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Bank Market Risk and Bank Efficiency: A Tale from Two Countries

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ABSTRACT

This paper examines the effects of cost and profit efficiencies on bank market risk using listed banks in Malaysia and China for the 2000–2015 period. The supervision of bank market risk is important because it can affect the stability of the entire banking system. The paper estimates the effects in panel data using stochastic frontier analysis and expected shortfall. The results show that while both efficiencies affect market risk, the cost efficiency has a different effect for both countries. Bank managers and supervisors in each country could apply the results as a basis for formulating business strategy and developing banking policy

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INTRODUCTION

Banks are offering innovative financial instruments to attract new customers while maintaining existing ones. The innovative financial instruments are engineered by transferring the normal credit risk associated instruments to the new market risk instruments. For example, normal loans are transferred to become bonds, real estate mortgages and other loans are securitised to become collateralised debt obligations (CDO), while other credit risk products are covered with the default swaps. Thus, by using derivatives, the credit risk instruments are successfully being transferred to market risk instruments (Alexander 2008).

These new and innovative financial instruments will increase banks' exposure to risk, especially market risk. According to Basel Committee on Banking Supervision (BCBS), bank market risk is the risk of losses resulting from the unexpected movements in financial instruments such as interest rate, exchange rate or equity values (BCBS 1993). The unexpected movements will cause banks to lose capital. Since banking institutions are heavily interconnected, the losses will have contagious effects on other banks. When many banks lose their capital rapidly over a short period, this will affect the stability of the entire banking system. Acknowledging the fragile nature of bank market risk, BCBS has made monitoring and controlling market risk priorities for the banking supervisors (Segoviano and Goodhart 2009; BCBS 2011).

Since the introduction of Value at Risk (VaR) method for market risk framework in 1996 (BCBS 1996), VaR has become the most common method used to measure the bank market risk (Jorion 2007). In the framework, banks must disclose the calculated market risk based on the VaR method. From the disclosed VaR, it provides the bank supervisors with; (i) the amount of market risk borne by the banks, (ii) the amount of capital buffer that needed to absorb the losses from the adverse market conditions, and (iii) the information to evaluate the validity of the VaR model by backtesting process (Pérignon and Smith 2010). After the Global Financial Crisis, BCBS has reformed the banking system with the implementation of Expected Shortfall (ES) to replace VaR as the advanced risk measure for market risk (BCBS 2016). The reform is essential to prevent the next crisis being more critical compared to the current one.

High levels of capital are important for the banks to absorb losses, become more resilient, prevent a bank run, limit the contagion effects and further strengthen the stability of the economy (Tian 2017). To have high levels of capital, researchers study the relationships between capital and bank risk with efficiency. In a review paper, Berger et al. (1993) claimed that the savings from efficiency could be used to improve banks' capital. The improvement in banks' capital enables banks to absorb more risk, create higher safety and strengthen the banking industry.

As argued by Chen et al. (2013), the current market structure is more complicated due to the diversity and innovativeness of the financial instruments thus increase the market risk. Acknowledging the fragile nature of bank market risk, it is important to study the determinants affecting market risk. Since most of the earlier researchers focused on the relationships between efficiency and general bank risk, there is a paucity of studies that focus specifically on market risk. The fragile nature of bank market risk should be examined to help ensure the stability of the entire banking system. In this regard, the types of efficiency that affect bank market risk play an important role.

The economic growth in the East Asia and Pacific (EAP) region is consistently higher compared to the world growth. According to IMF (2016), the growth in EAP is fuelled by the growth in China's economy. This study will examine China as the largest economy in EAP (GDP 2016 10.2 trillion USD) and compare it with Malaysia (GDP 2016 0.3 trillion USD). Malaysia is selected because both countries have their trading grown faster than the rest of the world since the Asian Financial Crisis (Devadason 2009). In addition, both countries have implemented liberalization of the interest rate since 1978 and 1996, for Malaysia China respectively (Njie 2006; Tan 2016). The liberalization of the interest rate increases competition and therefore efficiency in the banking system of the liberalizing country. Based on the unique economic background, it is interesting to study the effects of bank market risk on (i) differences in GDP, (ii) increase in trading, and (iii) liberalization of the interest rate between both countries.

Using sample data from banks in Malaysia and China, this paper examines the influence of cost and profit efficiencies on market risk using unbalanced panel data. The sample consists of (i) all banks listed in Malaysia and (ii) 12 biggest banks listed in China for the 2000-2015 period. This study limits the China banks sample to only 12 biggest banks listed due to the huge differences between bank size, cost and profits. There are four Chinese banks that are global systemically important banks in the sample according to the Financial Stability Board in 2016.

In this period, both countries still implemented the Basel II standard. The cost and profit efficiencies are constructed using Stochastic Frontier Analysis (SFA) and market risk by Expected Shortfall (ES). Our results show that the cost efficiency gives mixed effects to market risk compared to profit efficiency. Since differences in cost efficiency effects on market risk for both countries, bank managers and supervisors in each country could utilise the results when formulating their business strategy and developing banking policy.

This study contributes in the following ways: (i) it uses of ES method as the market risk measurement, (ii) the use of cost and profit efficiencies using SFA, (iii) extending Kwan and Eisenbeis' (1996) study in terms of the relationship between bank market risk and efficiency, (iv) examining the differences between the Malaysia and Chinese economies.

REVIEW OF THE LITERATURE

Expected Shortfall Bank Market Risk

The importance of monitoring market risk was highlighted during the global financial crisis (BCBS 2011). Immediately after the global financial crisis, BCBS introduced the stressed VaR (sVaR) to replace the VaR method as a measurement for market risk regulatory capital requirements. This measurement is part of the Basel 2.5 reforms package as a temporary measurement implemented to overcome the inadequacy of the VaR method to absorb the financial loss (BCBS 2011). Since 2013, BCBS has moved from sVaR to Expected Shortfall (ES) as the latest measurement method for market risk regulatory capital requirements (BCBS 2013).

Artzner et al. (1999) defined risk measure as coherent when it satisfies the four axioms: (i) translation invariance, (ii) positive homogeneity, (iii) monotonicity and (iv) sub-additivity. Based on the authors' definition, the VaR method is not a coherent risk measure because it fails to satisfy the sub-additivity axiom. The subadditivity axiom states that 'a merger did not create an extra risk'. The authors then introduce the ES method to compensate the VaR method. ES calculates the riskiness of the portfolio by considering the size and the probabilities of losses beyond VaR (BCBS 2013). Since ES is the newest method for measuring market risk, only a handful of studies has tested the effectiveness of the method. Thus, more study is needed to verify the effectiveness of the ES method for measuring bank market risk.

Bank Efficiency using Stochastic Frontier Analysis

According to Habibullah et al. (2005), the efficiency of a bank can be evaluated in three ways; (i) productivity using financial ratios, (ii) frontier analysis using parametric approach, and (iii) frontier analysis using non-parametric approach. For productivity using financial ratios, a high ratio commonly associated with the high efficiency. For example, the profitability ratio could be used by calculating return on assets (ROA) or return on equity (ROE) ratios. Using a different set of ratios can only capture a certain subset of efficiency and not the true efficiency (Coelli et al. 2005). Differed from the financial ratios, frontier analysis measures the deviations in performance from the bank with the best performance bank on the efficient frontier facing the same exogenous market conditions.

Both Aigner, et al. (1977) and Meeusen and Broeck (1977) proposed the SFA model for frontier analysis using a parametric approach. This model separates error terms into statistical noise and efficiency estimations compared to the frontier analysis using a non-parametric approach such as Data Envelopment Analysis (DEA) model that incorporates all error terms. It uses the econometric procedures to estimate the unknown parameters of the production, cost or profit functions and its technical and allocative efficiencies with the error term. By separating the error term, the estimation will produce more accurate results compared to the DEA model (Othman et al. 2017).

In bank efficiency literature, both cost and profit efficiencies are widely used because they are based on economic optimisation from the combination of market prices and competition (Berger and Mester 1997). In addition, the bank also behaves as intermediation firm and not production firm, therefore the cost and profit efficiencies are more suitable method to be applied to the bank (Kumbhakar and Lovell 2000). A study of both cost and profit efficiencies could provide more information regarding the relationships of the efficiencies whether it is complementary or substitution in nature (Aiello and Bonanno 2013) and have a complete assessment of the banks' efficiency (Pancurova and Lyocsa 2013).

Other Bank Specific Variables

Besides efficiency, this study examines other bank-specific variables as independent variables. Previously published studies on the effect of the bank-specific variables on market risk are inconsistent and depend on the objectives of the study, thus we included the independent variables for further examination. There are (i) natural logarithm of total assets (SZ) (Demirgüç-Kunt et al. 2013) (ii) total equity to total asset (CP) (Akhigbe et al. 2012) (iii) nonperforming loan to total loan (NPLL) (Klomp and Haan 2012) (iv) noninterest income to revenue (NI) (Abuzayed et al. 2018) (v) return on average assets (ROAA) (Williams 2014) and (vi) marketable securities to total assets (MS) (Williams 2014). Since our data will have effects from the global financial crisis (2008-2009), we employ the Early Warning System (EWS) to capture the effects of the crisis.

METHODOLOGY

This study examines ten listed banks in Malaysia and the 12 biggest banks listed on the Shanghai Stock Exchange for the 2000-2015 period. We chose the year 2000 as our starting period because we want to minimise the effects of the 1997 Asian Financial Crisis. This study employs a two-stage procedure for empirical analysis. In the first stage; the dependent variable, the market risk is measured by using the ES method. The independent variables – (i) the cost and profit efficiencies are estimated using SFA, (ii) EWS is constructed using logit model, and (iii) other banks specific variables calculated using financial ratios. The data for ES derived from daily stock price available at the Wall Street Journal (WSJ) website. In the second stage, the results from market risk (ES) is regressed with cost and profit efficiency scores, EWS and other bank-specific variables as the independent variables using panel data techniques to investigate the impacts of efficiency on bank market risk.

Expected Shortfall

ES is the average loss after VaR, α is the per cent of confidence level (Dowd 2005).

$$ES_{\alpha} = \frac{1}{1-\alpha}\sum_{p=0}^{n} p^{th}\ largest\ lost\ \times probability\ of\ p^{th}\ largest\ lost \tag{1}$$

Efficiency (SFA)

Cost Efficiency

The standard cost function model is:

$$\ln TC_i = f(Y_i, W_i;\ \beta) + v_i + u_i \tag{2}$$

where TC_i is the total costs for i-th bank. The TC_i representing the minimum cost of producing outputs Y_i with input prices W_i and β is a vector of the unknown technology parameters to be estimated. $v_i \sim i.i.d.N(0, \sigma_v^2)$ is a two-sided normal disturbance error term that captures the statistical noise and $u_i \sim i.i.d.N^+(0, \sigma_u^2)$ is a one-sided positive error term that captures the effects of cost inefficiency relative to the frontier. The total variance is $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and the Gamma ratio is $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$. The ratio has a value between 0 and 1. A hypothesis test of $\gamma = 0$ serves as a test of the existence of the one-sided error for half-normal model (Kumbhakar et al. 2015).

The base cost function model is:

$$Ln\,TC = \alpha_0 + \sum_{i=1}^{m}\alpha_i \ln y_i + \sum_{j=1}^{J}\beta_j \ln w_j + \frac{1}{2}\left[\sum_{i=1}^{m}\sum_{k=1}^{m}\delta_{ik}\ln y_i \ln y_k + \sum_{j=1}^{J}\sum_{h=1}^{J}\theta_{jh}\ln w_j \ln w_h\right] + \sum_{i=1}^{m}\sum_{j=1}^{J}\rho_{ij}\ln y_i \ln w_j + v_i + u_i \tag{3}$$

Symmetry restrictions are required, i.e. $\delta_{ik} = \delta_{ki}$ and $\theta_{jh} = \theta_{hj}$. The cost function model is homogeneous of degree one in input prices. It must satisfy the additional restrictions:

$$\sum_j \beta_j = 1, \sum_j \theta_{jh} = 0\ \forall\ h, \sum_j \rho_{ij} = 0$$

This model is using cross-section data and restricts to examining the technical inefficiency assuming the banks are fully efficient in allocative efficiency. This assumption is made as the banking firm has a unique production mix.

The cost efficiency results will be used as the independent variables in the bank market risk model. This study adopts; (i) the translog form as the functional form of production technology and (ii) the intermediation approach to describe the banking services (Boucinha et al. 2013). We followed Ab-Hamid et al. (2017) for variables definitions. Two outputs: (i) total loans (y_1) and (ii) other earning assets plus other operating income(y_2). Three inputs: (i) price of labour (w_l) - personnel expenses to total assets, (ii) price of physical capital (w_k) - other operating expenses to fixed assets, and (iii) price of funds (w_f) - total interest expense to deposits plus short-term funding. We normalised cost, profit, and outputs (y_1 and y_2) with total assets. To satisfy the homogeneous of degree one in input prices restrictions, total cost, price of labour and price of funds are normalised by price of physical capital (Srairi 2010).

Profit Efficiency

As indicated by Berger and Mester (1997), the alternative profit efficiency is chosen to measure the profit efficiency. The dependent variable is $\ln PE_i = ln\left(PF_i + \left|PF_i{}^{min}\right| + 1\right)$, where PF_i is the profit before tax of the -ith bank. The term $\theta = \left|PF_i{}^{min}\right| + 1$ indicates the absolute minimum value of net profits over all banks in a given year plus 1. The term θ is a constant added to every bank's profit, so the natural logarithm is a positive number since the minimum profits can be negative. The composite error term is $v_i - u_i$. Inefficiency term enters the frontier with a negative sign because inefficiency reduces profits below the best practice bank frontier. The profit efficiency is defined as $PE_i = \exp(-u_i)$. The efficiency scores take a value between zero and one with the value closer to one representing the most efficient bank.

Early Warning Systems

This study uses a logit model to construct the EWS for the individual banks in China and Malaysia. We use the nonperforming loan to total loan that exceeds 10% for crisis definition as stated in the first condition by Demirgüç-Kunt and Detragiache (1998). The dependent variable will have a value of one (indicates crisis) when the ratio exceeds 10% and zero otherwise.

$$y = \begin{cases} 0, no\ crisis \\ 1, crisis \end{cases} \tag{4}$$

$$P_{crisis} = Prob\ (y = 1|X) = F(x'\beta) = \Lambda(x'\beta) = \frac{\exp(x'\beta)}{1 + \exp(x'\beta)} \tag{5}$$

$F(x'\beta)$ is the Cumulative Distributive Function (CDF) that associates the nonlinear function of the dependent variable (y) with the sets of independent variables. $\Lambda(x'\beta)$ represents the logistic distribution of CDF. $x' = x_i$, and is a vector of potential explanatory variables for banking crises. β is the vector coefficients.

This model is using cross-section data. We use financial ratios as a proxy to examine the influence of asset quality, solvency, liquidity and profitability to the probability of relative risk. The ratios are; (i) asset quality – loan loss reserve to gross loans, (ii) solvency – equity to total assets, (iii) liquidity: (a) net loan to total assets and (b) liquid assets to total debt liabilities, (iv) profitability: (a) returns on average equity and (b) returns on average assets and (v) asset size – natural logarithm of total assets.

$$ln\frac{\hat{P}_{i,Crisis}}{1 - \hat{P}_{i,Crisis}} = \hat{C} + \hat{\beta}_1 LLRGL_i + \hat{\beta}_2 ETA_i + \hat{\beta}_3 NLTA_i + \hat{\beta}_4 LATDL_i + \hat{\beta}_5 ROAE_i + \hat{\beta}_6 ROAA_i + \hat{\beta}_7 \ln SZ_i + \varepsilon \tag{6}$$

Where, $\hat{P}_{Crisis}$ denotes the estimated probability of crisis. C is constant, $\hat{\beta}_i, i = 1\ to\ 7$, are unknown parameters. LLRGL (loan loss reserve to gross loans), ETA (equity to total assets), NLTA (net loan to total assets), LATDL (liquid assets to total debt liabilities), ROAE (returns on average equity), ROAA (returns on average assets), SZ (total assets) and ε is the error term.

Bank Market Risk Model

In this second stage, the result from the market risk dependent variable (ES) is regressed with the independent variables estimated earlier (cost and profit efficiency scores and EWS) and other bank-specific variables. Using panel data analysis, we examine the impacts of efficiency on bank market risk using yearly cross-section data or also known as panel data. The panel data analysis is suitable for this study as shown by Berger and DeYoung (1997). Following Papadamou and Tzivinikos (2013), the model is;

$$MR_{it} = \beta_0 + \beta_1 EF_{it} + \beta_2 EWS_{it} + \beta_3 \ln SZ_{it} + \beta_4 \ln CP_{it} + \beta_5 NPLL_{it} + \beta_6 \ln NI_{it} + \beta_7 ROAA_{it} + \beta_8 \ln MS_{it} + \varepsilon_{it} \quad (7)$$
$$i = 1, \dots, N; t = 2000, \dots, 2015$$

Where MR = Market Risk, EF = Efficiency, EWS = Early Warning System, SZ = Size, CP = Capital, NPLL = Nonperforming Loan, NI = Noninterest Income, ROAA = Return on Average Assets and MS = Marketable Securities. The error term can be further decomposed into: $\varepsilon_{it} = \mu_i + \lambda_t + u_{it}$. Where, μ_i is called individual-specific effect, λ_t is called time effect, and $u_{it} \sim N(0, \sigma_u^2)$ denotes the well behave error term.

There are three competing models in panel data; (i) pooled, (ii) random effect and (iii) fixed effects model. Three tests are conducted in order to select the correct panel data model; (i) Poolability F-Test, (ii) Breusch-Pagan LM test and (iii) Hausman's specification test.

Data Description

The banks' financial data are collected from the Bankscope database from 2000 to 2015. The banks' annual reports are used when data is unavailable or for cross-references. The daily stock price is collected from the WSJ website. The sample contains unbalanced data from (i) Malaysia with 146 and (ii) China with 117 observations. The average bank size for China and Malaysia are 1.45 trillion USD and 0.05 trillion USD. **Error! Reference source not found.** presents the variables description, expected sign and data sources for all variables used in this study and **Error! Reference source not found.** summarises the variables statistics.

Table 1 Variables description, expected sign and data sources.

Variables	Description	Expected Sign	Source
Market Risk Model			
MR	Market Risk measured using Expected Shortfall		WSJ and author's calculation
EF	Cost and Profit Efficiencies estimated using SFA	negative	Author's calculation
EWS	Early Warning Systems measured using logit	negative	Author's calculation
SZ	Size - Natural Log of Total Assets	positive	Bankscope
CP	Capital - Total equity / Total Assets	negative	Bankscope
NPLL	Nonperforming Loan - Nonperforming Loan / Total Loan	positive	Bankscope
NI	Noninterest Income - Noninterest Income / Revenue	negative	Bankscope
ROAA	Return on Average Assets	negative	Bankscope
MS	Marketable Securities - Marketable Securities / Total Assets	negative	Bankscope
Efficiency (SFA) Model			
Cost	Total Interest Expense + Total Noninterest Expenses		Bankscope
Profit	Profit before tax		Bankscope
y1	Total Loans	positive	Bankscope
y2	Other Earning Assets + Other Operating Income	positive	Bankscope
wl	Personnel Expenses / Total Assets	positive	Bankscope
wk	Other Operating Expenses / Fixed Assets	positive	Bankscope
wf	Total Interest Expense / Deposits & Short-term funding	positive	Bankscope
Early Warning System (Logit) Model			
Asset Quality	Loan Loss Reserve to Gross Loans	positive	Bankscope
Solvency	Equity to total assets	positive	Bankscope
Liquidity (1)	Net Loan to total assets	positive	Bankscope
Liquidity (2)	Liquid Assets to Total Debt Liabilities	positive	Bankscope
Profitability (1)	Returns of Average Equity	positive	Bankscope
Profitability (2)	Returns of Average Assets	negative	Bankscope

Table 2 Summary statistics for China and Malaysia

Variables	China			Malaysia		
	Obs.	Mean	Standard Deviation	Obs.	Mean	Standard Deviation
Bank Size (Mil USD)	12	1450244	317641	10	51736	15568
Market Risk Model						
ES	117	-0.051	0.021	146	-0.040	0.019
EF (Cost)	117	0.930	0.038	146	0.895	0.067
EF (Profit)	117	0.778	0.122	146	0.812	0.102
EWS	117	0.065	0.081	146	0.316	0.403
SZ	117	14.827	1.253	146	11.298	0.933
CP	117	0.055	0.014	146	0.089	0.028
NPLL	117	0.015	0.013	146	0.076	0.066
NI	117	0.176	0.076	146	0.348	0.128
ROAA	117	0.010	0.003	146	0.009	0.009

Table 2 Cont.

MS	117	0.204	0.069	146	0.196	0.070
Efficiency (SFA) Model						
Cost (Mil)	183	113063.7	128627.4	183	4129.1	4109.4
Profit (Mil)	183	64679.9	89140.2	183	1504.0	1846.8
y1 (Mil)	183	2091150.0	2513862.0	183	67037.4	84666.1
y2 (Mil)	183	1483297.0	1609301.0	183	25692.5	29015.6
wl	183	0.004	0.001	183	0.007	0.002
wk	183	0.622	0.265	183	1.277	0.841
wf	183	0.020	0.006	183	0.033	0.015
Early Warning System (Logit) Model						
Asset Quality	206	2.839	2.588	171	4.562	3.216
Solvency	206	4.979	2.926	171	9.034	3.324
Liquidity (1)	206	52.131	6.484	171	59.844	10.301
Liquidity (2)	206	23.196	9.477	171	24.446	9.927
Profitability (1)	206	14.553	17.862	171	12.069	14.066
Profitability (2)	206	0.858	0.414	171	0.956	0.936

RESULTS AND DISCUSSIONS

Efficiency

Table 3 reports the estimation results for the cost and profit efficiencies model. For China, eight regressors are statistically significant for the cost model. The log likelihood value is high (214.900) and LR test is significant at the 1% level. The sigma-squared is significant at the 1% level. The high and significant value of the log-likelihood function and significant value of sigma-squared indicates highly significant parameter estimates. The estimation results show a positive and significant relationship between the two outputs (total loans, y_1 and other earning assets, y_2. This means that higher outputs lead to higher costs. The coefficient for the price of inputs (price of labour, w_l and price of fund, w_f) is also positive and significant. It shows that high price of inputs leads to higher costs. The elasticity of the price of labour (0.985) is higher than the elasticity of the price of fund (0.556). This suggests that banks should focus more on the personnel expenses compared to interest expenses to control the cost. The coefficient for combinations of the outputs γ_{11}, γ_{22} and γ_{12} are also significant (5%, 10%, and 5%, respectively). Both γ_{11} and γ_{22} are positive, while γ_{12} is negative. This shows that the combinations between different output prices reduce the efficiency. The coefficient of the double input price for labour (δ_{ll}) is significant, at 1%. The results indicate that w_l contributes more than does w_f .

The profit model shows that five regressors are statistically significant. The log likelihood value is 8.696 and LR test is significant at the 1% level. The sigma-squared is significant at the 1% level. The significant value of the log-likelihood function and significant value of sigma-squared indicates significant parameter estimates. The estimation results show a positive and significant value for other earning assets output. This means that higher other earning assets outputs lead to higher profits. The coefficient for the price of fund is negative and significant. It shows that the high price of fund leads to lower profit efficiency. Its own outputs' combination (γ_{22}) reduces the profit efficiency, as it has a negative value and is significant at the 10% level. The coefficient for w_f is negatively significant at 1%. This indicates that an increase in w_f reduces the profit efficiency, while the combination of its price (δ_{ll}) increases the efficiency by being positively significant, at 1%. The coefficient of cross input prices (δ_{lf}) is significant at 1% and has a negative value. This means that the combination of the input price reduces the profit efficiency.

For Malaysia, eight regressors are statistically significant for the cost model. The log likelihood is high (161.605) and LR test is significant at the 1% level. The sigma-squared is significant at the 1% level. The high and significant value of the log-likelihood function and significant value of sigma-squared indicates highly significant parameter estimates. The estimation results show a positive and significant relationship between the two outputs (total loans, y_1 and other earning assets, y_2). This means that higher outputs lead to higher costs. The price of labour is positive and significant at 1% level. These estimates show that the higher the price of labour, the higher the cost. The coefficient for combinations of the outputs γ_{22} and γ_{12} are also significant at 1% level each. Coefficient for γ_{22} is positive, while γ_{12} is negative. This shows that the combinations between different output prices reduce the efficiency. The coefficients for the (i) double input price for labour (δ_{ll}) and (ii) double input price for fund (δ_{ff}), are positive and significant, both at 1% level. While the coefficients for the cross-input prices (δ_{lf}) is negative and significant, at 1% level. The results show that individually, w_l and w_f contribute more than combination between w_l and w_f do.

The profit model shows that eight regressors are statistically significant. The log likelihood is 31.034 and LR test is significant at the 1% level. The sigma-squared is significant at the 1% level. The significant value of the log-likelihood function and significant value of sigma-squared indicates significant parameter estimates. The estimation results show a positive sign and significant at 1% level of the total loans output, y_1. This means that higher loans lead to higher profits. The coefficient for the price of fund, w_f is positive and significant. It shows that high price of fund leads to high profits. The coefficient for combinations of the outputs γ_{11}, γ_{22} and γ_{12} are also significant, at 1%, respectively. Both γ_{11} and γ_{22} are positive, while γ_{12} is negative. This shows that the combinations between different output prices reduce the efficiency. The combination price of labour (δ_{ll}) and price of fund (δ_{ff}) reduce the efficiency due to the negatively significant, at 1% each. The coefficient of cross input prices (δ_{lf}) is significant at 1% and has a positive value. This means that the combination of the cross-input price increases the profit efficiency.

Table 3 Estimation results for the cost and profit efficiencies

Variables	Parameters	China		Malaysia	
		CE	PE	CE	PE
Constant	α_0	5.542	1.777	3.692	5.063
		(0.474)	(1.156)	(0.427)	(0.908)
$\ln y1$	α_1	0.514[a]	-0.516	0.841[a]	0.916[a]
		(0.191)	(0.578)	(0.148)	(0.266)
$\ln y2$	α_2	0.362[c]	1.179[b]	0.273[b]	-0.013
		(0.192)	(0.583)	(0.144)	(0.244)
$\ln wl$	β_l	0.985[a]	0.887	0.555[a]	0.059
		(0.207)	(0.568)	(0.172)	(0.380)
$\ln wf$	β_f	0.556[a]	-1.413[a]	0.188	0.738[b]
		(0.166)	(0.450)	(0.148)	(0.317)
$\ln y1 \ln y1$	γ_{11}	0.286[b]	-0.268	0.049	0.486[a]
		(0.122)	(0.280)	(0.055)	(0.111)
$\ln y2 \ln y2$	γ_{22}	0.219[c]	-0.584[c]	0.113[a]	0.202[a]
		(0.118)	(0.309)	(0.024)	(0.064)
$\ln y1 \ln y2$	γ_{12}	-0.241[b]	0.442	-0.094[a]	-0.283[a]
		(0.118)	(0.288)	(0.035)	(0.082)
$\ln wl \ln wl$	δ_{ll}	0.204[a]	0.481[a]	0.204[a]	-0.459[a]
		(0.063)	(0.158)	(0.058)	(0.125)
$\ln wf \ln wf$	δ_{ff}	0.041	0.220	0.177[a]	-0.606[a]
		(0.053)	(0.211)	(0.059)	(0.126)
$\ln wl \ \ln wf$	δ_{lf}	-0.067	-0.516[a]	-0.227[a]	0.497[a]
		(0.054)	(0.140)	(0.056)	(0.122)
$\ln y1 \ln wl$	θ_{1l}	-0.015	-0.163	0.063	0.088
		(0.063)	(0.167)	(0.043)	(0.080)
$\ln y1 \ln wf$	θ_{1f}	-0.051	-0.196	-0.016	0.035
		(0.054)	(0.139)	(0.039)	(0.080)
$\ln y2 \ln wl$	θ_{2l}	-0.010	0.139	-0.016	0.026
		(0.058)	(0.156)	(0.044)	(0.081)
$\ln y2 \ln wf$	θ_{2f}	0.047	0.062	0.001	-0.044
		(0.051)	(0.147)	(0.043)	(0.089)
Log likelihood		214.900	8.696	161.605	31.034
Variance components:	$\sigma^2(u) =$	0.013[a]	0.171[a]	0.021[a]	0.081[a]
		(0.002)	(0.032)	(0.004)	(0.022)
	$\sigma^2(v) =$	0.001[b]	0.003	0.002[a]	0.014[b]
		(0.001)	(0.003)	(0.001)	(0.005)
LR test of the one-sided error		11.898[a]	20.394[a]	14.516[a]	8.271[a]

Standard Error in parentheses [a] Significant level at 1%; [b] Significant level at 5% and [c] Significant level at 10%

EWS

Error! Reference source not found. reports the estimation results from the logit model for the probability of default. For both countries, the probability of crisis increases significantly with the increase in (a) Loan Loss Reserve to Gross Loans - LLRGL (5% China, 1% Malaysia) and (b) Total Assets - SZ (5% China, 1% Malaysia). Whereas it reduces the probability significantly with the increase in the Returns on Average Assets - ROAA (1% China, 10% Malaysia). For China, Liquid Assets to Total Debt Liabilities - LATDL (5%) is also significant. Even though the other determinants are not significant, their inclusion has allowed this model to correctly classify the probability of crisis by 90% with the pseudo R^2 of 0.378 (China) and 0.686 (Malaysia).

Table 4 EWS logit model results

Variables	Parameters	China	Malaysia
Constant	$\hat{C}$	-9.753	11.546
		(5.025)	(7.483)
LLRGL	$\hat{\beta}_1$	0.272[b]	1.590[a]
		(0.116)	(0.329)
ETA	$\hat{\beta}_2$	0.074	-0.108
		(0.124)	(0.131)
NLTA	$\hat{\beta}_3$	0.020	-0.032
		(0.049)	(0.050)
LATDL	$\hat{\beta}_4$	0.104[b]	0.041
		(0.040)	(0.043)
ROAE	$\hat{\beta}_5$	0.004	0.235
		(0.111)	(0.160)
ROAA	$\hat{\beta}_6$	-5.306[a]	-4.142[c]
		(0.951)	(2.187)
Ln SZ	$\hat{\beta}_7$	0.496[b]	-1.554[a]
		(0.210)	(0.569)
Pseudo R^2		0.378	0.686

Standard Error in parentheses: [a] Significant level at 1%; [b] Significant level at 5% and [c] Significant level at 10%

Bank Market Risk

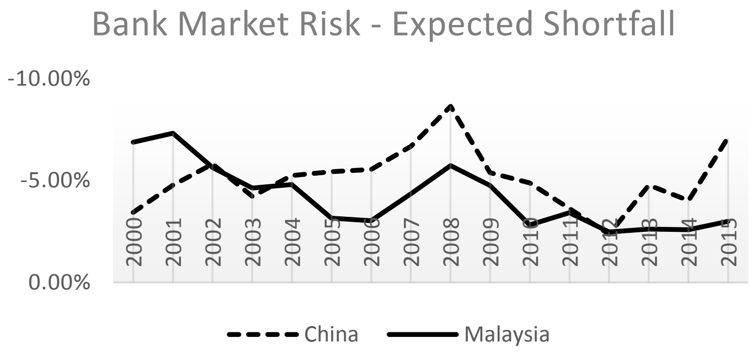

Figure 1 Bank Market Risk Using Expected Shortfall

Bank market risk is fluctuating throughout the sample period. The highest recorded losses for China is -8.6% in 2008 (Global Financial Crisis) while for Malaysia is -7.32% in 2001 (Global Economic Slowdown). The second highest losses for Malaysia is in 2008 at -5.73%. It shows that the Malaysian banks are also affected by the global financial crisis.

To decide which is the best model for the bank market risk, each model is estimated using three-panel data methods: (i) Pooled Ordinary Least Squares (POLS), (ii) Fixed Effects (FE), and (iii) Random Effects (RE). Then three sets of tests: (i) Poolability F-Test, (ii) Breusch-Pagan LM test and (iii) Hausman's specification test are conducted to select the best model from the panel data. From the test, we found that Pooled OLS was preferred by dataset from China and profit efficiency model for Malaysia, while cost efficiency for Malaysia preferred the fixed effect model.

Table 5 Bank Market Risk Model Results

		China		Malaysia	
Variables	Parameters	ES - Cost	ES - Profit	ES - Cost	ES - Profit
Constant	β_0	-0.031	-0.182	-0.298	-0.098
		(0.058)	(0.036)	(0.049)	(0.031)
Eff	β_1	-0.126[b]	0.029[c]	0.048[c]	0.026[c]
		(0.048)	(0.017)	(0.026)	(0.014)
EWS	β_2	-0.045	-0.050	-0.009	-0.000
		(0.042)	(0.043)	(0.007)	(0.007)
Ln SZ	β_3	0.008[a]	0.010[a]	0.020[a]	0.004[b]
		(0.003)	(0.003)	(0.003)	(0.002)
CP	β_4	-0.345	-0.426[c]	-0.022	-0.068
		(0.226)	(0.226)	(0.061)	(0.055)

Table 5 Cont.

NPLL	β_5	0.442[b]	0.470[b]	0.008	-0.120[a]
		(0.188)	(0.195)	(0.048)	(0.042)
NI	β_6	0.007	0.029	-0.004	0.000
		(0.031)	(0.031)	(0.015)	(0.013)
ROAA	β_7	0.005	-0.879	-0.250	-0.319[c]
		(1.357)	(1.469)	(0.163)	(0.184)
MS	β_8	-0.096[a]	-0.109[a]	-0.026	-0.001
		(0.031)	(0.031)	(0.033)	(0.021)
F-Test		F(11, 97) = 1.60	F(11, 97) = 1.03	F(9, 128) = 3.74[a]	F(9, 128) = 3.21[a]
LM Test		chibar2(01) = 0.00	chibar2(01) = 0.00	chibar2(01) = 0.48	chibar2(01) = 0.03
Hausman Test		chi2(8) = 14.96[c]	chi2(8) = 10.39	chi2(8) = 20.74[a]	chi2(8) = 13.02

Standard Error in parenthesis: [a] Significant level at 1%; [b] Significant level at 5% and [c] Significant level at 10%

The cost efficiency is significant in China and Malaysia (5% and 10%, respectively). China has a negative sign for the coefficient while Malaysia has a positive sign. For China, the higher the cost efficiency, the lower the market risk. The scenario is inverse in Malaysia where the higher the cost efficiency, the higher the market risk. The inverse scenario could be explained by the differences in banks size. The average size of banks in each country is substantial (China - 1.45 trillion USD and Malaysia - 0.05 trillion USD). The economy of scale for bigger banks are easily achieved compared to smaller banks. Thus, the impact of savings from cost efficiency is easily gained by bigger banks compared to smaller banks. The negative effects of cost efficiency on bank market risk are in line with the studies conducted in the US. As earlier study done by Kwan and Eisenbeis (1997) found that the increased cost efficiency lowers the bank risk-taking due to the leveraging in the economies of scale. As the positive effects of cost efficiency on bank market risk could be contributed to the small bank size in the sample. The smaller banks could not achieve the economies of scale in the financial instruments compared to their larger counterparts. Therefore, smaller banks have to increase more cost to offer the same financial instruments as compared to larger banks (Saeed and Izzeldin 2016).

For profit efficiency, both countries exhibit a positive sign and significant at 10%. This means that for both countries, the higher the profit efficiency, the higher the market risk. As banks are embarking on profit orientated initiatives, they will offer more innovative financial instruments that have high market risk exposure. Thus, by offering more innovative financial instruments, the bank has increased their exposure to market risk. As indicated by Liadaki and Gaganis (2010), the change in profit efficiency has significant and positive effects on stock prices.

For other bank-specific variables, the EWS does not show any significant effect in China and Malaysia context. This could be interpreted as the Global Financial Crisis does not give significant impact to both countries compared to other developed countries. The size of banks can affect risk positively. This is in line with De Haan and Poghosyan (2012) that found the bank size is positively related to total risk. For the negative effects of capital, as bank become bigger, they able to increase their capital with lower cost (i.e. better resource leverage) and thus able to absorb higher risk. The positive relationship between NPLL and market risk in China supports the indicator scenarios of the bank's aggressive lending strategies, whereas the negative relationship between NPLL and market risk in Malaysia might be due to the banks with sound capital position are in better position to manage the risk arising from the losses, thus resulted in the reduced market risk (Papadamou and Tzivinikos 2013). As for the negative effects of Return on Assets and Marketable Securities, the bank can invest in short to medium term marketable securities such as subordinated notes and debentures (SND) to increase the return. Investing in large amounts of marketable securities provides liquidity for banks and increase the return, thus it lowers the likelihood of risk (Demirgüç-Kunt and Huizinga 2013).

CONCLUSIONS

From this study, we found that for both countries, the cost and profit efficiencies, and bank size affect bank market risk. Our model also proves (i) the cost efficiency significantly affects the market risk but with different coefficients signs and (ii) the profit efficiency positively affecting market risk.

This study has uncovered elements of the fragile nature of market risk compared to the previous studies. First, there are differences in the effects of cost and profit efficiencies on bank market risk. The supervisors should give more attention to the development of cost efficiency initiatives especially for bigger banks to reduce the volatility of bank market risk. Since there are differences in cost efficiency effects on market risk for China and Malaysia, the banking supervisors and managers should give more attention when formulating cost efficiency policies to control the market risk exposure. On the other hand, the development of profit efficiency initiatives could be given more attention when the market risk is in tranquillity period.

Second, this study also explores the effects of bank-specific variables that contribute to the significance of the bank market risk model. Based on the review of the literature, this study examines seven bank-specific variables (EWS, size, capital, nonperforming loans, noninterest income, returns on assets and marketable securities) on bank market risk. The findings highlight the significant variables and could be used by the regulators and the bank management.

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