Seminar FEP2001 16

Financial Volatility and Bank Stock Returns: An Armax-Garch-M Modelling

HOOY CHEE WOOI[1]
TAN HUI BOON[2]

Introduction

The recent Asian financial crisis had highlighted the potential risks and uncertainty of globalize financial system. In Malaysia, the government had closely regulated and conducted various rescue programs to ensure that the banking industry preserved its stability. The aim of the rescue programs, in the long run, is to create a more competitive and market-driven financial sector.

The movement of commercial bank stock has always been seen as an important performance indictor of the commercial banks. This however, depends much on the sensitivity of the bank stock to various risk factors, especially exchange rate and interest rate. If the bank stock is very sensitive to these financial factors, then the movement of these factors will determine the performance of the banks.

On the contrary, if the bank stock is not sensitive to these financial factors, the banks will be able to remain competitive under various circumstances. The increasing volatility of both exchange rate and interest

[1] Ph D candidate, Department of Economics and Management, Faculty of Economics and Management, Universiti Putra Malaysia, Serdang
[2] Associate Professor, Department of Economics, Faculty of Economics and Management Universiti Putra Malaysia, Serdang

rate during the crisis has deep impact on the risk-sensitive banks. The exposure to the exchange rate volatility may condense the net position of banks currency transaction and its foreign operations, which can cause further losses to the banks. The exposure to the interest rate volatility on the other hand, causes unfavorable mismatches of the pricing of assets and liabilities during the crisis. Consequently, it shrinks the net interest income and various interest rate sensitive accounting items. Using the ARMA-GARCH model, the conditional volatility of the exchange rate and interest rate are generated and depicted in Figures 1 and 2 respectively. Note that the change of both financial factors during the crisis was abnormally large.

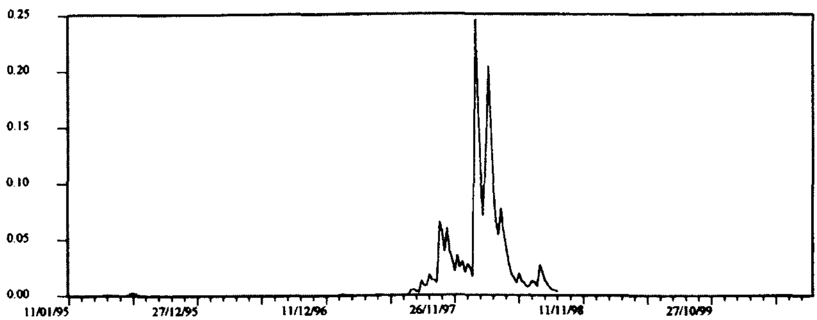

Figure 1: Volatility of exchange rate

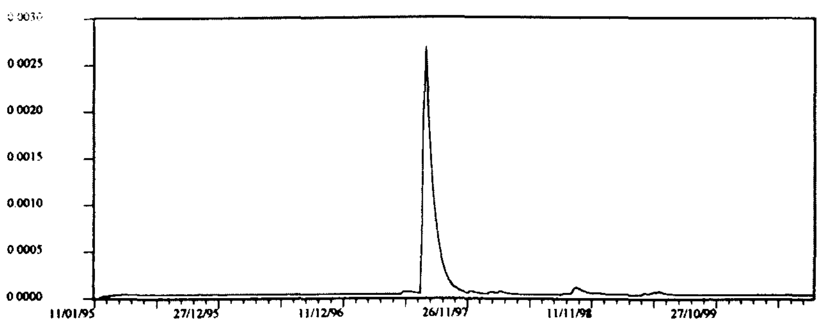

Figure 2: Volatility of interest rate

The unexpected deteriorations of the currency and the large changes of the interest rate prevented banks from their smooth operation and threatened the economy to a deep recession. The domestic banking sector had been accused of failing to overcome the crisis due to its structural and financial inefficiency, and ineffective assets and loans management. As a consequence, the market lost its confidence in the banks. As depicted in Figure 3, the average bank stock price of the domestic commercial banks suffered a vast deterioration during the crisis. Within a year, the average price has dropped from about RM 11 to RM 2. The fall of the bank stock prices nevertheless started much earlier before the crisis. Figure 4 depicts the volatility of the average bank stock price. It is very

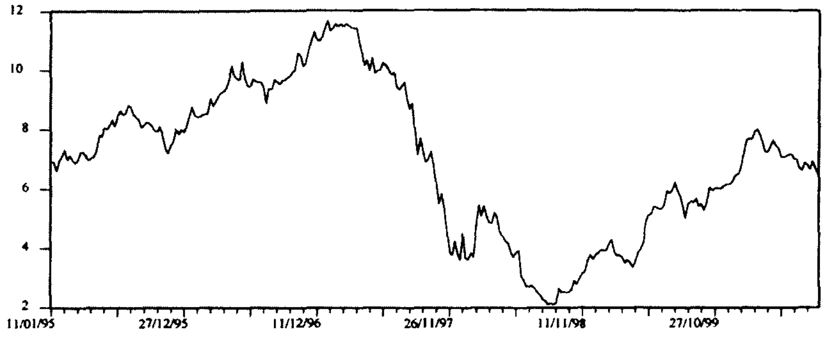

Figure 3: Equal weighted bank stock prices level from January 1995 to July 2000

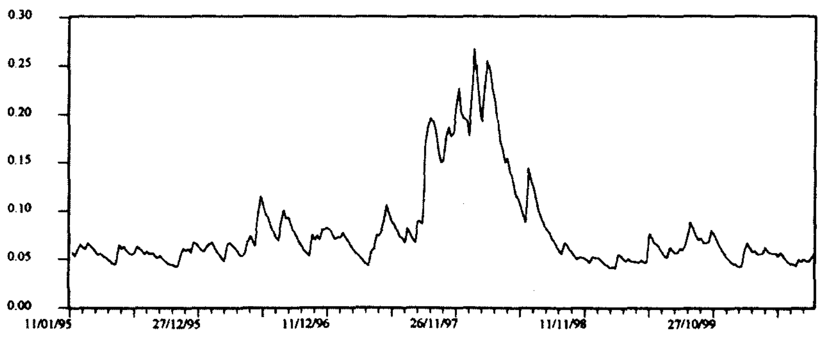

Figure 4: Volatility of the equal weighted bank stock prices model.

clear that during the crisis, the average price became highly volatile relative to before the crisis and also relative to after September 1998.

In general, there is insufficient literature regarding the relevance of exchange rate on bank stock pricing. Likewise, there is a lack of published research that explicitly examines the joint interaction of exchange rates and interest rate on bank stock pricing. The interest rate and exchange rate risk exposure of banking institutions thus continue to be an interesting and crucial research topic. The objective of this paper is to examine the sensitivity of the excess returns of the bank stock portfolios in KLSE to the volatility level and financial risk factors (measured by interest rate risk and exchange rate risk) before, during and after the crisis.

Literature Review

Stock Returns and Volatility

Most of the literature postulate a positive relationship between the expected returns of a stock portfolio with its risk level. Pindyck (1984) attributes much of the decline in stock prices during the 1970s to increases in volatility. French, *et al.* (1987) also found evidence that the unexpected stock market returns are negatively related to the unexpected change in the volatility of stock returns and this finding is interpreted as evidence of a positive relationship between expected risk premiums and ex ante volatility.

Using the GARCH-M types methodology, Bailie and DeGennaro (1990) and Alles and Murray (2001) fail to derive a significant relationship between risk and returns. However, Ng *et al.* (1992), Flannery, *et al.* (1997), Hansson and Hordahl (1998) found evidence to support positive risk-return tradeoff. In addition, Ronn and Wadhwa (1998) found a significant positive relation between expected returns and implied volatility applying the GLS methodology.

While the literature might support that market agents require compensation for holding risky assets, Glosten, *et al.* (1993) however, point out that both positive as well as negative tradeoff would be consistent with the theory because risky time periods could coincide with time periods when investors are better able to bear particular types of risk. Further, some investors may want to save relatively more in times when the future carries risk or when no risk free investment opportunities are available. Subsequently, the price of risky asset may be bid up considerably, thereby reducing the returns. To note, Campbell and Hentschel (1992), Glosten, *et al.* (1993), Elyasiani and Mansur (1998), and Chiang and Doong (1999) had found that the returns are negatively correlated to its future volatility.

Bank Stock Returns and Financial Risk

The early studies on bank stock sensitivity dated back to Officer (1973), Stone (1974), and Lynge and Zumwalt (1980); followed by the work of Flannery and James (1984), Giliberto (1985), Aharony *et al.* (1986), Elijah and Lee (1990), Spiro (1990), Saunders and Yourougou (1990), Yourougou (1990), Flannery, *et al.* (1997) Elyasiani and Mansur (1998), and Srivastava *et al.* (1999). Elyasiani and Mansur (1998) was the first to apply GARCH-M in modeling the bank stock returns. They particularly focus on the effect of interest rate and its volatility on the bank stock returns. They found that interest rate and interest rate volatility have direct impact on the first and second moments of the bank stock risk premium respectively. The study on bank stock sensitivity to exchange rate risk on the other hand is inadequate. To date, only Choi et al. (1992) and Chamberlain *et al.* (1997) investigated exchange rate sensitivity of bank stock. They found that exchange rate risk is insignificant in bank stock pricing. The significant effect of exchange rate risk is more pronounced in the stock market.

A common conclusion from the GARCH-M type's literature was the rejection of the stationary assumption in the second moment of the stock returns distribution, which implies that volatility must be accounted in stock returns pricing and hence be modeled as conditionally heteroscedasticity. Accordingly, this shows evidence that changes in interest rate or other exogenous factors, are characterized by random volatility and hence time varying volatility should be a basis of such model. Hence, it is more appropriate to apply the methodology that can account and model the time varying nature of stock returns sensitivity. Note that from the above discussion, only Elyasiani and Mansur (1998) applied GARCH-M on bank stock returns. This shows that there is still lack of attempt to incorporating the GARCH-M methodology in banking studies.

Methodology and Data

The modern theoretical framework on asset pricing was by large based on Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT). The shortcoming of both CAPM and APT was the constant variance assumption applied to their estimation process (Hansson and Hordahl, 1998). Since ARCH and Generalized ARCH (GARCH) model proposed by Engle (1982) and Bollerslev (1986) respectively, many researchers have applied them to test both the CAPM and APT framework. The conditional model is of interest since its accountability for the heteroscedasticity problem. As several empirical studies reveal, GARCH (1,1) model adequately fits most of the univariate economic time series. For example see Akgiray (1989), Engle and Ng (1993), and Alles and Murray (2001). Recent studies employed GARCH-in-Mean model (GARCH-M), initiated by Engle *et al.* (1987) as GARCH-M allows for much longer memory and a more flexible lag structure by adding a conditional standard deviation term into the theoretical APT framework.

Our study incorporates interest rate and exchange rate as financial risk factors, generated via univariate ARMA-GARCH (p, q). We employed ARMAX-GARCH-M model, which encompasses an autoregressive (AR), moving average (MA), and exogenous variable (X) to the GARCH-M specification as given in equation (1) and (2) respectively as follows:

$$ER_t = \mu + b_1 \sigma_{IT,t-1} + b_2 \sigma_{EX,t-1} + \delta \sqrt{h_t} + \sum_{k=1}^{m} \phi_k ER_{t-k} + \theta \varepsilon_{t-1} + \varepsilon_t \tag{1}$$

$$h_t = \omega + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \gamma_1 \sigma^2{}_{IT,t-1} + \gamma_2 \sigma^2{}_{EX,t-1} \tag{2}$$

where ER_t is the excess returns, h_t is the conditional variance of the excess returns, σ_{IT} is the conditional standard deviation of the interest rate and σ_{EX} is the conditional standard deviation of the exchange rate. The square σ_{IT} and σ_{EX} are the conditional variances. Following the argument by Elyasiani and Mansur (1998), the financial risk factors are lagged one period to avoid the problem of exogeneity regressor and inconsistency estimation. The parameters of the variables are b_1, b_2, δ, θ, ϕ_k, α, β, γ_1 and γ_2 respectively. On the other hand, μ and ω are the intercept terms. The parameters are estimated by using the maximum likelihood method.

In this study, higher order ARMAX-GARCH (p, q)-M is employed. To test for higher order GARCH we minimize the Akaike Information Criterion (AIC) and Schwarz Criterion (SC).[1] To check the specification of the model, Q statistics is employed to test on both residuals and squared residuals. The Q statistics of both residuals and squared residuals should not be significant if both the mean and variance equation is correctly specified. In the estimation process, non-converging models and models containing singularity problems were excluded.

Data used in this study covers the weekly stock prices of seven commercial banks traded on the main board of KLSE.[2] Due to existence of settlements and clearing effect accounted by Bailie and DeGennaro (1990) and the reason of low trading activity of some bank stock by Saunders and Yourougou (1990), daily data are not so relevant and thus can safely be ignored. In order to reflect the current situation of the financial crisis, we chose weekly data instead of the low frequency monthly data. The seven commercial bank stocks are disaggregated by

[1] As indicated by McKenzie (1997), this method requires the GARCH (p, q)-M jointly fitted to residuals of the estimated ARMA process. The joint estimation of the ARMA process and the GARCH-M model is important to avoid a loss in estimating power.

[2] All of them are the stock for licensed commercial bank that continuously traded over the period on organized exchanges and principally engaged in all aspects of banking and in the provision of related financial services. Other commercial bank holding company's stocks are excluded because they are registered under their company stock and thus not a pure commercial bank stock. Bank Islam was also excluded due to non-interest rate transactions of its business nature.

[3] The weekly data employed here is different with the end of week (Friday) daily bid prices used by Aharony *et al.* (1986), Saunders and Yourougou (1990), Yourougou (1990) and Flannery, *et al.* (1997). Weekly data in this paper are the daily closing prices collected on each Wednesday to avoid the opening effect on Monday and closing effect on Friday. If the observation is not available, the nearest Tuesday or Thursday observation will replace it.

Table 1: Banks list and total assets

Bank Name	Total Assets (RM million) at the end of year	
	1997	1998
Large Bank Portfolio		
1. Malayan Banking Berhad	86,936	77,896
2. Public Bank Berhad	29,444	31,582
3. Hong Leong Bank Berhad	13,754	15,095
Small Bank Portfolio		
1. Pacific Bank Berhad	10,985	10,956
2. Southern Bank Berhad	7,899	8,193
3. Ban Hin Lee Bank Berhad	6,968	6,821
4. Hock Hua Bank Berhad	4,622	4,935

Source: Association of Bankers in Malaysia (ABM), 1999/2000

size (capital value) into two equal weighted portfolios - the large bank portfolio (LBP) and small bank portfolio (SBP), as shown in Table 1. The range of the sample is from January 1, 1995 to July 26, 2000 with a total of 291 observations.[3]

The weekly average of overnight KLIBOR (Kuala Lumpur Interbank Offered Rates) is used as proxy for interest rate. The selling rate of Ringgit denominated in U.S dollar is used as the exchange rate proxy. Both the series and the risk free rate series are collected from the monthly statistical bulletin published by Bank Negara Malaysia, the Malaysia central bank. Figures 5 and 6 depict the plotting of the excess returns of both portfolio series. The excess returns, ERt are calculated based on the following equation:

$$\left[\frac{(p_t - p_{t-1} + Div_t)}{p_{t-1}}\right] - RTB_t \qquad (3)$$

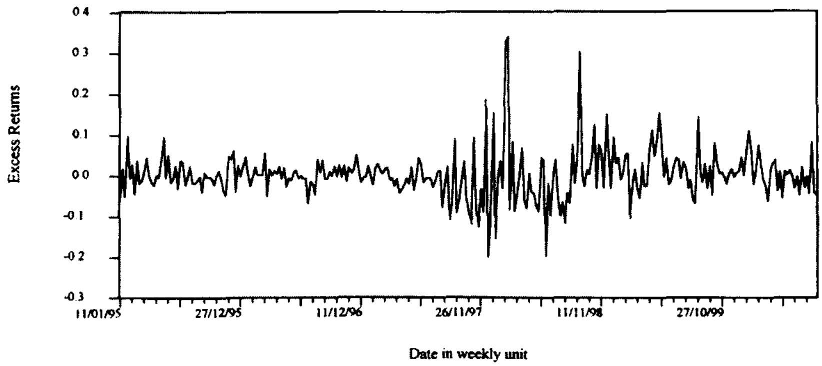

Figure 5: Excess returns of large banks portfolio

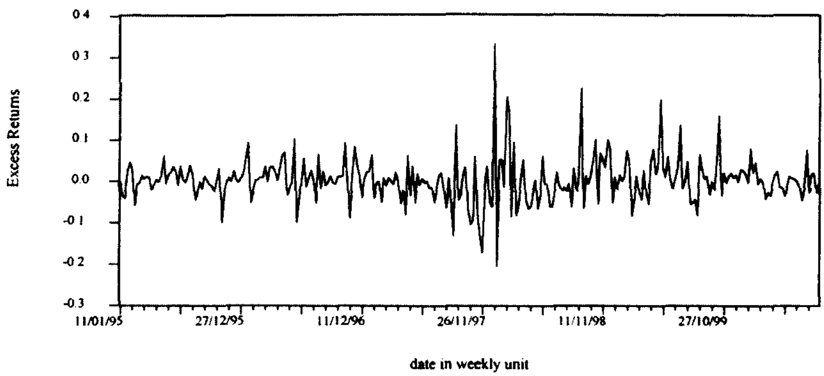

Figure 6: Excess returns of small banks portfolio

where t is the current time denominator, p is the price, Div is the level of dividends, RTB is the proxy for risk free rate, the weekly rate for the 3 month Treasury bills issued by Bank Negara Malaysia.

Clearly, the volatility of both excess returns is highly affected by the crisis as the fluctuations of the series became very large after the end of 1997 but stabilized after end of 1998. Due to the above reason, our analysis is divided into three sub-periods to account for non-homogeneity of the excess returns. The first sub-period (pre-crisis period/Pre Crisis) starts from 11 January 1995 to 25 Jun 1997 with 129 observations. The second sub-period (during crisis) ranges from 2 July 1997 to 2 September 1998 with 62 observations, it is the most volatile period among the three sub-periods. The third sub-period (post control) continues from 9 September 1998 to 26 July 2000 with 99 observations. It is identified after the Malaysia government applies the capital control and pegging its exchange rate against USD with RM 3.8 per 1 USD.

Results and Discussion

Table 2 presents the summary statistics for the bank portfolios excess returns while Table 3 presents the summary statistics for the interest rate and exchange rate series. Both LBP and SBP show negative excess returns and higher standard deviation during the crisis. After September 1998, the excess returns became positive but with a mean and standard deviation values higher than pre-crisis period. The financial factors as well, show higher standard deviation during the crisis period. The interest rate is higher during the crisis while the average exchange rates devaluated to

Table 2: Summary statistics for bank portfolios excess returns

Summary statistics	Observations	LBP	SBP
Pre Crisis:	129		
Mean		0.0011	0.0031
Std. Dev.		0.0281	0.0353
Maximum		0.0973	0.1019
Minimum		-0.0692	-0.1007
Skewness		0.4650	-0.1047
Kurtosis		4.0378	4.2192
During Crisis:	62		
Mean		-0.0203	-0.0163
Std. Dev.		0.0992	0.0834
Maximum		0.3405	0.3305
Minimum		-0.2013	-0.2074
Skewness		1.4724	1.3287
Kurtosis		6.5316	7.3131
Post Control:	99		
Mean		0.0161	0.0098
Std. Dev.		0.0572	0.0517
Maximum		0.3024	0.2220
Minimum		-0.1061	-0.0867
Skewness		1.5698	1.4116
Kurtosis		8.3229	6.6011

Std. Dev. denotes standard deviation

Table 3: Summary statistics for interest rate and exchange rate

Summary statistics	Observations	Interest rate	Exchange rate
Pre Crisis:	129		
Mean		0.0684	2.5084
Std. Dev.		0.0071	0.0329
Maximum		0.0850	2.5621
Minimum		0.0535	2.3890
Skewness		-0.4173	-0.4941
Kurtosis		2.0828	3.1953
During Crisis:	62		
Mean		0.0979	3.5905
Std. Dev.		0.0160	0.5503
Maximum		0.1600	4.5200
Minimum		0.0745	2.5044
Skewness		0.6497	-0.5390
Kurtosis		4.6456	2.2309
Post Control:	99		
Mean		0.0440	-
Std. Dev.		0.0169	-
Maximum		0.0950	-
Minimum		0.0300	-
Skewness		0.9551	-
Kurtosis		2.4078	-

Std. Dev. denotes standard deviation

3.5905. After the crisis, the interest rate has been reduced to lower level than pre-crisis period, while the exchange rate is removed from the third sample period because Ringgit is pegged at RM3.8/USD in the post control period.

The volatility of the financial factors of interest rate and exchange rate are generated via univariate ARMA-GARCH (p, q) model. The parameter estimation for each selected models of each sample period is given in Table 4, Table 5, and Table 6. Before crisis, GARCH (1,1)

Table 4: Parameter estimates results for the period of pre-crisis

$$ER_t = \mu + b_1 \sigma_{IT,t-1} + b_2 \sigma_{EX,t-1} + \delta \sqrt{h_t} + \sum_{k=1}^{m} \phi_k ER_{t-k} + \theta \varepsilon_{t-1} + \varepsilon_t$$

$$h_t = \omega + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \gamma_1 \sigma^2_{IT,t-1} + \gamma_2 \sigma^2_{EX,t-1}$$

Variable	Portfolio Excess Return	
	LBP ARMA(1,0)-Garch(1,2)-M	SBP ARMA(2,0)-Garch(2,1)-M
μ	-0.0135	0.0072
	(0.5523)	(0.7411)
b_1	10.3777	-6.3503
	(0.4643)	(0.6695)
b_2	0.1358	1.6417
	(0.8524)	(0.0458)**
δ	-0.0533	-0.3401
	(0.8971)	(0.1756)
ϕ_1	0.0717	-0.0139
	(0.5174)	(0.8756)
ϕ_2	-	-0.1229
		(0.1773)
ω	0.0011	0.0004
	(0.0000)***	(0.0000)***
α_1	0.2211	0.0555
	(0.0000)***	(0.0125)**
α_2	0.2131	-
	(0.0000)***	
β_1	-1.0242	1.4423
	(0.0000)***	(0.0000)***
β_2	-	-0.8935
		(0.0000)***
γ_1	16.8230	-1.7292
	(0.8307)	(0.9346)
γ_2	0.2711	0.2660
	(0.5973)	(0.1896)
LogL	284.3329	254.2770
AIC	-4.3733	-3.9077
SC	-4.1244	-3.6348

All the models are estimated under the assumption of conditional normality. The optimal autoregressive terms and the MGARCH (*p*, *q*)-M are determined via traditional time series methodology. LogL is the log-likelihood functions value. AIC and SC denotes the Akaike and Schwarz values. Values in the parentheses are the p-values. * denote significant at the 0.10 level ; ** denote significant at the 0.05 level and *** denote significant at the 0.01 level.

Table 5: Parameter estimates results for the period of during crisis

$$ER_t = \mu + b_1\sigma_{IT,t-1} + b_2\sigma_{EX,t-1} + \delta\sqrt{h_t} + \sum_{k=1}^{m}\phi_k ER_{t-k} + \theta\varepsilon_{t-1} + \varepsilon_t$$

$$h_t = \omega + \sum_{j=1}^{p}\beta_j h_{t-j} + \sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2 + \gamma_1\sigma^2_{IT,t-1} + \gamma_2\sigma^2_{EX,t-1}$$

Variable	Portfolio Excess Return	
	LBP ARMA(0,0) -Garch(1,1)-M	SBP ARMA(0,0)-Garch(2,1)-M
μ	-0.1028	-0.0449
	(0.2166)	(0.0007)***
b_1	0.5213	-0.5294
	(0.8138)	(0.6646)
b_2	0.5334	0.3359
	(0.1391)	(0.1463)
δ	0.2051	-0.0758
	(0.7127)	(0.8764)
ω	0.0075	0.0009
	(0.0036)***	(0.5430)
α_1	0.1851	0.3187
	(0.1240)	(0.3041)
β_1	0.5890	-0.1765
	(0.0173)**	(0.3914)
β_2	-	0.4740
		(0.0801)*
γ_1	-2.7880	-3.3956
	(0.0009)***	(0.0022)***
γ_2	-0.3364	0.0663
	(0.0020)***	(0.1892)
LogL	69.1853	87.1025
AIC	-1.9415	-2.4872
SC	-1.6327	-2.1441

All the models are estimated under the assumption of conditional normality. The optimal autoregressive terms and the MGARCH (p, q)-M are determined via traditional time series methodology. LogL is the log-likelihood functions value. AIC and SC denotes the Akaike and Schwarz values. Values in the parentheses are the p-values. * denote significant at the 0.10 level ; ** denote significant at the 0.05 level and *** denote significant at the 0.01 level.

Table 6: Parameter estimates results for the period of post capital control

$$ER_t = \mu + b_1\sigma_{IT,t-1} + \delta\sqrt{h_t} + \sum_{k=1}^{m}\phi_k ER_{t-k} + \theta\varepsilon_{t-1} + \varepsilon_t$$

$$h_t = \omega + \sum_{j=1}^{p}\beta_j h_{t-j} + \sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2 + \gamma_1\sigma^2_{IT,t-1}$$

Variable	Portfolio Excess Return	
	LBP ARMA(1,0) -Garch(2,1)-M	SBP ARMA(0,1)-Garch(2,1)-M
μ	-0.0487 (0.0000)***	-0.0196 (0.0347)**
b_1	3.1565 (0.0542)*	8.5544 (0.0321)**
δ	1.2252 (0.0000)***	0.3310 (0.3113)
ϕ_1	-0.0204 (0.3789)	-
θ	-	-0.0052 (0.9362)
ω	0.0020 (0.0005)***	0.0042 (0.0000)***
α_1	0.3640 (0.0000)***	0.0123 (0.4551)
β_1	-0.5829 (0.0000)***	-0.2096 (0.0000)***
β_2	0.2822 (0.0104)**	-1.0007 (0.0000)***
γ_1	1.0493 (0.9657)	107.4375 (0.0001)***
LogL	172.7416	170.9657
AIC	-3.3417	-3.2720
SC	-3.1043	-3.0361

All the models are estimated under the assumption of conditional normality. The optimal autoregressive terms and the MGARCH (*p*, *q*)-M are determined via traditional time series methodology. LogL is the log-likelihood functions value. AIC and SC denotes the Akaike and Schwarz values. Values in the parentheses are the p-values. * denote significant at the 0.10 level ; ** denote significant at the 0.05 level and *** denote significant at the 0.01 level.

generally fit the financial factors with ARMA (3,1) and AR (1) terms in the mean equation of interest rate and exchange rate respectively. During crisis however, GARCH (1,3) fits to model the highly volatile exchange rate. After the financial control, GARCH (2,1) fits interest rate well.

The returns generating process generally follows low orders ARMA effects. Before the crisis, the large and small banks portfolio can be modeled via AR (1) and AR (2) respectively. During crisis, there is no ARMA effect detected. After the financial control, the AR effects emerge but SBP now follow an MA (1) process. Note that the ARMA effects are not strong in all sample periods. This is indicated by an insignificant p-value for almost all ARMA parameters. It seems that the non-synchronous and thin trading effect are very weak in the excess returns of bank stock in Malaysia since the excess returns of both portfolio follow a white noise process.

The intercept term of ω in the variance equation indicates the unconditional volatility. From the estimation result, ω is positive and significant for both portfolios in all the sample periods except for the SBP during crisis. This indicates that most of the volatility series have time independent component, which is consistent with the results of most empirical studies. Almost all the ARCH and GARCH terms are statistically significant (13 out of 17 terms).[4] Note that the sum of the ARCH magnitude in both portfolios in each period is found to be much smaller that the sum of the GARCH magnitude. This indicates that the banking industries has a memory longer than one period and the volatilities are more sensitive to its own lagged values rather than to new surprises in the market place. Table 7 presents the diagnostic checking on the residual of the fitted models. The Ljung-Box Q statistics of lag 12

Table 7: Diagnostic checking

Variable	Portfolio Excess Return					
	Pre Crisis		During Crisis		Post Control	
	LBP	SBP	LBP	SBP	LBP	SBP
Skew	0.1742	-0.0005	1.5796	1.5982	0.3495	1.2665
Kur	6.8859	4.1219	7.2927	8.9319	3.2228	6.3465
Q(12)	2.0938	14.041	12.670	17.674	7.8356	11.764
Q(20)	8.4959	19.300	17.466	25.878	13.510	13.842
$Q^2(12)$	19.683**	9.0679	11.924	5.0255	7.7282	5.4946
$Q^2(20)$	32.259**	16.762	15.735	6.7900	12.924	6.9590

LBP and SBP denote large bank portfolio and small bank portfolio respectively. Skew and Kur denote the skewness and kurtosis of the residual terms. Q(12), Q(20), $Q^2(12)$and $Q^2(20)$ are the Box Pierce portmanteau test statistics applied to the standardized residuals and squared standardized residuals for lag 12 and lag 20 respectively. ** denote significant at the 0.05 level.

and 20 for the standardized residuals and the squared standardized residuals indicate that the linear dependences in the mean and variance has been captured in the fitted model except for the large banks portfolio before crisis.

[4] In this paper, GARCH effects refer to significant GARCH and/or ARCH terms while ARCH effect refer to significant ARCH terms only.

The coefficient describes inter-temporal relationship between risk and the excess returns of the banks portfolios. As noted by Elyasiani and Mansur (1998), the fluctuations in volatility are mostly due to shocks to the unsystematic risk, causing the coefficient to have any sign. Note that the coefficients are statistically insignificant with different sign in tested periods except for LBP after the capital control. After the capital control, LBP had significant large positive value of risk coefficient. The positive sign means that investors are not willing to bear risk under risky periods and the risk adverse investors demand higher risk premium compensation. The large coefficients magnitude shows that the price of large bank now depends much on its volatility level. When volatility of the bank stock increased, the investor and market participant will demand more bank stock and this bid up the prices of bank stock and consequently drive up the excess returns.

The parameters in the conditional mean i.e. equation (1) of the excess return indicate the sensitivity of the excess returns to stock volatility and the financial risk factors. Before crisis, most of the parameters involved are statistically insignificant except for the exchange rate risk of small bank portfolio. The excess returns can be best described by a white noise process as the AR and financial volatility factors are all not significant. Only SBP show relationship with the exchange rate volatility before the crisis and significant constant terms. In the post control period, almost all parameters in the mean equation are statistically significant. The significant positive interest rate volatility in the mean equation indicates that interest rate volatility had become a significant factor in pricing Malaysian bank excess returns after the capital control.

The result indicates that before the crisis, with bull market sentiment, investors generally traded bank stock irrationally without much concern about the financial risk. This could also be attributed to the high stability of both financial factors as the banking industry was closely monitored by the government. Hence the excess returns fail to show a pricing relationship with the volatility factors. The situation was not much different during the crisis. Due to the government's proactive counter policy, and good exchange rate practice by the commercial banks, the market confidence remains. Although contagion effect of the crisis had led to large amount of capital outflow, there is no case of bank failure. Investors and market participants generally have confidence with the counter policy and did not react enormously to the market volatility. Hence, all the risk parameters remain insignificant under the crisis circumstances. However, after the implementation of the capital control, the sensitivity of bank stock changes. In addition, the domestic banking industry was under the financial reconstruction program arranged by the government. These drastic and unexpected policies had made investors realize that the booming myth has ended. Thus, in the post capital control period, investors become rational and trade consciously towards the risk factors. This can be shown by the sensitivity of bank stock excess returns on the interest rate risk and the stock volatility.

The parameters in the conditional variance equation i.e. equation (2) of the excess return indicate the sensitivity of the bank excess returns' volatility to the volatilities of the financial factors. Generally, the variance equation, or the volatility of the excess returns follows a strong GARCH specification in all sample periods except for during crisis. Before the crisis, the volatility of the excess returns is not sensitive to the financial risk factors. During the crisis however, the volatility of exchange rates shows a significant stabilizing effect on the excess returns, while interest rate risk is negatively significant only in LBP. The significant negative pricing of the risk factors in the variance equation indicates that increasing volatility of financial risks reduces the volatility of the excess returns. After the selective capital control, the interest rate risk had significant positive coefficients in small bank portfolio variances equations but insignificant for LBP. Although our results here show that volatility of large banks excess returns react adversely to the increasing volatility of exchange rate during periods of large currency depreciations, however the magnitude of the effect is relatively small compared to the magnitude of interest rate volatility. As Kho and Stulz (2000) argued, the currency movements may have explained little of bank stock performance during crisis. This is because bank performance may better be explained by the overall stock market performance. After the control, the GARCH effect dominated the volatility of excess returns. Only the excess returns of small bank portfolio are positively sensitive to interest rate risk. The result indicates that the volatility of depressing interest rate policy do alter the interest rate risk exposure of small bank portfolio excess returns but not the LBP.

Conclusion

This study investigates commercial bank stock excess returns and its volatility, together with the volatility of interest rate and exchange rate. Application of time varying risk model to bank stock is of special importance because in recent financial crisis both the financial risk factors and the stock returns volatility have varied substantially. The results of this study indicate that bank size do matter in studying the risk exposure of bank stock excess returns during the financial crisis period. According to the results, risk sensitivities are found to be non-homogeneous across different bank size. The diagnostic result showed that ARMAX-GARCH (p, q)-M specification generally manages to capture almost all of the linear dependences in the mean and variance of the fitted model. Also we documented that bank stock in KLSE, do have significant GARCH effect. In fact, bank stock has a memory longer than one period and the volatilities are more sensitive to its own lagged values rather than to new surprises in the market place.

Before crisis, the banks equity returns are not exposed much to its own volatility level and the financial risk factors. Our results fail to show a risks pricing relationship. The excess returns of the commercial bank stock generally followed white noise process and its variances have strong GARCH effects. During the crisis, we found that government intervention to raise the interest rate following the collapse of the currency market had implications on stabilizing the volatility of the bank stock excess returns. On the other hand, the instability in the currency market did not increase the volatility of the excess returns. The results indicate that the government policy during crisis and the hedging activities of the commercial banks do stabilize the bank stock during crisis, at least the sample banks in this study. After the financial control, both large and small portfolio bank excess returns are found to be significantly sensitive to the interest rate volatility. In addition, the small banks' volatility is also significantly driven by the interest rate volatility. It shows that market sentiment has change after the crisis. This can be reflected by the increase in the prices of bank stock, which generates larger excess returns, when the volatility of the interest rate increases.

The results of this study indicate that trading of local commercial bank stock was generally irrational during the boom period (pre-crisis), as they failed to incorporate the risk factors in the pricing process. They also failed to react during the early phase of the financial crisis (crisis period). Nevertheless, it seems that there was a significant change in investor's behavior with respect to bank stock during the post capital-control period. The implementation of the capital control policy has resulted in increasing risk concern of investor in bank stock. Furthermore, the increases in bank stock prices after the control also indicate that the government has successfully regained part of the investors' confidence in domestic commercial banks.

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