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Bank Market Risk and Efficiency of Commercial Banks in Malaysia

(Risiko Pasaran dan Kecekapan bagi Bank-bank Komersial di Malaysia)

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ABSTRACT

Since the global financial crisis, banking supervisors have realised that bank market risk is crucial to banking stability. Guided by the Financial Sector Master Plan, Bank Negara Malaysia has implemented risk-focused and pre-emptive regulation and supervision to control the market risk exposure. This paper examines the market risk and effects of cost and profit efficiencies on market risk using all listed banks in Malaysia for the 2000–2015 period. Using the Expected Shortfall and Stochastic Frontier Analysis, this paper estimates the cost and profit efficiencies and analyses the effects on market risk. The results show that the bank market risk exposure decreases and both cost and profit efficiencies affect market risk. Bank managers and supervisors could apply the results as a basis for formulating business strategy and developing banking policy.

Keywords: Malaysian banks; market risk; expected shortfall; stochastic frontier analysis; logit

ABSTRAK

Sejak krisis kewangan global, penyelia perbankan telah menyedari bahawa risiko pasaran bank adalah penting untuk kestabilan sistem perbankan. Berpandukan Pelan Induk Sektor Kewangan, Bank Negara Malaysia telah melaksanakan penyeliaan yang berorientasikan risiko dan pengawalan terhadap pendedahan risiko pasaran. Makalah ini mengkaji risiko pasaran dan kesan kecekapan kos dan kecekapan keuntungan terhadap risiko pasaran menggunakan kesemua bank yang tersenarai di Malaysia untuk tempoh 2000-2015. Menggunakan Kekurangan Dijangka (ES) dan Analisa Sempadan Stokastik (SFA), makalah ini menganggarkan kecekapan kos dan keuntungan dan menganalisa kesannya kepada risiko pasaran. Keputusan menunjukkan bahawa pendedahan bank terhadap risiko pasaran berkurangan dan kedua-dua kecekapan mempengaruhi risiko pasaran. Pengurus penyelia perbankan dapat menggunakan dapatan kajian sebagai dasar untuk merumuskan strategi perniagaan dan membangunkan polisi perbankan.

Kata kunci: Bank; risiko pasaran; kekurangan dijangka (ES); analisa sempadan stokastik (SFA); logit

INTRODUCTION

As profit orientated firms, banks seek to increase their profit by offering high-risk instruments while leveraging their trading portfolios. This is evident in the increased global over the counter (OTC) derivatives markets that exceeded more than USD 14 trillion in 2016 (BIS 2017). As the banks seek to increase their profit objective, this effort will also increase their risk exposure. The intrinsic nature of the derivatives products which are made of hedging, arbitrage and speculation have resulted in a zero-sum game (Alexander 2008). After the global financial crisis, banking supervisors have realised that the risk management in banks must be reformed (Tian 2017). As the market risk from the derivatives product is more than USD 14 trillion, a shift in the market risk management is needed now more than ever. In lieu of this, as the international body of banking supervisory, the Basel Committee on the Banking Supervision (BCBS) issued "Revisions to the Basel II market risk framework" in 2011 to strengthen the market risk management of the banking sector (BCBS 2011).

From the Malaysian standpoint, Bank Negara Malaysia (BNM) as the banking supervisory in Malaysia has implemented risk-focused and pre-emptive regulation and supervision to the banks since the Asian financial crisis. The regulation is imposed due to the nature, size and complexity of the banking institutions. Guided by the Financial Sector Master Plan (FSMP) 2001-2010, domestic banks have undergone restructuring, consolidation and rationalisation and becoming less fragmented in recent years (Saha, Ahmad & Yeok 2016). From 77 domestic banking institutions in 1980 to only 34 in 2011. From the exercises, the institutions now have higher capital and loan loss buffer, improvements in underwriting and risk management practices, and strengthened governance structures and discipline (BNM 2011). These improvements could be reflected when the domestic banks have become more efficient and resilient from the global financial crisis compared to those following the Asian financial crisis. From the initiatives taken by BNM, it is important to examine the effects of the risk-focused regulation on market risk and the improvement in efficiency. Although earlier researches have been carried out to examine the relationships between efficiency and overall bank risk in Malaysia, there are inadequate studies that empirically examine the effect of efficiency on the bank market risk. The fragile nature of bank market risk should be examined to help ensure the stability of the entire banking system.

The objective of this paper is to empirically examine bank market risk and the effect of efficiency on bank market risk in Malaysia. The effect of cost and profit efficiency on bank market risk is examined using panel data of all listed banks in Malaysia for the period of 2000-2015 to reduce the effects of the Asian financial crisis. The cost and profit efficiencies are estimated using the Stochastic Frontier Analysis (SFA) and market risk measured using the Expected Shortfall (ES). The results demonstrate that Malaysian banks have the ability to sustain the market risk exposure from the effects of the global financial crisis. Moreover, the cost and profit efficiencies have an effect on the market risk. The findings could be used by banking supervisors as the basis to establish efficiency-related policy and for bank managers as supporting tools to formulate their business strategy.

The remainder of this article is organized as follows. Section 2 reviews the literature related to the bank market risk and efficiency. Section 3 presents the methodology related to the cost and profit efficiencies and bank market risk. Section 4 presents the findings regarding the effect of efficiency on market risk. Finally, Section 5 concludes the paper.

LITERATURE REVIEW

BANK MARKET RISK

The Basel Committee on Banking Supervision (BCBS) highlighted the importance of market risk in 1993. BCBS defined market risk as "the risk of losses in on- and off-balance-sheet positions arising from movements in market prices, including interest rates, exchange rates and equity values" (BCBS 1993). From there, the definition of market risk expanded to "the possible loss caused by the unexpected movements in financial instruments such equity prices, interest rates, credit spreads, foreign exchange rates, commodity prices and other financial instruments whose values are set in a public market. The unexpected movements reduce the earnings or valuation of the banks resulting in a capital loss" (Christoffersen 2012; Li et al. 2015; Tian 2017). The importance of market risk is further strengthened by its inclusion in the Basel II Framework in 2006 (BCBS 2006).

Since the global financial crisis of 2007-2008, the management of bank market risk has become more significant than ever. VaR is the first advanced risk measure for market risk that was proposed in a comprehensive capital framework by BCBS (BCBS 2006). In the framework, banks must disclose the calculated market risk based on the VaR method. In 2016, BCBS has implemented ES to replace VaR as the advanced risk measure for market risk (BCBS 2016).

ES is also known as conditional VaR (cVaR) or tail loss. ES is the average of all the theoretical losses beyond VaR. The ES method was introduced by Artzner et al. (1999) to compensate the limitations in VaR method. ES estimates the expected loss of the portfolio on the loss distribution tail. It computes the riskiness of a position by considering both (i) the size and (ii) the probabilities of losses beyond a certain confidence level. Since ES estimates the average loss in leptokurtic distribution, it gives better accuracy than VaR. Rockafellar and Uryasev (2002) supported the ES as a coherent risk measure because it fulfils all axioms defined by Artzner et al. (1999). The use of ES enables capturing comprehensive information on the tail risk and capital adequacy during the financial market crisis (BCBS 2016).

It is interesting to note that the bank market risk in Malaysia is not fully examined in the literature compared to bank efficiency. Abdul Rahman (2009) examined the linkages between lending structure and market risk exposure. Using CAPM to determine market risk exposure, the results showed that there were higher levels of market risk during the Asian financial crisis and its aftermath while the market risk exposure of merged banks were not reduced.

BNM has expected that the financial sector depth (sum of loans outstanding, stock market capitalisation and bonds outstanding) will increase up to six times of gross domestic products (GDP) in 2020 (BNM 2011). As the increase in these financial instruments will also increase their risk exposure, there is a need to conduct the examination of market risk to ensure the sustainability of the financial system. To the best of our knowledge, we could not find other research that focused on market risk for domestic banks in Malaysia. Thus, this warrants further empirical study regarding bank market risk.

BANK EFFICIENCY

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 nonparametric approach (Habibullah et al. 2005). Using a different set of ratios can only capture a certain subset of efficiency and not the true efficiency (Coelli et al. 2005). As distinct to financial ratios, the parametric and non-parametric frontier analysis measures the deviations in the performance of the bank with the best performance bank on the efficient frontier facing the same exogenous market conditions. Current researchers have adopted the frontier analysis to measure efficiency due to the advantages of the method.

In contrast to market risk, the Malaysian banking efficiency has received great attention from researchers. Katib and Matthews (1999) were the earliest researchers that have studied the efficiency of Malaysian domestic commercial banks using non-parametric frontier analysis

– the Data Envelopment Analysis (DEA). Using data from 20 commercial banks from 1989-1995, the results showed that most of the banks were inefficient in combining their inputs and not operating at constant returns to scale. Since then, the DEA method has been used by most of the Malaysian banking efficiency studies (see Ab Rahim 2015; Azad, Kian-Teng & Talib 2017; Sufian 2009, 2011; Sufian, Kamarudin & Mohd Noor 2013).

In addition, there were authors that use parametric frontier analysis such as SFA method in evaluating Malaysian bank efficiency. Using SFA to measure the technical efficiency, Mohd Tahir, Abu Bakar and Haron (2008) found that the technical efficiency of commercial banks was high in the 2000-2006 period (around 81%). The findings were supported by Hasan et al. (2012) who found the technical efficiency of domestic banks were higher than the previous findings (around 94%) over the period 2005-2010. There were also studies conducted to analyse the Islamic and conventional banks (Abdul-Majid, Saal & Battisti 2011; Ahmad Mokhtar, Abdullah & Al-Habshi 2006). Ahmad Mokhtar et al. (2006) investigated the efficiency of Islamic banks in Malaysia. Using SFA to measures technical and cost efficiencies over the 1997-2003 period, the authors found that the efficiency of Islamic banks had increased compared with conventional banks that remained constant during the sample period. Abdul-Majid et al. (2011) examined the efficiency, economies of scale and productivity of Islamic banks compared to conventional banks. Using cost efficiency SFA and a generalised parametric Malmquist productivity index (MPI) from 1996-2002, the authors found that Malaysian banks had moderate economies of scale and annual productivity change.

It is evident from the literature review that most of the researchers in Malaysian banks are using the DEA method to measure efficiency. In contrast to the international bank efficiency researches, SFA is preferred compared to DEA (Lampe & Hilgers 2015). This paper therefore examines the cost and profit efficiencies of banks using the SFA method.

Overall, the empirical literature on the relationship between efficiency and bank risk is somewhat limited. Although earlier researches have been carried out to examine the relationships between efficiency and overall bank risk (Berger & DeYoung 1997; Berger, Hunter & Timme 1993; Kwan & Eisenbeis 1996) empirical studies to examine the effect of efficiency on bank market risk remains inadequate. This study fills this gap by examining the effects of bank efficiency on market risk measured using the Expected Shortfall (ES) method for the post-Asian financial crisis period.

OTHER BANK MARKET RISK DETERMINANTS

This study includes other determinants in the bank market risk model. They are (i) natural logarithm of total assets (SZ) (Demirgüç-Kunt et al. 2013) (ii) total equity to total asset (CP) (Beltratti & Stulz 2009) (iii) non-performing loans to total loan (NPLL) (Klomp & Haan 2012) (iv) noninterest income to revenue (NI) (Akhigbe, Madura & Marciniak 2012) (v) return on average assets (ROAA) (Akhigbe et al. 2012) and (vi) marketable securities to total assets (MS) (Akhigbe et al. 2012). Since our data will have effects from the global financial crisis (2007-2008), we employ the Early Warning System (EWS) to capture the effects of the crisis.

METHODOLOGY

This study examines all listed banks in Malaysia for the 2000-2015 period (16 years). We chose the year 2000 because by then the repercussions of the Asian Financial Crisis in 1997 were considered minimal. Three different methods were used to measure the variables. The dependent variable, bank market risk is measured from the daily stock price using historical ES method (Alexander 2008). The independent variables, the cost and profit efficiencies were calculated using one-stage SFA model (Battese & Coelli 1995) and the EWS is measured using logit method (Li & Wang 2014). The panel data was constructed to examine the effects of the banks' efficiency, early warning systems and other determinants on bank market risk. The SFA, EWS and panel data analysis were constructed using Stata software (version 14).

EXPECTED SHORTFALL

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

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

COST EFFICIENCY

The standard cost function model is:

$$TC_i = f(y_i, w_i, \beta) + \upsilon_i + \mu_i \qquad (2)$$

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. β is a vector of the unknown technology parameters to be estimated. $\upsilon_i \sim i.i.d.N(0, \sigma^2_v)$ is a two-sided normal disturbance error term that captures the statistical noise and $u_i \sim i.i.d.N^+(0, \sigma^2_u)$ is a one-sided positive error term that captures the effects of cost inefficiency relative to the frontier. The total variance is $\upsilon^2 - \upsilon^2_v + \upsilon^2_u$. The gamma perimeter defined as $\gamma - \upsilon^2_u/(\upsilon^2_u + \upsilon^2_v)$. The parameter 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, Wang & Horncastle 2015).

Following Boucinha, Ribeiro and Weyman-Jones (2013), this study adopted (a) the translog form and (b) the intermediation approach. The translog form is the commonly used functional form in the bank efficiency literature in estimating the variable cost function as a function of input prices and outputs. The outputs were (i) total loans, y1, and (ii) other earning assets, y2, (Inter-bank funds, investment securities, and other investments) and the inputs were (i) price of labour (wl) measured as personnel expenses divided by the total assets, (ii) price of physical capital (wk) measured by operating expenses minus personnel expenses divided by fixed assets, and (iii) price of funds (wf) measured as total interest expenses divided by total funding (Srairi 2010). To satisfy linear homogeneity at input prices, all variables were normalized by the price of capital.

The translog cost function model is:

$$LnTC_i = \beta_0 + \Sigma^2_{s=1}\beta_s \ln y_{s,t} + \Sigma^2_{j=1}\beta_j \ln y_{j,i} + 1/2[\Sigma^2_{s=1}\Sigma^2_{r=1}\beta_{sr} \ln y_{s,t} \ln y_{r,i} + \Sigma^2_{j=1}\Sigma^2_{k=1}\beta_{jk} \ln w_{j,i} \ln w_{k,i}] + \Sigma^2_{s=1}\Sigma^2_{r=1}\beta_{sj} \ln y_{s,t} \ln w_{j,i} + \upsilon_i + \mu_i \quad (3)$$

Symmetry restrictions are required, i.e. $\beta_{sr} = \beta_{rz}$ and $\beta_{jk} = \beta_{kj}$. The cost function model is homogeneous of degree one in input prices. It must satisfy the additional restrictions:

$$\Sigma_j \beta_j = 1, \Sigma^k{}_j \beta_{jk} = \Sigma^j{}_s \beta_{sj} = 0$$

This study was limited to examining the technical inefficiency assuming the banks are fully efficient in allocative efficiency. This assumption was made as the banking firm had a unique production mix.

ALTERNATIVE PROFIT EFFICIENCY

As indicated by Berger and Mester (1997), the alternative profit efficiency (PE) is chosen to measure the profit efficiency. The dependent variable is $PE_i = \ln (PF_i + \theta)$, where PF_i is the profit before tax of the *i*-th bank. The term $\theta = |PF_i^{min}| + 1$ indicates the absolute minimum value of net profits over all banks in each year plus 1. The term 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 = exponential $(-u_i)$. The efficiency scores take a value between zero and one with the value closer to one representing the most efficient bank. This study use the Stata code written by Kumbhakar et al. (2015) and modified it based on the model constructed.

EARLY WARNING SYSTEMS

Studies have employed various models to model the banking crisis. The model ranges from dummy variables, credit default swap (CDS) prices to logistic regression method to identify banking crisis. The issues usually arise regarding which model is suited to the model banking crisis. Demirguc-Kunt and Detragiache (1998) combined both the qualitative approach with quantitative measures to model banking crisis. According to the authors banking crisis occurs in a situation when at least one of the four following conditions transpires; (i) the nonperforming loans ratio is greater than ten percent, (ii) the cost of rescue operation is at least two percent of GDP, (iii) large scale of banks nationalisation, and (iv) extensive bank runs that lead to emergency measures. In the Malaysian scenario, the second to fourth conditions did not occur. We therefore apply the first condition of non-performing loans ratio being greater than ten percent as the condition for crisis as stated by the authors. The dependent variable will take the value of zero when there is no crisis and the value of one when there is a crisis.

Since there are many ways to model banking crisis, this study uses the logistic regression method suggested by Demirguc-Kunt and Detragiache (1998) to capture the information concerning banking crisis. We used financial ratios that correspond to the CAMEL rating system as the explanatory variables for the banking crisis (Rozzani & Rahman 2013). The CAMEL rating system was developed as the supervisory tool to monitor the performance and soundness of the banking industry. The CAMEL is the acronym for Capital adequacy, Asset quality, Management capacity, Earnings power and Liquidity position (Lopez 1999). The ratio for; (a) Capital adequacy - Equity to Total Assets (Lin & Yang 2016), (b) Asset quality - Loan Loss Reserves to Gross Loans (Betz et al. 2014), (c) Management capacity - Return On Average Equity (Betz et al. 2014), (d) Earnings power - Return on Average Assets (Lin & Yang 2016), (e) Liquidity position - (i) Net Loans to Total Assets and (ii) Liquid Assets to Total Debt Liabilities (Arena 2008), and (f) asset size – natural logarithm of total assets (Lanine & Vennet 2006).

Based on the review above, this study formulates the equation below for the EWS

$$\ln \frac{\hat{p}_{Crisis}}{1-\hat{p}_{Crisis}} = \hat{C} + \hat{a}_1 ETA + \hat{a}_2 LLRGL + \hat{a}_3 ROAE + \hat{a}_4 ROAA + \hat{a}_5 NLTA + \hat{a}_6 LATDL + \hat{a}_7 \ln SZ + \varepsilon \quad (4)$$

Where, $\hat{p}_{Crisis}$ denotes the estimated probability of crisis. $\hat{C}$ is constant, $\hat{a}_i$, i = 1 to 7, are unknown parameters and ε is the error term.

BANK MARKET RISK MODEL

To examine the effects of efficiency on market risk, the dependent variable (bank market risk measured using Expected Shortfall) was regressed against the independent variables (efficiency, EWS and other market risk determinants) using yearly cross-section data or also known as panel data. The micro panel data was in accordance with the calendar year or bank financial year reports (Beccalli, Casu & Girardone 2006).

Following De Haan and Poghosyan (2012) and Papadamou and Tzivinikos (2013), the proposed model is;

$$ES_{it} = b_0 + b_1EF_{it} + b_2EWS_{it} + b_3 \ln SZ_{it} + b_4 \ln CP_{it} + b_5NPLL_{it} + b_6 \ln Nl_{it} + b_7ROAA_{it} + b_8 \ln MS_{it} + \epsilon_{it} \quad (5)$$

Where ES = Expected Shortfall, EF = Efficiency (Cost/Profit), EWS = Early Warning System, SZ = natural logarithm of total assets, CP = total equity to total assets, NPLL = nonperforming loan to total loan, NI = noninterest income to revenue, ROAA = Return on Average Assets and MS = marketable securities to total assets. Based on the equation (5), this study produced two models to examine the effects. These were; (i) ES - Cost Efficiency, and (ii) ES - Profit Efficiency.

In this study which used panel data techniques, there were three competing models in the panel data; (i) pooled OLS, (ii) random effects and (iii) fixed effects model. Three tests were 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. Poolability F-Test is initially used to test whether the fixed effects model should be favoured instead of the pooled OLS model. Then the Breusch-Pagan LM test was used to determine whether the random effects should be favoured instead of the pooled OLS. If the fixed effects and the random effects model both outperformed the pooled OLS, then the Hausman's specification test would be used to select which model to be favoured.

DATA DESCRIPTION

The banks' financial data were collected from the Bankscope database from 2000 to 2015. The banks' annual reports were used when data were unavailable or for cross-references. The daily stock price was collected from the Wall Street Journal (WSJ) website. The variable definitions are summarized in Appendix 1 and Appendix 2 presents descriptive statistics of variables.

RESULTS

EFFICIENCY

Table 1 reports the stochastic translog cost and profit parameter estimates. Overall, the estimation results show good fit and the signs of most variables conform to the theory. First, from 14 variables used as regressors in cost and profit models, eight regressors were statistically significant, respectively. Second, the value of the log-likelihood functions estimates was high (161.605 for cost and 31.034 for profit) and statistically significant at the 1% level. Third, the sigma-squared was significant at 1% level for both models which indicated highly significant parameter estimates. In addition, the high gamma in cost and profit models (0.913, 0.852) indicated the existence of the inefficiencies.

From the estimations, the coefficients of the two outputs (total loans and other earning assets) and the two inputs (price of labour and price of funds) show a positive and significant sign. This means that increase in outputs and inputs generate higher costs and profits. These findings are in line with Srairi (2010). The different signs for the regressors coefficients in both models indicate that the regressors effect the cost and profit models accordingly.

EARLY WARNING SYSTEMS

Table 2 reports the estimation results from the logit model for the probability of default. The probability

TABLE 1. Estimation results for the cost and profit models

Variables	Parameters	CE	PE
Constant	β_0	3.692	5.063
		(0.427)	(0.908)
ln $y1$	β_1	0.841***	0.916***
		(0.148)	(0.266)
ln $y2$	β_2	0.273**	-0.013
		(0.144)	(0.244)
ln wl	β_l	0.555***	0.059
		(0.172)	(0.380)
ln wf	β_f	0.188	0.738**
		(0.148)	(0.317)
ln $y1$ ln $y1$	β_{11}	0.049	0.486***
		(0.055)	(0.111)
ln $y2$ ln $y2$	β_{22}	0.113***	0.202***
		(0.024)	(0.064)
ln $y1$ ln $y2$	β_{12}	-0.094***	-0.283***
		(0.035)	(0.082)
ln wl ln wl	β_{ll}	0.204***	-0.459***
		(0.058)	(0.125)
ln wf ln wf	β_{ff}	0.177***	-0.606***
		(0.059)	(0.126)
ln wl ln wf	β_{1f}	-0.227***	0.497***
		(0.056)	(0.122)
ln $y1$ ln wl	β_{1l}	0.063	0.088
		(0.043)	(0.080)
ln $y1$ ln wf	β_{1f}	-0.016	0.035
		(0.039)	(0.080)
ln $y2$ ln wl	β_{zl}	-0.016	0.026
		(0.044)	(0.081)
ln $y2$ ln wf	β_{zf}	0.001	-0.044
		(0.043)	(0.089)
Log-likelihood		161.605	31.034
Variance	$\sigma^2(\omega) =$	0.021***	0.081***
components:		(0.004)	(0.022)
	$\sigma^2(\omega) =$	0.002***	0.014**
		(0.001)	(0.005)
Gamma perimeter		0.913	0.852
Likelihood Ratio test of the one-sided error		14.516***	8.271***

Standard Error in parentheses
*** Significant level at 1%; ** Significant level at 5% and * Significant level at 10%

of crisis increases significantly with the increase in (a) Loan Loss Reserve to Gross Loans - LLRGL (1%) and (b) Total Assets - SZ (1%). Whereas it reduces the probability significantly with the increase in the Returns on Average Assets - ROAA (10%). 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 μ^2 of 0.686.

TABLE 2. EWS logit model results

Variables	Parameters	Malaysia
Constant	$\hat{C}$	11.546 (7.483)
ETA	$\hat{a}_1$	-0.108 (0.131)
LLRGL	$\hat{a}_2$	1.590*** (0.329)
ROAE	$\hat{a}_3$	0.235 (0.160)
ROAA	a_4	-4.142* (2.187)
NLTA	a_5	-0.032 (0.050)
LATDL	$\hat{a}_6$	0.041 (0.043)
Ln SZ	$\hat{a}_7$	-1.554*** (0.569)
Pseudo R^2		0.686

Standard Error in parentheses
*** Significant level at 1%; ** Significant level at 5% and * Significant level at 10%

BANK MARKET RISK

Figure 1 shows the average bank market risk measured using Expected Shortfall. From the graph, it shows that the average bank market risk is fluctuating and in decreasing trend throughout the sample period. The highest recorded losses are 7.32% in 2001 (global economic slowdown). The second highest losses for Malaysia is in 2008 at 5.73% (global financial crisis). The results showed that Malaysian banks were more resilient from the repercussion of the global financial crisis in 2008 eliciting lesser losses compared to the impact of the global economic slowdown in 2001.

From the bank market risk model, we estimated three-panel data models: (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 were conducted to select the best model from the panel data. From the tests, the Poolability F-Test and Hausman's specification test were significant for ES - Cost Efficiency model, thus the test preferred the fixed effect (see Appendix 3). For ES - Profit Efficiency model, only the Poolability F-Test was significant, resulting in the Pooled OLS model being preferred (see Appendix 4). The preferred models are summarized in Table 3.

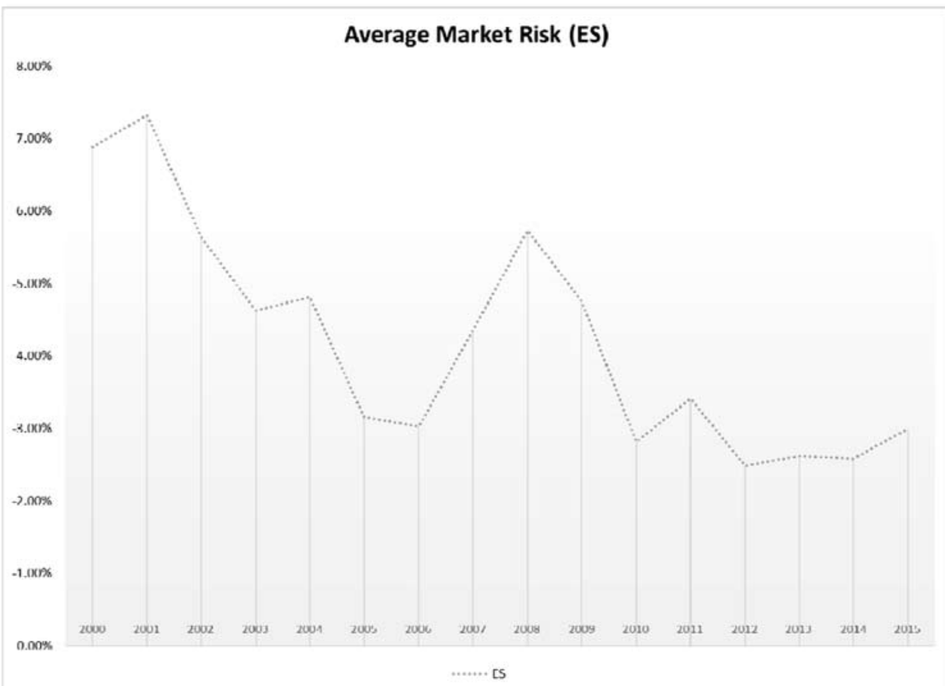

FIGURE 1. Average bank market risk (expected shortfall)

TABLE 3. Preferred bank market risk model

Variables	Parameters	ES - Cost Efficiency (FE)	ES - Profit Efficiency (POLS)
Constant	b_0	-0.298	-0.098
Efficiency	b_1	0.048*	0.026*
EWS	b_2	-0.009	-0.000
Ln SZ	b_3	0.020***	0.004**
CP	b_4	-0.022	-0.068
NPLL	b_5	0.008	-0.120***
NI	b_6	-0.004	0.000
ROAA	b_7	-0.250	-0.319*
MS	b_8	-0.026	-0.001

Note: *** Significant level at 1%; ** Significant level at 5% and * Significant level at 10%

The cost and profit efficiencies shown in Table 3 are significant at 10% and positive for both models. The increase in cost efficiency leads to increase in bank market risk. This could be due to the heavily regulated and competitive nature of the banking system. To stay competitive, banks must offer products and services that are comparable to those of other competitors. The bank also could not easily increase their margin due to the heavily regulated industry and must keep the product cost to a minimum level. To achieve this, the bank may reduce the number of resources allocated to underwriting and risk management practices. Although the reduction in resource allocation increases the cost efficiency, it also increases the bank market risk. This result is in line with findings by Mohd Said et al. (2008) and corroborated the skimping hypothesis proposed by Berger and DeYoung (1997).

As for the positive sign in profit efficiency, the higher the profit efficiency, the higher the market risk. This could be due to the bank, embarking on profit orientated initiatives, offering high-risk financial products while simultaneously leveraging the trading portfolios. The initiatives increased the exposure to bank market risk. The results are in line with findings by Saeed and Izzeldin (2016).

The size of banks is also significant at 1% and positive for both models. As for bank size, the larger the bank, the more prone it becomes to higher market risk. Thus, the increase in bank size will increase the market risk. The coefficients for non-performing loans and return on assets are negative and significant for the profit model (1% and 10%, respectively). For returns on asset, as the revenue derived from the business operations increase, will reduce the bank market risk exposure. This finding supports the study by Srairi (2013) who reported that the return on asset shows a strong and negative association with bank risk. For non-performing loans, the increase in loan loss provisions resulting from the increase in such loans could be an indicator for the bank's risk management activities during a crisis. When the bank management engages in risk management initiatives, it curbs the bank exposure to risk and thus reduces the market risk (Athanasoglou, Brissimis & Delis 2008).

MANAGERIAL IMPLICATION

From the cost efficiency findings, we conjecture that Malaysian banks are embarking on the skimping practices. The skimping hypothesis explains the scenario when banks reduce the number of resources allocated to underwriting, monitoring, and controlling the loans. Although this reduction increases the cost efficiency in the short run, it however leads to increases in risk in the future. This result could assist bank supervisors to focus on bank improvements in underwriting practices and risk management activities in order to reduce skimping practices.

CONCLUSION

The management of bank market risk has become one of the banking supervisors' priority. One lesson learned from the global financial crisis is that bank market risk must be monitored and controlled constantly so that the loss which occurred does not spread frenetically to other banks. Although BNM has successfully affected improvement on the banks by making them more efficient and resilient, the findings could be used by bank supervisors to further establish management tools that focus on controlling market risk and efficiency initiatives. This study fills the gap in the literature by empirically examining the effects of efficiency using Stochastic Frontier Analysis (SFA) cost and profit efficiencies on bank market risk.

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APPENDIX

APPENDIX 1. Variables description

Variable	Description
Efficiency (SFA) Model	
Cost	Total Interest Expense + Total Noninterest Expenses
Profit	Profit before tax
y1	Total Loans
y2	Other Earning Assets (Inter-bank funds, investment securities, and other investments)
price of labour (wl)	Personnel Expenses / Total Assets
price of physical capital (wk)	Other Operating Expenses / Fixed Assets
price of funds (wf)	Total Interest Expense / Deposits & Short-term funding
Early Warning System (Logit) Model	
Capital adequacy	Equity to Total Assets
Asset quality	Loan Loss Reserves to Gross Loans
Management capacity	Return on Average Equity
Earnings power	Return on Average Assets
Liquidity position	Net Loans to Total Assets
	Liquid Assets to Total Debt Liabilities
Bank Market Risk (Panel Model)	
ES	Market Risk measured using Expected Shortfall
EF	Cost and Profit Efficiencies estimated using SFA
EWS	Early Warning Systems measured using logit
SZ	Size - Natural Log of Total Assets
CP	Capital - Total equity / Total Assets
NPLL	Nonperforming Loan - Nonperforming Loan / Total Loan
NI	Noninterest Income - Noninterest Income / Revenue
ROAA	Return on Average Assets
MS	Marketable Securities - Marketable Securities / Total Assets

APPENDIX 2. Descriptive statistics

Variables	Obs.	Mean	Standard Deviation
Bank Size	10	51736	15568
Efficiency (SFA) Model			
Cost (Mil)	183	4129.1	4109.4
Profit (Mil)	183	1504.0	1846.8
Total loans (Mil)	183	67037.4	84666.1
Other Earning Assets (Mil)	183	25692.5	29015.6
price of labour (wl)	183	0.007	0.002
price of physical capital (wk)	183	1.277	0.841
price of funds (wf)	183	0.033	0.015
Early Warning System (Logit) Model			
Capital adequacy	171	9.034	3.324
Asset Quality	171	4.562	3.216
Management capacity	171	12.069	14.066
Earnings power	171	0.956	0.936
Liquidity (Net Loans/ Total Assets)	171	59.844	10.301
Liquidity (Liquid Assets/ Total Debt Liabilities)	171	24.446	9.927
Bank Market Risk (Panel Model)			
ES	146	-0.040	0.019
EF (Cost)	146	0.895	0.067
EF (Profit)	146	0.812	0.102
EWS	146	0.316	0.403
SZ	146	11.298	0.933
CP	146	0.089	0.028
NPLL	146	0.076	0.066
NI	146	0.348	0.128
ROAA	146	0.009	0.009
MS	146	0.196	0.070

APPENDIX 3. ES - Cost Efficiency panel models

Variables	Parameters	Pooled OLS	Fixed Effect	Random Effect
Constant	b_0	-0.094	-0.298	-0.134
		(0.031)	(0.049)	(0.035)
CE	b_1	0.032	0.048*	0.041**
		(0.021)	(0.026)	(0.022)
EWS	b_2	-0.001	-0.009	-0.002
		(0.007)	(0.007)	(0.007)
Ln SZ	b_3	0.004**	0.020***	0.006***
		(0.001)	(0.003)	(0.002)
CP	b_4	-0.081	-0.022	-0.079
		(0.056)	(0.061)	(0.057)
NPLL	b_5	-0.122***	0.008	-0.096**
		(0.042)	(0.048)	(0.043)
NI	b_6	-0.003	-0.004	-0.000
		(0.013)	(0.015)	(0.014)
ROAA	b_7	-0.235	-0.250	-0.236
		(0.174)	(0.163)	(0.170)
MS	b_8	-0.004	-0.026	-0.009
		(0.021)	(0.033)	(0.023)
Poolability F-Test			F(9, 128) = 3.74***	
Breusch-Pagan LM test			chibar2(01) = 0.48	
Hausman's specification test			chi2(8) = 20.74***	

Standard Error in parenthesis
*** Significant level at 1%; ** Significant level at 5% and * Significant level at 10%

APPENDIX 3. ES - Profit Efficiency panel model

Variables	Parameters	Pooled OLS	Fixed Effect	Random Effect
Constant	b_0	-0.098	-0.274	-0.171
		(0.031)	(0.049)	(0.040)
PE	b_1	0.026*	0.007	0.018
		(0.014)	(0.019)	(0.017)
EWS	b_2	-0.000	-0.007	-0.003
		(0.007)	(0.007)	(0.007)
Ln SZ	b_3	0.004**	0.020***	0.011***
		(0.002)	(0.003)	(0.002)
CP	b_4	-0.068	0.017	-0.034
		(0.055)	(0.057)	(0.056)
NPLL	b_5	-0.120***	0.001	-0.071
		(0.042)	(0.050)	(0.046)
NI	b_6	0.000	-0.001	0.000
		(0.013)	(0.015)	(0.014)
ROAA	b_7	-0.319*	-0.286	-0.301
		(0.184)	(0.184)	(0.184)
MS	b_8	-0.001	0.004	0.002
		(0.021)	(0.028)	(0.025)
Poolability F-Test			F(9, 128) = 3.21***	
Breusch-Pagan LM test			chibar2(01) = 0.03	
Hausman's specification test			chi2(8) = 13.02***	

Standard Error in parenthesis
*** Significant level at 1%; ** Significant level at 5% and * Significant level at 10%