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Risk-taking and Efficiency of Banks for Emerging Eastern Asian Countries

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Abstract

To investigate the risk-taking impacts on bank efficiency in emerging Asian countries, we used a stochastic frontier approach technique. Empirical findings indicate more bank inefficiency in China than other countries, implying that management must not understand how to ensure their resources are being effectively utilized. The results show that credit risk plays more of an important role in banks' efficiency than operating risk and market risk, and this is consistent with the general idea that banks have a better profitability when they are more stable.

JEL classification numbers: D24, G21, G34
Key words: Risk-taking, Bank Efficiency, Stochastic Frontier Approach

1. Introduction

The risk indicator in the banking industry of developed and emerging countries has a major impact on efficiency and asset quality. In general, risk indicators have been used to evaluate whether to associate with banks efficiency. In the existing literature, it is typical to use non-performance loans and loan loss reserves as proxies

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for credit risk and to explain how risk indicators affect bank efficiency scores. In January 2001, the Basel Committee described bank risks that could be divided into three parts including credit risk, market risk, and operating risk. Most studies incorporate external environment risk and internal risk in measuring banks efficiency, such as Hughes et al. (2001) and Girardone et al. (2004). Chiu and Chen (2009) considered not only the controllable factors involved in the internal risk of bank management, but also how the external environmental risk factors impact bank efficiency. However, they did not consider the market and operating risks to measure banks efficiency. To the best of our knowledge, few studies have considered operating and market risk in banks efficiency evaluations, such as done by Sun and Chang (2011); they considered three distinct risk aspects, and their empirical result shows that risk measure represents significant effects on both the level and variability of bank efficiency. This study provides an interesting case study on efficiency for one basic problem with risk-taking. This study attempt explains how Basel II risks impact bank efficiency for emerging Asian countries.

In recent years, in the processes of rapid growth and recovery, emerging Asian countries have undoubtedly played a key role in world economics. More scholars have interest and pay more attention to Asian countries, especially those emerging markets, such as China. Most studies analyzed used sample emerging Asian countries' applications for various management, economics, and financial management topics. This study mainly adopted three emerging Asian countries including China, Hong Kong, and Taiwan. These countries have similar backgrounds, language, culture, race, and societal makeup, and the economic development is very homogenous amongst them.

This study aims to examine how Basel II risks affect bank efficiency for Asian emerging countries including China, Hong Kong and Taiwan over the period from 2005 to 2010. Using a stochastic frontier approach to estimate bank efficiency in the first stage, the second stage used panel data model with a fixed effect model and a random effect model to estimate regression and explain the relationship between Basel II risks and banks efficiency. This paper is organized as follows: section one contains the introduction; section two describes the model specification, data source, and empirical design; and section three presents the empirical results, while conclusions are drawn in section four.

2. Methodology specifications

Using a popular stochastic frontier approach in existing literature to estimate banks efficiency indicates that bank efficiency measures the extent to which a bank's costs approximate those of the best practice frontier banks, producing an identical output bundle under the same conditions. This study used two-stage SFA to investigate how Basel risk affects bank efficiency for Asian emerging countries. First, this study used the stochastic frontier approach independently proposed by Aigner et al. (1977), which is a means to measure the relative efficiency of banks by objectively providing numerical efficiency scores.[2] Second, regression analysis was used to determine whether the bank efficiency derived from the pooled sample is related to risk-factors. The measure is derived from a cost function where the dependent variable is each bank's total cost, and the independent variables include the prices of inputs, the quantities of variable outputs, and a composite error term. Specifically, a stochastic cost function model implies that banks' observed total cost deviates from the cost-efficient frontier. For panel data, a general version of this cost function for banks may be written as,

$$\ln C = \ln C(w_t, y_t) + \varepsilon \tag{1}$$

where C is total costs, w is input prices, y is the output quantities and ε is the error term.

Following Christensen et al. (1973), a translog cost function is used to estimate the efficiency of each individual bank. The cost function, given the variables defined above, is written as,

$$\ln \frac{C_{it}}{w_{Lit}} = \alpha_0 + \sum_{j=1}^{2} \alpha_j y_{jt} + \sum_{j=1}^{2} \beta_j \frac{w_{jit}}{w_{Lit}} + \frac{1}{2} \sum_{k=1}^{2} \sum_{j=1}^{2} \alpha_{jk} \ln y_k \ln y_j + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{2} \beta_{jk} \ln \left(\frac{w_{jit}}{w_{Lit}} \right) \ln \left(\frac{w_{kit}}{w_{Lit}} \right)$$

$$+ \sum_{i=1}^{2} \sum_{j=1}^{2} \rho_{ij} \ln y_i \ln \frac{w_{jit}}{w_{Lit}} + u_{it} + v_{it} \tag{2}$$

[2] The stochastic frontier approach is a parametric approach that estimates efficiency. Numerous empirical studies of banking industry efficiency have employed SFA across several countries, such as Bonin et al. (2005), Zhao et al. (2010), and Sun and Chang (2011).

In general terms, the error term is $\varepsilon_{it} = u_{it} + v_{it}$ and decomposes into two parts, of which v_{it} is a random variable that is assumed to be an independent but not identical distribution non-negative random variable, while u_{it} is the error of approximation and other source of statistical noise assumed to be independent and identically distributed as $N(0, \sigma_u^2)$. Following the Battese and Coelli (1995) model, the overall cost efficiency of production for *i*, the bank, at *t*, the year of observations, is the ratio of the stochastic frontier input cost used to the observed input used. The stochastic frontier input cost use is defined by the value of input cost if the cost inefficiency effect, v_{it}, is zero. The cost efficiency of a bank can be written as,

$$CE_{it} = \exp(v_{it}) \tag{3}$$

which indicates that a result in excess of one is a measure of bank cost inefficiency. Cost efficiency value can range from one to ∞, and efficiency value close to one indicates the bank is more efficient.

The input-output specification of this research is based on the intermediation approach as suggested by Berger (1995). Most studies follow the intermediation approach definition of input-output variables, where the employee expense, physical capital expense, and fund expense are the input factors used to produce earning assets, labor, capital, and interest price.[3] The price of labor is defined as the total salary to total number of employees. The price of physical capital is defined as the operating expense minus employee expense of fixed assets. The price of fund is defined as the paid interest to all funding. The two outputs are total loans and investment, which are commonly used in the existing literature, such as Berger (1995), Bonin et al. (2005), and Haiso et al. (2010). The primary data source for this study was the Taiwan Economics Journal (TEJ); the samples included 61 banks during the period from 2005 to 2010, and total observation was 366 full samples.

Under a Basel II framework, we assumed that banks face three major sources of risks (risk indicators): credit risk, market risk, and operating risk. This study attempts

[3] Comparison with Sun and Chang (2011) only used two input variables to establish cost function in their paper and omitted labor input, perhaps causing a bias problem. With respect to input prices, the price of labor, capital, and funds are conventional input prices in previous studies such as Berger (1995).

to incorporate these three aspects of risks. Previous studies often used non-performance loans as proxies for credit risk, but some countries, used as samples, cannot obtain non-performance loans. Following Barry et al. (2011), we used loan loss provisions over gross loan as a proxy for credit risk. Using interest rate volatility to measure market risk, we calculated the standard deviation of monthly, one year, and time deposit interest rate. The operating risk was measured by ROA volatility following Liu et al. (2012). This rate is an accounting-based volatility indicator measured by standard deviation of each bank's yearly ROA. On the other hand, as a measure of bank risk taking, most studies use the natural logarithm of the Z-score, which is the number of standard deviations that a bank's rate return of assets has to fall for the bank to become insolvent, such as found by Demirguc-Kunt and Huixinga (2010).[4] This study expects that the Basel II risk has a significant impact on banks' efficiency. Thus, the empirical equation can be written as,

$$EFF_{it} = \beta_0 + \beta_1 C\_Risk_{it} + \beta_2 O\_Risk_{it} + \beta_3 M\_Risk_{it} + \beta_4 Z\_Score_{it} + \varepsilon_{it} \qquad (4)$$

where EFF indicates banks inefficiency, C_ Risk indicates credit risk of banks, O_ Risk indicates operating risk of banks, M_ Risk indicates market risk of banks, and Z_ Score indicates Z-score value of banks. Descriptive statistics of the empirical variables are provided in Table 1.

[4] In general, Z-score is calculated by $= \frac{(ROA + EQAS)}{\sigma(ROA)}$,

where ROA is the mean return of assets, EQAS is the mean equity to assets ratio, and $\sigma(ROA)$ is the standard deviation of ROA. Higher Z-score indicates higher bank stability than lower Z-score.

Table 1: Descriptive Statistics

	Mean	**Std.**
Output items		
Investment	3.7141E+4	9.2594E+4
Loans	5.8047E+4	9.568E+4
Input price		
Labor price	581.5085	401.427
Fund price	0.7874	0.7038
Capital price	0.0197	0.0097
Total cost	4860.175	1.11032E+4
Risk Indicators		
Credit risk	0.0138	0.0194
Operating risk	0.7445	0.8139
Market risk	0.2104	0.2183
Z_ Score	1.6381	2.7226

Note: the primary data source for this study was the Taiwan Economics Journal (TEJ). The input-output variables unit measure by millions, fund and Capital price measure by percent.

3. Empirical Results

3.1 Results of Cost function

This section reports the results of banks' inefficiency by the stochastic frontier approach. As can be seen Table 2, 13 out of the 14 parameters of the cost frontier are significant at the 0.1 level. Looking at the result output items indicates that higher loan amounts would reduce total cost. One possible reason to explore is that speedy economic growth reflects a huge funds demand amount in local market, and this reduces stretch cost for loans. The sign of interaction of loan and investment items is positive and significant, implying that they are not the scope of economies.

As can be seen Table 3, the results show substantial inefficiencies in our samples. This suggests that over 50% of banks' costs are wasted relative to best-practice frontier facing the same output within the samples. This shows that cost inefficiency gradually decreased from 2005 to 2010, and mean cost inefficiency at 2.1531 fell to 1.4861 during the period of 2005 to 2010, implying banks significantly

improved efficiency in the emerging countries. These results might be due to these countries having speedy economic growth. The mean cost inefficiency score is 2.115 for China, 1.4012 for Hong Kong, and 1.3715 for Taiwan, implying the banks have costs that are 111.5%, 40.12%, and 37.15%, respectively, above the minimum defined by the frontier.

As can be seen Table 4, this finding shows that Chinese banks inefficiency is greater than other counties.[5] Despite the significant change and reforms of the past two decades in China, the banking system still remains at a low level of efficiency, and greater non-performance loans and lower contestability do not ensure banks' incentive to improve their efficiency. This is despite the fact that China joined the World Trade Organization (WTO) in December 2001. Rezanian et al. (2011) found that the efficiency of domestic banks has declined post-WTO accession. On the other hand, comparing China and Taiwan: they joined the WTO at the same time, but Taiwanese banks have a higher efficiency than Chinese banks. This suggests that the improved efficiency in the post-reform period is possibly due to enhanced bank efficiency and risk management practices and benefits obtained from compliance with the First Financial Reform (2000-2005) for Taiwan (Haiao et al., 2010).

Comparing to previous studies, Sun and Chang (2011) found a mean banks efficiency of 0.527 to 0.719 in the emerging Asian countries over the period of 1998 to 2008. This result shows that banks had close to 40% of their inputs under utilized. The results of Sun and Chang (2011) and Filippaki et al (2009) also show that the efficiency score is relatively lower than developed counties. In this study, that mean cost inefficiency score is 0.5334, which is significantly higher than the findings from studies of developed countries. For instance, in a comparison study of bank efficiency with EU countries, Chortareas et al. (2010) found that banks' cost efficiency levels are about 0.8 for the Eurozone. This result suggests that banks of developed countries own operating advantages from finance service skills, quality of human capital, bank supervisory, and legal framework; thus, efficiency scores for developed countries are greater than emerging countries.

[5] This study tests whether each other country has a gap as follows: T test, one-way ANOVE test with F-statistics, Mann-Whitney-Wilcoxon Test with Z-statistic, and Kolmogorov-Smirnov Test with Z-statistic. As can be seen in Table 4, Chinese banks' inefficiency is higher than the other two countries.

Table 2: Parameter Estimates of Cost Function

Parameter	*Coefficient*	*t value*
Constant	-1.764	-1.254
$\ln \frac{P_{Kit}}{P_{Lit}}$	-0.6117	-3.973***
$\ln \frac{P_{Rit}}{P_{Lit}}$	0.929	6.884***
$\ln Q_{1it}$	-0.2873	-3.621***
$\ln Q_{2it}$	1.3178	8.771***
$\ln \left(\frac{P_{Kit}}{P_{Lit}} \right)^2$	0.0538	3.215***
$\ln \left(\frac{P_{Rit}}{P_{Lit}} \right)^2$	0.103	6.115***
$\ln \left(\frac{P_{Kit}}{P_{Lit}} \right) \left(\frac{P_{Rit}}{P_{Lit}} \right)$	-0.1042	-8.088***
$\ln Q_{1it}^2$	-0.0032	-0.8206
$\ln Q_{2it}^2$	-0.0518	-8.067***
$\ln \left(\frac{P_{Kit}}{P_{Lit}} \right) Q_{1it}$	0.0404	4.641***
$\ln \left(\frac{P_{Kit}}{P_{Lit}} \right) Q_{2it}$	-0.0336	2.965***
$\ln \left(\frac{P_{Rit}}{P_{Lit}} \right) Q_{1it}$	0.0179	2.076**
$\ln \left(\frac{P_{Rit}}{P_{Lit}} \right) Q_{2it}$	-0.0209	-2.0711**
$\ln Q_{1it} Q_{2it}$	0.0485	5.3611***
$\sigma_u^2 + \sigma_v^2$	3.8066	1.5233
σ_u^2 / σ^2	0.9985	2.573E3***
Log likelihood function		216.363

LR test of the one-sided error	803.573

Note: Cost function estimated by maximum likelihood estimation (MLE). * Significant level at the α=0.1, **at α=0.05 and ***at α=0.01

Table 3: Results of Efficiency by SFA

	Full	CN	TW	HK
2005	2.1531	2.5238	1.7932	1.5328
2006	1.8792	1.8037	1.4029	1.4355
2007	1.4974	2.2199	1.3136	1.3384
2008	1.4499	2.1806	1.2892	1.2441
2009	1.4351	1.9677	1.3214	1.2489
2010	1.4861	1.9942	1.3028	1.4296
Mean	1.5334	2.115	1.4012	1.3715

Note: the banks efficiency score that range from 1 to ∞.

Table 4: Comparison among Bank Efficiency

	T test	One way ANOVAs	Mann-Whitney-Wilcoxon Test	Kolmogorov-Smirnov Test
CN vs. TW	5.816***	33.827	-3.05	2.927
		(0.000)***	(0.002)***	(0.000)***
CN vs. HK	4.766***	22.718	-3.239	2.511
		(0.000)***	(0.001)***	(0.000)***
TW vs. HK	-0.543	0.295	-0.715	1.23
		(0.587)	(0.475)	(0.097)*

Note: the banks efficiency score that range from 1 to ∞. This study test whether has a gap with each other countries, as follows T test, one-way ANOVE test with F-statistics, Mann-Whitney-Wilcoxon Test with Z-statistic. Kolmogorov-Smirnov Test with Z-statistic.* Significant level at the α=0.1, **at α=0.05 and ***at α=0.01

3.2 Results of inefficiency regression

This subsection explains how Basel risk affects bank cost inefficiency for Asian emerging countries. The main regression results are shown in Table 5. Using the Variance Inflation Factor (VIF) to test whether collinearity problem is significant, as can be seen Table 5 within column 7 shows all variables of VIF less than 10, this implies there are no collinearity problems in the regression analysis.[6] As can be seen in Table 5, the coefficient of C_ Risk is significantly positive except with column 2, indicating that credit risk is positively associated with bank inefficiency as is expected and consistent with existing literature. This implies that the quality of loan portfolios play an important role in bank efficiency; the banks operate under the efficiency frontier while holding a high level of loan loss reserve rates. The coefficient of M_ Risk is positive and insignificant in all regressions, which is inconsistent with Sun and Chang (2011); they found that external environmental variables do influence the efficiency of banks. One possible reason explored is that the interest rate has long run under an absolute low degree in the world economy, thus, interest rate volatility is not associated with banks' efficiency.

The coefficient of O_ Risk is negative and significant with column 1, and insignificant with columns 2-6. A higher operation uncertainly is seen when banks have high ROA volatility. A bank with higher ROA volatility should be more inefficient than other banks. We find slight evidence to support this viewpoint, and inefficiency is not associated with bank profitability even the bank has a high operating uncertainly. One possible reason explored is that a bureaucratic power and interference from regulators still plays an important role in improving efficiency in emerging countries, even in banks with higher operation uncertainly.[7] The coefficient of Z_ Score is insignificant with all regression; this indicates that bank stability is not associated with bank efficiency. In sum, this suggests that credit risk plays a key role in bank efficiency. Other risks are less significant. This result shows that the quality of loan business has a major impact on efficiency for emerging

[6] Previous studies further investigate the determinants of bank efficiency. We also used bank size and asset to equity as proxies for control variables. But in the result exists collinearity problems while including control variables in the regression, so we only consider risk variables in the empirical function.

[7] Bonin et al. (2005) and Liao (2009) illustrate that state-owned banks continue enjoying government policy advantage because their efficiency and profitability compared to private banks in emerging countries.

countries. Their operating activities are over-concentrated on loan business for emerging countries, with lack of scale and scope of economies, suggesting diversification across and within both interest income and non-interest income would generate activities to decrease insolvency risk and enhance profitability (Sanya and Wolfe, 2011).

Table 5: Results of Baseline Regression

	Full sample						
	OLS	**FM**	**RM**	**OLS**	**FM**	**RM**	**VIF**
Constant	1.511		1.1501	1.4973		1.4531	
	(20.18)***		(16.29)***	(15.051)***		(17.2)***	
C_ RISK	4.0314	3.4617	3.658	3.694	3.3714	4.0997	1.016
	(1.8022)*	(1.6375)	(1.8048)*	(1.8195)*	(1.7193)*	(1.8355)*	
O_RISK	-0.0926	-0.0129	-0.0538	-0.0502	-0.0132	-0.0632	1.143
	(-1.741)*	(-0.1653)	(-0.8576)	(-0.7884)	(-0.5964)	(-1.118)	
M_RISK	0.1691	0.0173	0.0607	0.0559	0.0244	0.1376	1.034
	(0.8475)	(0.0103)	(0.3668)	(0.3366)	(0.1163)	(0.687)	
Z_ Score				0.0065	-0.013	0.0254	1.14
				(0.3503)	(-0.7977)	(1.506)	
Hausman		4.5009			5.552		
test		(0.2122)			(0.2352)		
R^2	0.0197	0.4643	0.0186	0.0223	0.4649	0.0257	

Note: the dependent variable is inefficiency score, independent variables follow below C_ RISK indicates credit risk, O_RISK indicate market risk, M_RISK indicate market risk, Z_ Score indicate Z score, which higher Z-score indicates banks more stability than lower Z-score. OLS is ordinary least square, FM is Fixed effect model, RM is Random effect model.

Hausman test: $H_0 = RM \quad vs. \quad FM$, this result indicated that the Random effect model is more appropriate for these regressions.

* Significant level at the α=0.1, **at α=0.05 and ***at α=0.01

3.3 Additional analysis

In this subsection, following previous studies, firm performance is measured by accounting variables, such as return of equity and return of asset. To further investigate the various dependent variables in our empirical equation and decide whether to change our results, we re-estimated regression and used the dependent

variable as return of asset. The results are reported in Table 6. The ROA regression has higher R-square than efficiency regression, but these results still remain qualitatively similar, implying that efficiency and performance regression are consistent. We also find that the sign of Z-Score is significantly positive, implying banks have better profitability when they are more stable.

Table 6: Results of Performance Regression

	ROA		
	OLS	**FM**	**RM**
Constant	0.0709		-0.0468
	(0.809)		(-0.4509)
C_ RISK	-4.238	-1.7594	-2.3743
	-(1.8194)*	(-0.7965)	(-1.1229)
O_RISK	-0.262	0.0363	-0.1107
	(-4.44)**	(0.4451)	(-1.667)*
M_RISK	0.3074	0.0647	0.1433
	(1.4713)	(0.3707)	(0.8278)
Z_ Score	0.1873	0.1895	0.1957
	(10.6295)***	(8.2462)***	(10.1636)***
Hausman test		14.988	
		(0.0047)	
R^2	0.3491	0.6438	0.337

Note: the dependent variable is return of asset , independent variables follow below C_ RISK indicates credit risk, O_RISK indicate market risk, M_RISK indicate market risk, Z_ Score indicate Z score, which higher Z-score indicates banks more stability than lower Z-score. OLS is ordinary least square, FM is Fixed effect model, and RM is Random effect model.

Hausman test: $H_0 = RM \ \ vs. \ \ FM$, this result indicated that the fixed effect model is more appropriate for this regression.

* Significant level at the α=0.1, **at α=0.05 and ***at α=0.01

4. Conclusions

This study examined the how Basel II risk taking impacts bank efficiency in emerging Asian countries over the period of 2005 to 2010 and used stochastic frontier approach technique to estimate banks' efficiency. Empirical findings indicate Chinese banks' inefficiency is more than other countries, implying that managers must understand how to ensure their resources are effectively utilized. The bureaucratic power and interference from regulators still play an important role in improving efficiency in China. They have the duty to assist government to enforce relative policies and obtain franchise value from bureaucratic power. This mainly shows that credit risk plays an important role on banks' efficiency more than operating risk and market risk, and it is consistent with the general notion, which banks have a better profitability when they are more stable. This suggests that diversification is a mechanism to enhance profitability and operating efficiency, as is avoiding high insolvency risk due to over-concentrated on loan business.

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