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THREE-FACTOR CAPM RISK EXPOSURES: SOME EVIDENCE FROM MALAYSIAN COMMERCIAL BANKS

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ABSTRACT

This study investigates the determinants of the three-factor capital asset pricing model (CAPM) risk exposures in the case of commercial banks. Five risk exposures are examined namely, market, interest rate, exchange rate, total, and unsystematic risk exposures. Our findings provide four major contributions. First, we find that different types of risk exposures have different determinants. Second, the market risk exposure for the Islamic bank in our study is lower than for conventional banks. Third, the merger programme is fruitful because it reduces the interest rate risk exposure, total risk exposure, and unsystematic risk exposure. Finally, our results show that the banks under study have higher total and unsystematic risk exposures during the 1997 Asian financial crisis. Thus, a clear understanding of this evidence helps in ensuring effective and successful decision-making for regulators, policy makers and market players.

Keywords: banking, risk, merger, financial crisis

INTRODUCTION

Research found in banking literature has increasingly focused on risk exposure since the 1997 Asian financial crisis. In fact, risk exposure has become one of the most important factors in surviving the current, ongoing global economic crisis. Although the scope of risk is vast, many studies focus on market, interest rate, and foreign exchange rate risk exposure, as they are considered risks that can be monitored, measured, and minimised with proper management. Among others, one way to assess these risks is by using the three-factor capital asset pricing model (CAPM), which evolved from the single-factor CAPM originally developed by Sharpe (1964). Sharpe finds that the sensitivity to stock market

return can determine asset pricing. However, Ross (1976) shows that stock market return is not the only factor. Ross's arbitrage pricing theory (APT) demonstrates that multiple factors significantly affect asset pricing. For the banking sector, interest rate serves as the other established significant factor (Stone, 1974; Martin & Keown, 1977; Brooth & Officer, 1985; Flannery & James, 1984; Chance & Lane, 1980; Lynge & Zumwalt 1980; Jahankhani & Lynge, 1980; Bae, 1990; and Lloyd & Shick, 1997). As financial globalisation unfolds, a few studies have found that the exchange rate is another significant factor (Chamberlain et al., 1997; Hahm, 2004; Francis & Hunter, 2004; Wong et al., 2009; and Yong et al., 2009). Even though studies from developed countries (Jianping & Saunders, 1995; Jianping & Ahyee, 1994; Allen et al., 1995; He et al., 1996; and Lausberg, 2001) show that real estate investment return is another factor, it is not significant for emerging countries, as real estate investment is still at an early stage. Hence, market, interest rate, and exchange rate risk exposures appear to be the significant factors in determining asset pricing for the Malaysian banking sector.

It is important to take note that Malaysia applies a dual banking system in which both conventional and Islamic banking products are offered to the same customers. Hence, the customers are left with two choices in selecting which banks they use to meet their banking needs. Their decisions may be influenced by the risk exposures faced by the banks. To some extent, those risk exposures depend on the background information of the banking systems. For the Islamic banking industry, the first full-fledge Islamic bank was established in 1983, known as Bank Islam Malaysia Bhd. (BIMB). It was given a monopoly status for ten years to strengthen its position before the central bank allowed other Islamic banks or windows to emerge in 1993. The Islamic banks are governed by the Islamic Banking Act 1983 (IBA). As of January 2010, there are seventeen Islamic banks, but only BIMB is listed in the Malaysia stock exchange. Meanwhile, the conventional banking system began in Malaysia prior to its independence and is governed by the Banking and Financial Institutions Act 1989 (BAFIA). In 1990, there were 22 local and 16 foreign banks altogether. In order to encourage sustainability in the face of financial liberalisation, the Malaysian central bank launched a consolidation programme in the late 1990s. As of January 2010, there are 10 local and 13 foreign banks. Out of these, only 10 are listed in the stock exchange. As the estimation for CAPM risk requires data on stock returns, this study uses data comprising all 11 bank-holding companies listed in the stock exchange.

As burgeoning studies in this area centre on developed countries, research on the Islamic banking industry is still relatively scarce. Most attention is given either to conceptual frameworks or the macro-economic context. Many studies simply presume that the behavioural attributes of Islamic banks are

similar to conventional banks. However, the fact that both banking systems have different objectives, undergo different operational processes, and are bound by different regulatory acts, it is unfair to generalise such findings. Indeed, Rahman et al. (2009, 2008) show that the insolvency risk behaviour of Islamic banks is different from conventional banks. Thus, the aim of this study is to investigate the determinants of three-factor CAPM risk measures for Malaysian commercial banks while at the same time acknowledging the different risk level of the Islamic banking industry.

The contributions of this study are at least three-fold. Firstly, we evaluate various risk exposures uniquely for the case of emerging markets like Malaysia. Studying emerging markets is crucial, as there is no conclusive evidence indicating the similarity of risk behaviour between emerging and developed countries. On the one hand, Simpson (2002) finds that e-commerce risk, efficiency, and rate of progress are significantly different between emerging and developed countries. On the other hand, Joyce and Nabar (2009) show that global economic crisis and financial liberalisation cause emerging economies to be susceptible to the "sudden stops" on domestic investment due to the systemic banking crisis from the developed countries, thereby suggesting similarities between the two markets. In addition, as there are various types of bank risk exposures (e.g., insolvency risk, subordinated debt implied risk, credit risk, liquidity risk, and operational risk), we investigate the determinants of three-factor CAPM risk namely, market risk, interest rate risk, foreign exchange rate risk, unsystematic risk, and total risk exposure. Most prior CAPM research examines the macro-economic factors affecting the asset pricing of the banking industry, but it does not investigate the micro-economic features that may affect the risk exposure of dynamic macro-economic factors. Finally, we also investigate the different risk behaviour of the Islamic banking system.

The remainder of this paper is organised as follows: Section 2 outlines a review of the literature on risk determinants, and section 3 highlights the data and methodology. Section 4 reports the findings, and section 5 provides conclusion.

LITERATURE REVIEW

There are an enormous number of empirical studies on bank risk exposure. Whereas Madura et al. (1994) and Ahmad and Ariff (2004) observe the determinants of risk exposure *per se*, Saunders et al. (1990), Anderson and Fraser (2000), Konishi and Yasuda (2004), Hassan (1993), Cebeyonan and Strahan (2004), Gallo et al. (1996), Brewer et al. (1996), Gonzales (2004), Marco and Fernandez (2008), Lepetit et al. (2008), and Yong, Faff and Chalmers (2009) investigate various issues of bank risk exposure either in single-country or single-

region studies. There are some cross-country studies in this area, such as Dinger (2009), Laeven and Levine (2009), and Angkinand and Wihlborg (2009). Whereas single-country research includes bank-specific variables (BSV), cross-country research often includes BSV and country-specific variables (CSV) as control variables.

Madura et al. (1994) examine the determinants of the US-implied risk exposure of deposit-taking institutions and commercial banks. Their findings for depository institutions are not consistent with their findings for commercial banks. With regards to depository institutions, real estate financing, real estate owned, and level of capital buffer are the significant determinants. Meanwhile, for commercial banks, the significant factors are real estate owned and capital buffer. In another study, Ahmad & Ariff (2004) investigate the factors affecting the risk exposure of Malaysian deposit-taking institutions using a single-factor CAPM. Unlike Madura et al. (1994), they do not separately study commercial banks. Their findings show that the determinants for market risk exposure include loan default, cost of funds, loan expansion, and loan concentration. Meanwhile, the determinants for unsystematic risk include loan default, cost of funds, and short-term interest rate.

Studying how ownership structure affects US bank risk exposure, Saunders et al. (1990) incorporate equity capital, fixed asset, and size as BSV. They develop seven risk exposures based on a two-factor CAPM.[1] Their findings reveal that the BSV differently affect the seven types of risk exposure. One of their interesting findings is that size is positively related to the market risk but negatively related to the interest rate risk exposure. The underlying reason for this conflicting result is that larger banks tend to be sensitive to market movements, but at the same time, they are more able to diversify their interest rate risk exposure.

Studying a similar issue, Anderson and Fraser (2000) estimate the single-factor CAPM risk measure and insert an additional BSV, known as *frequency*.[2] They argue that *frequency* represents the level of business risk exposure, as it

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[1] The risk measures include 1) total risk, 2) unsystematic risk for short-term interest rate, 3) unsystematic risk for long-term interest rate, 4) market risk for short-term interest rate, 5) market risk for long-term interest rate, 6) short-term interest rate, and 7) long-term interest rate risk exposure.
The independent variables include 1) ownership structure (i.e., the proportion of stock held by managers), 2) financial leverage [Capital/Total Asset (TA)], 3) operating leverage [Fixed Asset/Total Asset (FA/TA)], and 4) size (TA).

[2] The single-factor CAPM risk measures may be total risk, unsystematic risk, and systematic risk exposures (i.e., total risk minus unsystematic risk exposures). *Frequency* is defined as the ratio of an average daily share volume traded to number of shares outstanding.

denotes the speed at which new information is captured in the stock price and is correlated to variances in bank balance-sheet and off-balance-sheet portfolios. Their findings show that size is negatively related to total risk but positively related to systematic risk; meanwhile, *frequency* is positively related to both total and systematic risks.

Whereas Saunders et al. (1990) and Anderson and Fraser (2000) analyse the case of US, Konishi and Yasuda (2004) and Marco and Fernandez (2008) present comparable studies for the cases of Japan and Spanish, respectively. Their studies add value to an existing gap in the literature with respect to risk measurements.[3] Whereas Konishi and Yasuda (2004) reveal that size and capital buffer are significantly related to the two-factor CAPM and insolvency risk exposures, Marco and Fernandez (2008) show that size, profitability, and business types are significantly related to insolvency risk exposure. Regarding cross-country research, Laeven and Levine (2009) and Angkinand and Wihlborg (2009) find that size, credit quality, capital buffer, liquidity ratio, Gross Domestic Product (GDP) growth, inflation, and interest rate are significantly related to credit and insolvency risk exposures.

Examining the impact of mutual fund investments on US bank risk exposure, Gallo et al. (1996) incorporate loan expansion, capital buffer, short-term investment securities, and size as BSV. Estimating market and industry risk exposures using the single-factor CAPM, they find that loan expansion is significant for market and industry risk exposures, whereas short-term investment securities are significant for industry risk exposure.

Looking into the impact of income structure on European banks risk exposure, Lepetit et al. (2008) include size, capital buffer, profitability, loan expansion, and cost of funds as BSV. Using the single-factor CAPM and insolvency risk estimations, they find that size and capital buffer are significant BSV.

Investigating how off-balance sheet activities affect bank risk, Hassan (1993), Cebeyonan & Strahan (2004), and Yong et al. (2009) find that credit expansion, credit quality, lending structure, cost of funds, Gap analysis, liquidity ratio, capital buffer, and size are significant BSV. Hassan (1993) investigates the

[3] Konishi and Yasuda (2004) analyse CAPM and insolvency risk whereas Marco and Fernandez (2008) only focus on the insolvency risk exposure. The two-factor CAPM risk exposures include 1) total risk, 2) unsystematic risk for the short-term interest rate, 3) unsystematic risk for the long-term interest rate, 4) market risk exposure for the short-term interest rate, 5) market risk exposure for the long-term interest rate, 6) systematic risk exposure for the short-term interest rate, and 7) systematic risk exposure for the long-term interest rate. The insolvency risk exposure is the *Z* risk score.

impact of loan sales on US bank risk exposures based on the single-factor CAPM and subordinated debt models.[4] In contrast to Hassan (1993), Cebenoyan and Strahan (2004) evaluate the loan sales-risk relationship based on financial ratios.[5] Meanwhile, Yong et al. (2009) study the impact of derivative activities on risk based on the three-factor CAPM approach.

DATA AND METHODOLOGY

This study adopts Generalised Least Squares (GLS) unbalanced panel regression estimation. Three models are tested namely, pooled effect, fixed effect, and random effect models. The best model is selected based on the Likelihood Ratio and Hausman tests.[6] To address heteroskedasticity, cross-section weighting is used in the GLS estimation. Following Shahimi (2006) and Zakaria (2007), the first-order autocorrelation problem is addressed based on the Park's model. The data are comprised of all 11 listed commercial bank-holding companies in Malaysia for 1994–2006. Table 1 displays the list of bank-holding companies, the sampling period, and the completed merger period. The period from 2007 to 2009 are excluded due to the volatile market resulting from the food crisis, the oil price crisis, and the US subprime crisis. The research design in this study is as follows:

$$Z_{it} = a_i + \beta\chi_{it} + \gamma I_{it} + \delta Y_{it} + \phi C_{it} + \varepsilon_{it} \quad (1)$$

Note that Z is the alternate measures of the three-factor CAPM risk exposures of banks, X is a vector of BSV, I is a dummy for Islamic banking, Y are dummies for the during and post-crisis periods, C is a dummy for the post-merger period, a_i is an individual-specific intercept, and β, γ, δ, and Φ are the slope coefficients to be estimated.

The five alternate risk measures include market, interest rate, exchange rate, total, and unsystematic risk exposures. (Detailed specifications of these risks are discussed in the following subsection). We analyse the risk behaviour of the Islamic banking industry using a dummy variable called DISLAM (Islamic bank = 1; conventional banks = 0).[7] We also take into account the financial crisis and

[4] Please refer to Hassan (1993) for a detailed explanation of the implied asset subordinated debt models.

[5] The four risk measures are 1) $\sigma_{ROE,}$ 2) σ_{ROA}, 3) $\sigma_{LLP./TL}$, and 4) $\sigma_{npl/TL.}$

[6] Please refer to Beaver et al. (1989), Hsio (2002), Gujarati (2003), Shahimi (2006), and Zakaria (2007) for further details on panel data regression techniques.

[7] The Islamic bank's stock return is based on the stock prices of BIMB. As the majority of Islamic banks are small and do not trade in Bursa Malaysia, BIMB is the only available sample representing the Islamic banking industry in Malaysia. We cannot consider Islamic banking

consolidation effect during the period of study using the variables DCRISIS (year 1997 and 1998), DPOST-CRISIS (year 1999 to 2006), and DMERGER (post merger = 1; pre-merger = 0). Most of the completed merger periods are either in year 2000 or 2001, and thus, they do not overlap with the post-crisis period.

Table 1
List of Commercial Banks: Sampling Period and Completed Merger Period

Type of Bank	Bank-Holding Company	Sampling Period	Completed Merger Period[1]
Islamic bank	Bank Islam Malaysia Bhd. (BIMB)	1994–2006	–
Conventional banks	Hong Leong Bank Bhd.	1994–2006	2000
	Malayan Banking Bhd.	1994–2006	2001
	Public Bank Bhd.	1994–2006	2001
	RHB Bhd.		2002
	Affin Bank Bhd.	1994–2006	2000
	Alliance Bank Bhd.	1994–2006	2001
	Ambank Bhd.	1994–2006	2001
	CIMB Bank Bhd.	1994–2006	2000
	EON CAP Bhd.	1994–2006	2001
	Southern Bank Bhd.	1994–2004	2001

Notes: [1]Completed merger period is based on the final merger entity as announced in the annual reports of bank-holding companies. See Said et al. (2008) for a detailed study of the evolution of banking groups and final entities after merger.

The selection of BSV in this study is closest in spirit to that of Hassan (1993), Madura et al. (1994), Ahmad and Ariff (2004), Cebeyonan and Strahan (2004), and Yong et al. (2009). (Appendix A presents a list of references that have adopted similar variables).The BSV are TL, BPS, PLL, TE, GAP, INTEXP, INV, LTA, NONII, and MGT. They are the best available proxies for loan expansion, real estate lending, loan quality, capital buffer, GAP analysis, cost of funds, liquid asset, size, non-interest income, and management efficiency, respectively.[8]

windows and other Islamic subsidiaries of domestic bank-holding companies since they are not listed in Bursa Malaysia, and hence, we do not have market prices.

[8] Appendix A lists a number of studies that have employed similar BSV. We select the best available variables for the case of Malaysia (that is, for a single-country study); thus, insignificant variables and CSV are not included in the analysis. For the case of Islamic banks, we let 1) interest expense be the sum of income distributed to depositor and shareholder fund and 2) non-interest income be the total income minus income from financing from both depositor and shareholder funds.

The expected relationships among the BSV follow from previous studies. For loan expansion, Hassan (1993), Madura et al. (1994), and Gallo et al. (1996) suggest that the illiquidity of loan and the default risk exposure are the underlying reasons for the positive relationship between TL and risk. For real estate lending, Blasko and Sinkey Jr. (2006) show that real estate lending increases the interest rate risk exposure, but Ahmad and Ariff (2004) find that risky sector lending (the majority of which comes from the real estate sector) reduces market risk exposure. Meanwhile, Rahman et al. (2008, 2009) show that real estate lending reduces the insolvency risk exposure for Islamic banks, but the reverse is true for conventional banks. Thus, the coefficient sign of BPS can be negative or positive, depending on different types of risk exposures. With regards to loan default, earlier studies hypothesise that PLL represents the probability of future default and loan quality; thus, it is expected to be positively related to risk. In the case of capital buffer, total equity is assumed to provide a cushion against loss; hence, an increase in TE can reduce the bank risk exposure. For GAP analysis, a positive GAP indicates that a particular bank is an asset-sensitive bank, whereas a negative GAP indicates that it is a liability-sensitive bank. A positive-GAP bank (that is, an asset-sensitive bank) is exposed to the risk that an interest rate will fall, whereas a negative-GAP bank (that is, a liability-sensitive bank) is exposed to the risk that an interest rate will increase. Thus, the greater the absolute value of GAP is, the more the bank is exposed to changes in the interest rate. Despite GAP analysis, Madura et al. (1994) argue that bank risk depends on the proportion of funds obtained in the deposit account as measured by interest expense, which is not captured in GAP analysis. They hypothesise that the higher the deposit is, the higher the interest expense and the volatility of net interest income are; thus, the bank is riskier. For the case of INV, it is linked to risk from the perspective of deposit withdrawal. Maintaining idle cash is an opportunity cost to banks, and thus, banks hold short-term investment securities to standby the need for extraordinary deposit withdrawal, suggesting a negative association between INV and risk. With regards to size, Saunders et al. (1990) and Hassan (1993) argue that the greater the size, the greater the potential to diversify business risk, thereby reducing bank risk exposure. However, Anderson and Fraser (2000) suggest that the impact of size on risk depends on the lending structure. If the loan composition is the same, larger banks should have lower risk as compared to smaller banks. Nonetheless, if the loan structure is different, a larger bank may have higher risk exposure than a smaller one due to its tendency to embark into riskier lending sectors that can yield higher returns. Similarly, Gonzales (2004) mentions that with the existence of the economy of scale, increased market power, and "too big to fail" policies for big banks, a larger bank tends to enter into risky activities either through lending strategies or off-balance sheet activities. Against this background, size can be positively or negatively related to risk exposure. For the case of non-financing activities, Madura et al. (1994) offer evidence that diversifying from the traditional role banking (that is,

providing loans) reduces bank risk exposure. With regards to management efficiency, Angbazo (1997) and Ahmad and Ariff (2003, 2004) believe that the increasing efficiency of management reduces bank risk exposure. With regards to Islamic banking, even though most of the Islamic banking research conceptually highlights the additional risk exposure faced by the Islamic bank, this heightened risk exposure has not yet been empirically tested. Considering this, DISLAM can be positive or negative, depending on the development stage. For the crisis dummies, risk exposures are expected to be higher during the crisis period but may be higher or lower during the post-crisis period, depending on the recovery process. Finally, if the benefit of bank consolidation indeed materialised, DMERGER is expected to be negative.

SPECIFICATION FOR THREE-FACTOR CAPM RISK EXPOSURES

Our three-factor CAPM risk measure is akin to that employed by Hahm (2004), Francis & Hunter (2004), Wong et al. (2009), and Yong et al. (2009). It is expressed as follows:

$$R_t = \alpha + \beta_m (R_{mt}) + \beta_i (R_{it}) + \beta_{forex} (R_{forex}) + \varepsilon_t \quad (2)$$

Note that:

R_t = daily stock return of bank-holding companies during a one-year period.
R_{mt} = daily Kuala Lumpur Composite Index (KLCI) market return during a one-year period.
R_{it} = daily Malaysian Government Securities (MGS) 10-year return during a one-year period.[9]
R_{forext} = daily nominal effective exchange rate (NEER) return during a one-year period.
e_t = the error term that captures all other factors that affect bank return that are not taken into account explicitly.
α_j = the intercept of the characteristic line.

From the above equation, 5 yearly risk measures from 1994 to 2006 are estimated for 11 Malaysian bank-holding companies. The five risk exposures are:

[9] Daily return on 10-year MGS represents the long-term interest rate risk exposure during a one-year period. We also analyse the short-term interest rate risk exposure using the overnight return of Kuala Lumpur Interbank Offer Rate (KLIBOR), but our finding fails the *F*-statistic test. We suspect that is due to very insignificant daily changes in the KLIBOR overnight rate. The results for short-term interest rate risk exposure are provided upon request.

(i) Market risk exposure (β_m)
(ii) Long-term interest rate risk exposure (β_i)
(iii) Exchange rate risk exposure (β_{forex})
(iv) Unsystematic risk exposure (standard deviation of ε_t)
(v) Total risk exposure (standard deviation of R_t)

After the five risk measures are estimated, we then analyse our research design based on Equation 1 using the GLS unbalanced panel regression estimation with yearly data.

FINDINGS

The descriptive statistics as well as the correlation matrix are displayed in Tables 2 and 3, respectively. As the correlation matrix in Table 3 shows lower values than 0.8, we consider that all independent variables are not seriously correlated; hence, all variables are regressed simultaneously.[10] For the regression results, the fixed effect model appears to be the best model for all types of CAPM risk exposures.[11] Hence, the discussion in this section is based on the fixed effect model. Table 4 presents the fixed effect estimations for market, long-term interest rate, exchange rate, total, and unsystematic risk exposures.

For the case of market risk exposure, Table 4 shows that total loan expansion (TL) is the only significant factor. The positive relationship of TL is as expected and consistent with Hassan (1993), Gallo et al. (1996), Ahmad and Ariff (2003, 2004), and Gonzales (2004). For DISLAM, our results show that the Islamic banking system has lower risk exposure than the conventional banking system. A lower market risk exposure for the Islamic banking industry may be due to heavy reliance on the fixed profit rate system. Even though nowadays there is another product innovation that offers a quite similar function to a floated profit rate system (that is, the principal of *Musyarakah Mutanakisah*), its use in the market is still new and limited, and thus, its influence on market risk exposure is insignificant.

[10] Gujarati (2003) sets a cut of point of 0.8 for the correlation coefficient matrix. Values higher than 0.8 indicate that the variables are strongly correlated; thus, they should be analysed to address issues of multicollinearity.

[11] The results for the no effect model, random effect model, the Likelihood ratio test, and the Hausman test are provided upon request.

Table 2
Descriptive Statistics

Variables	Mnemonics	Mean	Std. Dev
Risk Indicator (dependent variable)			
Market Risk Exposure	KLCI	1.077	0.404
Interest Rate Risk Exposure	MGS	0.006	0.114
Exchange Rate Risk Exposure	NEER	0.013	0.561
Total Risk Exposure	TRISK	0.025	0.013
Unsystematic Risk Exposure	UNSYS	0.019	0.008
Credit-related Variables			
Ratio of Total Loans to Total Asset	TL	0.520	0.250
Ratio of Broad Property Sector to Total Loan	BPS	0.393	0.082
Ratio of Provision of Loan Loss to Total Asset	PLL	0.009	0.010
Capital-related Variables			
Ratio of Total Equity to Total Asset	TE	0.085	0.037
Interest Rate-related Variables			
Ratio of GAP to Total asset	GAP	–0.166	0.187
Ratio of Interest Expense to Total asset	INTEXP	0.031	0.014
Liquidity-related Variable			
Ratio of Short Term Investment to Total Asset	INV	0.140	0.122
Business Operation-related Variables			
Log of Total Asset	LTA	7.318	0.440
Ratio of Non-interest Income to Total Asset	NONI	0.009	0.006
Ratio of Earning Asset to Total Asset	MGT	0.852	0.101

Table 3
Correlation Matrix of Independent Variables

	TL	BPS	PLL	TE	GAP	INTEXP	INV	LTA	NONII	MGT
TL	1									
BPS	–0.040	1								
PLL	0.502	–0.085	1							
TE	–0.076	0.426	–0.122	1						
GAP	0.019	0.029	0.126	0.013	1					
INTEXP	0.321	–0.154	0.540	–0.146	0.232	1				
INV	0.309	0.022	0.231	–0.270	–0.255	0.230	1			
LTA	–0.276	–0.295	–0.185	–0.172	–0.322	–0.442	–0.054	1		

(*continued*)

Table 3 (*continued*)

	TL	BPS	PLL	TE	GAP	INTEXP	INV	LTA	NONII	MGT
NONII	–0.342	–0.056	–0.309	0.071	0.133	–0.182	–0.260	–0.125	1	
MGT	0.389	–0.017	0.189	–0.052	–0.184	0.249	0.214	–0.456	0.175	1

For the case of long-term interest rate risk exposure, INTEXP and MGT show significant effects. Consistent with prior studies, INTEXP is positively related to interest rate risk. If a bank has a large amount of interest expenses, it is exposed to greater interest rate movements, thus increasing its risk exposure. MGT is negatively related to management efficiency, suggesting that banks are efficient in managing their long-term interest rate risk exposure. For DISLAM, our result shows that the risk behaviour of the Islamic banking industry is different from the conventional banks. To the extent that Islamic banks benchmark their profit rate to the market interest rate, their interest rate risk behaviour will always be similar to that of conventional banks.

Table 4
The GLS Fixed Effect Estimation for the CAPM Risk Exposures

	Expected coefficient sign	Market risk exposure	Interest rate risk exposure[5]	Exchange rate risk exposure	Total risk exposure	Unsystematic risk exposure
		–1.772	0.332	–2.869	3.424***	2.362**
C		(–1.069)	(0.876)	(–0.415)	(2.862)	(2.088)
	+	**0.291***	0.044	–0.797	0.001	–0.023
TL		(1.698)	(0.335)	(–0.767)	(0.006)	(–0.120)
	+/–	–0.045	–0.174	0.117	–0.035	0.050
BPS		(–0.294)	(–0.992)	(0.120)	(–0.166)	(0.263)
	+	–0.032	–2.170	**0.851****	0.0178	0.019
PLL		(–0.721)	(–1.658)	(–2.258)	(0.351)	(0.382)
	–	–0.035	0.254	–0.265	**–0.109****	**–0.097****
TE		(–0.763)	(0.814)	(–0.870)	(–2.605)	(–2.244)
	+	–0.018	–0.011	**–0.362****	0.026	0.021
GAP		(–0.606)	(–0.122)	(–2.162)	(1.042)	(0.982)
	+	–0.082	**8.186*****	0.728	0.117	0.110
INTEXP		(–0.728	(3.158)	(1.363)	(1.284)	(1.282)
	–	–0.047	0.218	–0.278	**–0.081****	–0.064
INV		(–1.415)	(1.121)	(–1.384)	(–1.999)	(–1.559)
	+/–	0.129	1.035	–1.201	**–1.119*****	**–0.946*****
TA		(0.539)	(0.602)	(–1.512)	(–6.239)	(–5.551)

(*continued*)

Table 4 (*continued*)

	Expected coefficient sign	Market risk exposure	Interest rate risk exposure[5]	Exchange rate risk exposure	Total risk exposure	Unsystematic risk exposure
	–	0.044	0.003	**–0.849***	–0.078	–0.062
NONII		(0.738)	(0.126)	(–1.795	(–1.420)	(–1.310)
	+/–	–0.050	**–0.622****	–1.623	0.838	**0.906***
MGT		(–0.079)	(–2.143)	(–0.392)	(1.598)	(1.877)
	+/–	**–0.372****	–0.015	–0.206	–0.163	–0.075
DISLAM		(–2.156)	(–0.268)	(–0.299)	(–1.504)	(–0.750)
	–	0.033	**–0.058***	–0.184	**–0.004***	**–0.004*****
DMERGER		(0.686)	(–1.751)	(0.196)	**(**–1.889**)**	**(**–2.987**)**
	+	0.211		–0.176	**0.674*****	**0.477*****
DCRISIS		(1.433)		(0.404)	(6.436)	(4.730)
	+/–	0.113		–0.148	**0.435*****	**0.330*****
DPOST-CRISIS		(0.760)		(0.476)	(3.796)	(3.152)
Adj *R*-squared		0.560	0.194	0.137	0.794	0.760
Prob (*F*-Stats)		0.000	0.021	0.029	0.000	0.000
D.W. statistics		1.980	1.832	2.603	1.911	1.978

Notes:
1. The dependent variables are market, long-term interest rate, exchange rate, total, and unsystematic risk exposures.
2. Figures in parentheses are *t*-statistics.
3. ***, **, and * denotes significance at 1%, 5%, and 10% confidence levels, respectively.
4. The findings for the GLS pool effect and GLS random effect models are available upon request.

With regards to exchange rate risk exposure, our result indicates that PLL, GAP, and NONII are significant factors. The positive relationship of PLL implies that as a bank increases its provision for loan losses, its exchange rate risk exposure increases, suggesting that the Malaysian banks are vulnerable to external shock. Note that increasing PLL implies decreasing loan quality. Decreasing loan quality can be due to foreign borrowers who obtain loans denominated in foreign currency or from local borrowers whose businesses are affected by the exchange rate movement. The inverse relationship of GAP reveals that an increase in the maturity mismatch of net short-term assets or liabilities is associated with a decrease in exchange rate risk exposure. As GAP shows the net absolute position of short-term assets and liabilities, a positive-GAP bank (that is, an asset-sensitive bank) is exposed to the risk that the interest rate will fall, whereas a negative-GAP bank (or a liability-sensitive bank) is exposed to the risk that the interest rate will increase.[12] During the period of study, the increasing

[12] GAP = [net fed funds sold + trading account securities + securities maturing in less than one year + loan and leases maturing in less than one year + customer liabilities to the bank for outstanding

dependency of net short-term position on foreign denominated assets or liabilities is beneficial, as it reduces exchange rate risk exposure. However, it should be noted that risk indirectly depends on the accuracy in forecasting foreign-denominated asset pricing; thus, banks should be aware of global economic developments. Finally, the inverse relationship of NONII implies that the increasing involvement of banks in fee-based activities reduces exchange rate risk exposure, as most of the off-balance-sheet activities are self-liquidating contingencies.

Regarding total risk exposure, TE, INV, and LTA are significant variables. The negative relationships of TE and INV are as expected and consistent to prior studies. Nonetheless, the inverse relationship of LTA implies that as a bank increases its size, it reduces its total risk exposure. This finding contradicts the results given by Saunders et al. (1990), Hassan (1993), and Gonzalez (2004), but it is consistent with Anderson and Fraser (2000) and Konishi and Yasuda (2004). Recall that total risk is a summation of systematic (that is, market, interest rate, and exchange rate risk) and unsystematic risk. As our findings show that LTA is not significant for systematic risk exposure but is significant for unsystematic risk exposure. This implies that the impact of size on the total risk exposure is greatly influenced by unsystematic risk exposure. This inverse relationship implies that a larger Malaysian bank is more capable of diversifying its unsystematic risk, which then reduces its total risk exposure.

For unsystematic risk exposure, the significant factors are TE, LTA, and MGT. These variables are similar to total risk exposure, except for MGT. As total risk exposure comprises both systematic (i.e. market, interest rate, and exchange rate risk) and unsystematic risk, it can be inferred that the positive relationship between MGT and unsystematic risk exposure is offset by the negative relationship between MGT and interest rate risk exposure, which produces an insignificant relationship between MGT and total risk exposure.

CONCLUSION

This study offers four contributions. First, as different types of risk exposure have different risk determinants, market players should prioritise their risk management based on their mission and vision. If a bank takes aggressive strategies aimed at international activities, its main concern should be how to efficiently manage the determinants of exchange rate risk exposure rather than

acceptances] – [domestic and foreign deposit less than one year + CDs less than one year + other borrowed money + the bank liabilities on customer acceptances outstanding]. The absolute value of GAP is deflated by total assets.

other types of risk exposure. Second, even though our findings show that the risk behaviours of Islamic and conventional banking systems are similar for all types of risk exposure except market risk exposure, it is worth mentioning that in the upcoming years, the Islamic banking industry may behave differently as grows in number and size. With the assumption that Islamic banks would eventually based on practices different from those of conventional banks (particularly in determining the profit rate return), we believe that the determinants of the interest rate, total risk, and unsystematic risk exposures will differ greatly in the future. Third, our findings show that bank mergers seem to benefit market players, as they reduce interest rate, total, and unsystematic risk exposures. Finally, our findings provide empirical evidence suggesting that the 1997 financial crisis increased total and unsystematic risk exposures. With this in mind, policy makers as well as market players in the banking industry should be better prepared to face the ongoing global financial crisis by proactively introducing prudent risk management guidelines to prevent the Malaysian banking system from repeating the US subprime crisis.

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APPENDIX A
Independent Variables Adopted In Bank Risk Research

	Author(s) and Publication Date	Dependent Variables	Independent Variables
1	Ahmad, N. H., & Ariff, M. (2004). Key risk determinants of listed deposit-taking institutions in Malaysia. *Malaysian Management Journal, 8*(1), 6–81.	4 risk measures: β = market risk standard deviation of the error term of the regression equation = unsystematic risk standard deviation of bank return = total risk Ratio of Book Value to Market Value of equity = equity risk.	NPL/TL MGT: as in Angbazo LEV: Tier2/Total Capital (data started in year 2002) RISKY= (BPS + Purchase of securities loan + consumption credit loan) Regulatory Cap: Tier 1/TL (data started in year 2002) Interest expense PLL: Provision for Loan Loss RWA: Risk Weighted Asset IBOR: Interbank rate SPREAD: MGS rate- T-Bill GAP: (RSA-RSL)/TA Loan expansion: Loan/Deposit: Size: Log of TA
2	Madura, J., Martin, A. D., & Taylor, D. A. (1994). Determinants of implied risk of depository institutions. *Applied Financial Economics, 4*, 363–370	The ex-ante risk: using average daily implied standard deviation (ISD) of the j^{th} bank in year *t*. (followed Latane & Rendleman (1976) ISD = based on call option price. Disadvantage of ISD: since it is implied, it may be different to the actual risk of the firm.	Loan Expansion: TL/TA Real Estate Financing: RE loan/TA RE owned/TA (no data in Malaysia) Capital buffer: TE/TA PLL: PLL/TA GAP =(RSA/RSL) Interest expense/TA Non-interest income/TA
3	Saunders, A., Strock, E., & Travlos, N. G. (1990). Ownership structure, deregulation and bank risk taking. *Journal of Finance. 45*(2) June 643–654	7 risk measures: ○ σ_s = tot risk ○ σ_e^s =unsys for s/t ○ σ_e^l= unsys for l/t ○ β_m^s = sys for s/t ○ β_m^l= sys for l/t	Ownership structure - proportion of stock held by managers – expected to be (+) related to risk. Capital Buffer: TE/TA Operating Leverage –

		○ β_i^s=sys for s/t ○ β_i^l= sys for l/t	FA/TA (in significant data in Malaysia) Size –log of TA
4	Hassan, M. Kabir. (1993). Capital market tests of risk exposure of loan sales activities of large US commercial banks. *Quarterly Journal of Business and Economics*, 27–49	β= systematic risk σ= standard deviation of equity return DRM (default Risk Premium) of subordinated debt Bank Implied Asset Risk (Ronn-Verma Option Pricing Model) Bank Implied asset Risk (Gorton-Santomero debt pricing method)	Loan sales: Loan sale/TA (no data in Malaysia) Capital buffer: TE/TA Specialisation index/TA Loan Quality: PLL/TA GAP: (RSA-RSL)/TA Size: Log of TA Dividend Payout Ratio/TA (no data in Malaysia)
5	Gallo, John G., Apilado, Vincent P., & Kolari, James W. (1996). Commercial bank mutual fund activities: Implications for bank risk and profitability. *Journal of Banking and Finance*, *20*, 1775–1791	3 risk measurements: β(market risk: Wilshire 5000 Index, systematic risk) FINL(industry risk: Wilshire finance Index, systematic risk) Standard deviation of the error term of the regression equation (unsystematic risk)	Investment securities/TA Loan Expansion: TL/TA (Sales Fed-purchased Fed)/TA (insignificant in Malaysia) Capital buffer: TE/TA Size: log of TA Profitability: interest income/TA NONII: NONII/TA FEES – Mutual fund Fee/TA
6	Angbazo, Lazarus. (1997). Commercial bank net interest margin, default risk, interest rate risk, and off-balance sheet banking. *Journal of Banking and Finance*, *21*, 55–87.	NIM= Net Interest Income/average earning asset. NII= interest income – interest expense.	Loan Quality: NCO/TL (in consistent NCO data in Malaysia) Liquid risk: Investment securities/TL Capital Buffer: (Tier 1+ Tier 2)/TA (data started in year 2002) Cost of funds: (non-interest expense- non-interest income) /earning asset Non-interest bearing reserve/TA (no data in Malaysia) Mgt efficiency: Earning asset/TA
7	Anderson, Ronald D., & Fraser, Donald R. (2000). Corporate control, bank risk taking, and the health of the banking industry. *Journal of Banking and Finance*, *24*(8), 1383–1398	3 risk measures: total risk (σ_{SP}) unsystematic risk (σ_ε) systematic risk (total risk – unsystematic risk)	Ownership variable (% of shares held by unaffiliated blockholders) Outside-blockholders Size: log of TA Frequency: average daily share volume traded/number of shares outstanding. (market data) Tobin Q: $\Sigma(CS_{mv}+Liability_{bv}/TA)$ (market data)

8	Cebeyonan, A. Sinan & Strahan, Philip E. (2004). Risk management, capital structure and lending at banks. *Journal of Banking and Finance, 28*, 19–43	Use four financial ratio measures: σ_{ROE} σ_{ROA} $\sigma_{LLP./TL}$ $\sigma_{npl/TL}$	Loan sales (no data and insignificant in Malaysia) Loan purchase (no data and insignificant in Malaysia) Capital buffer: TE/ Earning asset Liquid Asset: Investment securities/TA Commercial + industrial loan) / TA Real estate loan /TA
9	Gonzales, Francisco. (2004). Bank regulation and risk-taking incentives: An international comparison of bank risk. *Journal of Banking and Finance, 29*, 1153–1184.	2 proxies: total risk exposure: $\sigma_{StockReturn}$ credit risk exposure: NPL/TL	Size: log of TA FA/TA (insignificant in Malaysia) Investment in unconsolidated subsidiaries (insignificant in Malaysia) Liability: Total Debt/TA Tobin's Q: (market data) REG – annual index of freedom in finance & banking activities (no data in Malasyia) LAW and Order: annual index (no data in Malaysia) Legal origin (insignificant in Malaysia)
10	Konishi, Masaru & Yasuda, Yukihiro. (2004). Factors affecting bank risk taking: Evidence from Japan. *Journal of Banking and Finance*. *28*, 215–232	Risk measures: total risk: (σ_{SR}) unsystematic risk: (σ_{error}) systematic risk: (total risk - unsystematic risk) market risk: (β_1) interest rate risk: (β_2) Insolvency risk: (*Z*-score developed by Boyd et al. (1993)- using market data	Size – log of TA Frequency: volume o shares/number of shares outstanding Akumudari officers – retired high rank ministry of finance and bank of Japan (not applicable in Malaysia) Franchise value: (market data) Capital constraint: (dummy)
11	Marco, Teresa Garcia and Fernandez, M. Dolores Robles. (2008). Risk-taking behaviour and ownership in the banking industry: The Spanish evidence. *Journal of Economics and Business, 60*, 332–354	*Z* risk index	Ownership structure: (dummy) Diversification: Herfindahl index Public control: (dummy) Turnover of government structure: (dummy) Profitability: ROE Loan Expansion: TL/TA Size: Log of TA
12	Dinger, Valeriya. (2009) Do foreign-owned banks affect banking system liquidity risk? *Journal of Comparative Economics, 41*(2&3) doi:10.1016/j.jce.2009.04.003	Liquidity risk	Transnational: (dummy) Size: log of TA Capital buffer: TE/TA Foreign Asset/TA (insignificant in Malaysia) Loan Expansion: TL/TA Fiscal policy (cross-country

			study) GDP growth (cross-country study) Per capita GDP (cross-country study)
13	Angkinand, Apanard, & Wihlborg, Class. (2009) Deposit insurance coverage, ownership, and banks' risk-taking in emerging markets. *Journal of International Money and Finance*, 1–23. Doi:10.1016/j.jimonfin.2009.08.001	NPL/CAP Std dev of NPL/CAP *Z*-score	Capital buffer: TE/TA Real GDP/Cap (cross-country study) Real GDP growth (cross-country study) M2/Reserve (cross-country study) Inflation(cross-country study) Real interest rate (cross-country study)
14	Yong, Hue Hwa Au, Faff, Robert., & Chalmers, Keryn. (2009). Derivative activities and Asia-Pacific banks' interest rate and exchange rate exposures. *International Financial Markets, Institutions and Money, 19*, 16–32.	Interest rate risk Exchange rate risk	TDER – derivative/TA (insignificant in Malaysia) Size: log of TA Capital buffer: TE/TA liquid asset: Investment securities/TA Profitability: net interest income/TA NONII: NONII/Total income Loan expansion: TL/TA PLL: PLL/TA
15	Laeven, Luc., & Levine, Ross. (2009). Bank governance, regulation and risk-taking. *Journal of Financial economics, 93*, 259–275	*Z*-score Std deviation of ROA Equity volatility Earning volatility	Tobin's Q (market data) Profitability: Revenue growth Per capita income (cross-countries study) Rights (no data in Malaysia) Capital buffer: TE/TA Capital stringency (no data in Malaysia) Restrict (no data in Malaysia) DI: (dummy for insurance)