CMB	-0.0621			
_HXB	-0.3786			
_BC	-0.0296			
_ICBC	0.5433			
_IBC	-0.1127			
_CCB	-0.1568			
_CITIC	-0.5530			
_BCC	-0.1568			
_BNB	0.6342			
_BNJ	0.9651			
_BB	-0.0150			
R-squared	0.6830			
Adjusted R-squared	0.6261			
F-Statistic	12.0183			
Log likelihood	-16.9547			

Notes: ***Statistically significant at the 1% level; **Statistically significant at the 5% level.