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TIME-VARYING MARKET, INTEREST RATE AND EXCHANGE RATE RISKS OF THAI COMMERCIAL BANKS

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ABSTRACT

This study investigates the sensitivity of the stock returns of Thai commercial banks to market, interest rate, and foreign exchange rate risks in a time-varying framework employing the GARCH approach. The empirical evidence reveals that market risk is the major component of the sensitivity of bank stock returns, with large banks being more sensitive to changes in market conditions than medium and small banks. There is also evidence to support the influence of the interest rate on bank stock returns, indicating a decline in longer-term interest rate sensitivity. The results also reveal important information regarding the Thai banking industry: banks with high market power can take advantage of interest rate changes, leading to higher profitability, indicating a positive interest rate sensitivity, while banks with low market power and less efficient banks may not efficiently manage their risk exposures, resulting in negative effects of the interest rate risk from the maturity mismatching of their assets and liabilities. The exchange rate risk is relevant for small banks, whereas large and medium banks may have adequately hedged their foreign exchange rate exposure throughout the sample period. The time-varying estimation confirms that the bank stock-return-generating process follows the GARCH model and that volatility is time variant with a relatively high value of persistence measures.

Keywords: banks, foreign exchange rate risk, GARCH, interest rate risk, market risk

INTRODUCTION

The presence of commercial banks provides an important service to facilitate the flow of money through the economy. Commercial banks are responsible for allocating resources from savers to investors across economic sectors. In performing these functions, the bank faces a variety of risks, including market risk, interest rate risk and foreign exchange risk (Choi, Elyasiani, & Kopecky, 1992; Daugaard & Valentine, 1993; Wetmore & Brick, 1994; Madura & Zarruk, 1995; Prasad & Rajan, 1995; Adjaoud & Rahman, 1996; Chamberlain, Howe, & Popper, 1997; Choi, Hiraki, & Takezawa, 1998; Tai, 2000; Atindéhou & Gueyie, 2001; Rahman, 2010). These risk factors affect the efficiency in the provision of banking services, banks' operations, and, thus, their stock returns. As a result, the stock price of a bank is partly determined by how effectively the bank manages its risk exposures.

The assessment of the sensitivity of stock returns of commercial banks has received a great deal of attention in developed markets including the U.S. (Grammatikos, Saunders, & Swary, 1986; Choi et al., 1992; Choi & Elyasiani, 1997; Martin & Mauer, 2003, 2005), Japan (Chamberlain et al., 1997) Canada (Atindéhou & Gueyie, 2001), and Australia (Tai, 2000; Shamsuddin, 2009). However, the results are mixed, and studies focusing on less developed banking markets are relatively limited.

Despite the clear importance of the influence of the market, interest rate, and foreign exchange risk in the banking sector, very little empirical evidence has been found concerning the Asian context. This study focuses on bank stock returns in Thailand, where the 1990s Asian financial crisis was originated. The Thai banking industry is of interest because it has experienced a significant change and has been transformed through several transitions in the last two decades. Two examples of massive transformations were the liberalisation of the banking industry in the 1980s and the relaxation of the interest rate ceiling in the 1990s to allow commercial banks to compete freely, which led to a more volatile interest rate in the economy.

Moreover, the exchange control relaxation in 1994 helped to create liquidity for the Thai baht and encourage capital inflows to Thailand, leading to the substantial volatility of the Thai baht. The Thai baht had been attacked by speculators several times, and finally on 2 July 1997, the Bank of Thailand announced the implementation of a floating exchange rate regime in Thailand, leading to one of the most serious financial crisis in the emerging markets.

Since 1997, the financial development of Thailand can be divided into two periods. From 1997 to 2004, when the crisis was severe, the government authorities were strictly monitoring financial institutions. In addition, there were several takeovers and merger activities, leading to changes in ownership structures and names among Thai banks. From 2005 to present, the financial and economic environment has become a less supervised competitive environment. Such a deregulated system leaves banks less protected and more vulnerable to market sensitivities.

In an attempt to bring in the supervisory and regulatory framework, whose deficiencies became obvious in the run-up to the 1997 financial crisis, the implementation of the International Accounting Standard (IAS) 39 began in

Thailand at the end of 2006. IAS 39 concerns the classification and measurement of financial instruments, impairment of financial assets, recognition and de-recognition of financial assets and liabilities, derivatives accounting and hedge accounting (Bank of Thailand, 2006, p. 34). Later, Thai commercial banks adopted various measures aimed at strengthening risk management in line with international standard systems such as BASEL II in 2008.

This study adds to the scarce literature evaluating several risk exposures using the data from Thai banks in a time-varying framework by employing the GARCH model. I choose to study the Thai banking environment for several very important reasons. First, the size of the Thai banking industry is the largest relative to other Association of Southeast Asian Nations (ASEAN) countries (Nguyen, Sharma, & Roca, 2012). Further, although the competition in the Thai banking industry has increased over a decade, it is much less competitive compared to the banking industries in developed countries (Kubo, 2006; Roengpitya, 2010; Subhanij & Sawangngoenyuang, 2011). Therefore, banks who are price setters with high market power can use their competitiveness and market power to take advantage of interest rate changes, whereas banks with low market power and less efficient banks may not efficiently manage their risk exposures.

The rest of this paper is divided into five sections. First, this paper reviews the related literature. Next, this paper discusses the model specification and the hypotheses tested. Then, the descriptive statistics of the data employed in this study and the empirical results are presented. The final section offers conclusions.

LITERATURE REVIEW

The sensitivity of commercial bank stock returns has been the subject of significant attention from regulators, financial intermediaries, and academics for a long time. A large amount of previous research has focused on the market model of the capital asset pricing model (CAPM), which is a common specification of the return-generating process for bank stock returns. Beyond the CAPM, which is one-factor model, the arbitrage pricing theory (APT) model includes other factors that influence stock returns where the sensitivity to changes in each factor is represented by a factor-specific beta coefficient.

General economic theory suggests that the interest rate plays a major role in determining banks' profits because both returns and costs of financial institutions are directly dependent on interest rates. Early empirical investigation on the sensitivity of stock returns to the interest rate has produced evidence in favour of the existence of such sensitivity. Fama and Schwert (1977), Fogler, Kose, & Tipton (1981), and Sweeney and Warga (1986) have shown that the inclusion of an interest rate factor adds substantially to the explanatory power of the single factor model. Further attempts to estimate the two-index model to measure market and interest rate risks of financial institutions are presented in Stone (1974) and also in Lloyd and Shick (1977), who perform a test on Stone's model and find that bank stock betas are insignificant, while the interest rate sensitivity does add explanatory power. The significant effect of the interest rate sensitivity of commercial bank returns is confirmed by Martin and Keown (1977) and Lynge and Zumwalt (1980). The interest rate sensitivity of common stock returns of financial institutions is related to the maturity composition of the firms' net nominal asset holdings, as indicated in Flannery and James (1984). This finding is consistent with the nominal contracting hypothesis.

Substantial evidence of a statistically significant negative relationship between bank stock returns and interest rate changes are also outlined in Martin and Keown (1977), Lynge and Zumwalt (1980), Flannery and James (1984), Brewer and Lee (1985), Scott and Peterson (1986), Kane and Unal (1988), Saunders and Yourougou (1990), Kwan (1991), Neuberger (1991), Akella and Greenbaum (1992), Choi et al. (1992), Madura and Zurruk (1995), Adjaoud and Rahman (1996), Allen and Jagtiani (1997), Flannery, Hameed and Harjes (1997), Elyasiani and Mansur (1998), and Faff and Howard (1999).

Further evidence on interest rate sensitivity is provided in Ho and Saunders (1981) who examine the determinants of net interest margins of banks and propose a model of banks as risk-averse dealers facilitating deposits and loans. The generalisation of their model implies that banks are able to manage net interest margins to their advantage in the face of interest rate changes if they have market power, particularly if the banking industry lacks adequate competition. As mentioned by Vaz, Ariff and Brooks (2008), an increase in interest rates may have positive effects if future income is likely to increase by more than the cost of securing the funds, namely, higher net interest margins that should increase returns. This phenomenon is consistent with Williams (2007) who states that an increase in the interest rate may enable banks to pass on these costs, leading to higher income. Therefore, banks that have competitive advantage over others are able to increase net interest margins and enjoy higher profitability as a consequence of increased market power. However, Choi, Elyasiani and Saunders (1996), Allen and Jagtiani (1997), and Benink and Wolff (2000) conclude that the interest rate sensitivity has decreased in the late 1980s and early 1990s due to the availability of interest rate derivatives contracts that can be used for hedging purposes.

As with the early work on interest rate sensitivity, empirical studies concentrate on augmenting the simple market model with a second factor for exchange rate risk. Adler and Dumas (1983) examine the international portfolio and also the purchasing power parity in the sense of international finance. The authors find that the firm's exchange rate risk exposure can be measured by a coefficient in the regression of a firm's stock returns on exchange rate changes. Further, Flood and Lessard (1986) discussed the differences between operating exposure and contracting exposure and related the firm's foreign exchange exposure to the underlying market conditions for its outputs and inputs. Eun and Resnick (1988) demonstrate the significant effect of the systematic exchange rate risk on the performance of international portfolios.

Moreover, the high degree of openness of the economy coupled with the floating exchange rate system increases the exposure of commercial banks to foreign exchange rates. The elimination of government controls over the banking system and the change in the exchange rate regime may expose the banking industry to new risk factors. Hence, the exchange rate variable might be able to explain the bank stock returns.

The issue of foreign exchange risk in the banking sector has been explored by Aharony, Saunders and Swary (1985), and Grammatikos et al. (1986). The authors conclude that the effect of the foreign exchange rate risk on bank stock returns is statistically significant because banks have imperfectly hedged their overall asset position in individual foreign currencies and exposed themselves to exchange rate risks. Further, Hooy, Tan and Nassir (2004) examines the risk sensitivities of Malaysian bank stocks to interest rate and exchange rate changes during the Asian financial crisis. The authors reveal that the risk exposures of commercial banks are increased and that those risk factors affect both large and small Malaysian bank stocks. However, there are no significant differences prior to and during the Asian financial crisis.

Based on previous research in this area, the three factors commonly recognised to affect bank stock returns are market risk, interest rate risk, and foreign exchange rate risk. Choi et al. (1992) present and estimate a multi-factor model that measures the market risk, interest sensitivity, and exchange rate risk of commercial bank stock returns. Wetmore and Brick (1994) also find that the interest rate risk and foreign exchange rate risk have an influence on bank stock returns. Furthermore, these authors also provide evidence that the foreign exchange rate risk is explained by unhedged foreign loan exposure. In addition, Atindéhou and Gueyie (2001) examine the six largest Canadian chartered banks and observe that a depreciation of foreign currencies against the Canadian dollar reveals a positive effect on bank stock returns, which is consistent with the negative foreign currency position of Canadian banks over their sample period.

Other studies that examine the joint interaction of market, interest rate, and foreign exchange rate risks are Daugaard and Valentine (1993), Madura and Zarruk (1995), Adjaoud and Rahman (1996), Prasad and Rajan (1995), Choi et al. (1998), Chamberlain et al. (1997), Tai (2000) and Rahman (2010).

Recently, there have been attempts to examine risk exposures of banks using models from the GARCH family. The first effort in this area is a study by Elyasiani and Mansur (1998) on interest risk exposures of U.S. banks. The authors find that both the interest rate and interest rate volatility have an impact on the mean and the conditional volatility of bank stock returns. Ryan and Worthington (2002, 2004) include the foreign exchange rate risk in the model applied with Australian data. However, these studies examined risk exposures at the portfolio level, not the individual bank level. Tai (2000) explores the sensitivity of Australian bank stock returns to market, interest rate and foreign exchange rate risks by the GARCH-M model and reveals that the market risk, short- and medium-term interest rates and their volatility are important factors determining bank stock returns but that long-term interest rates and the foreign exchange rate are insignificant. Shamsuddin (2009) also estimates the systematic risk exposure of publicly listed Australian banks with respect to the market, interest rate and foreign exchange rate risks using the GARCH-M model and finds that foreign exchange rate risk changes affect stock returns of small banks only.

This paper attempts to evaluate all three important factors revealed by previous literature in determining bank stock returns, namely market, interest rate, and foreign exchange rate risks, in one study. Furthermore, the risk exposures are explored for the commercial banks in Thailand, representing the case of emerging markets. This study also investigates the sensitivity of bank stock returns within the time-varying framework where there are a limited number of studies.

MODEL SPECIFICATION

The sensitivity of bank stock returns to market, interest rate, and foreign exchange risks are investigated in this paper through the estimation of the following multi-index model:

$$R_{i,t} = \beta_0 + \beta_1 R_{m,t} + \beta_2 R_{r,t} + \beta_3 R_{f,t} + \varepsilon_{i,t} \qquad (1)$$

Previous empirical studies have indicated that volatility should not be constant but rather varies over time (Pagan & Schwert, 1990; Bollerslev, Chou, & Kroner, 1992; Bollerslev, Engle, & Nelson, 1994; Bera & Higgins, 1993; Brailsford & Faff, 1996). To capture this time-varying behaviour, Engle (1982) proposes the autoregressive conditional heteroskedasticity (ARCH) process in which the past disturbances are used to model the time-varying conditional variance. In addition, Bollerslev (1986) has developed the generalised autoregressive conditional heteroskedasticity (GARCH) model, which is the generalised model of the ARCH process that can reduce the high ARCH orders. The ARCH/GARCH models are extensively used in previous studies dealing with financial returns data. Therefore, the GARCH technique is employed for empirical investigation as follows:

$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1} \quad (2)$$

$$\varepsilon_{i,t} | \Omega \sim N(0, h_{i,t}) \quad (3)$$

In the mean equation (Equation 1), $R_{i,t}$ is the return on stock *i* at time *t*; $R_{m,t}$ is the return on market at time *t*; $R_{r,t}$ is the change in the interest rate at time *t*; and $R_{f,t}$ is the change in the foreign exchange rate at time *t*. The variance equation (Equation 2) shows that the conditional variance, $h_{i,t}$, is linearly dependent on the past behaviour of the squared error terms, $\varepsilon_{i,t-1}^2$, and the last period conditional variance, $h_{i,t-1}$. The parameter α_1 represents the sensitivity of the conditional variance to the past values of the squared error whilst parameter α_2 measures the variance responsiveness to its own past behaviour. The sum of α_1 and α_2 measures the volatility persistence. The persistence will increase as $\alpha_1+\alpha_2$ approaches one. $\varepsilon_{i,t}$ is the error term that is normally distributed with zero mean and a variance of $h_{i,t}$.

In the GARCH model, the conditional variance is specified as a function of the past shocks allowing volatility to evolve over time and permitting volatility shocks to persist. This method allows for a non-constant error variance where shocks may persist and have a continuing effect on the return-generating process. The GARCH model is employed in this study instead of the ARCH model because the ARCH technique allows for a limited number of lags in deriving the conditional variance while the GARCH model allows all lags to exert an influence, thereby constituting a long-term memory model. As a result, the model used in this study assumes that shocks to volatility are expected to continue to impact bank returns for a relatively long period.

Ryan and Worthington (2002) and Shamsuddin (2009) examine the sensitivity of bank stock returns to the risk exposures using the GARCH-M model and find that the parameter is insignificant. That is, the GARCH-M model collapses to the GARCH model. In this study, the GARCH technique is employed because previous studies revealed that the model is sufficient to address the issue.

The null hypotheses tested in this study are as follows:

Hypothesis 1: $\beta_1 = 0$. (H1)

The bank stock return is invariant to market conditions.

Hypothesis 2: $\beta_2 = 0$. (H2)

The bank stock return is not affected by change in interest rate.

Hypothesis 3: $\beta_3 = 0$. (H3)

The bank stock return is insensitive to the change in the foreign exchange rate.

Hypothesis 4: $\alpha_1 = \alpha_2 = 0$. (H4)

The volatility of the bank stock return is time invariant.

DATA

The null hypotheses are tested for the individual bank stocks. Ten commercial banks listed on the Stock Exchange of Thailand (SET) during the observation period are considered in this study. The banks are Bank of Ayudhya Public Company Limited (BAY), Bangkok Bank Public Company Limited (BBL), CIMB Thai Bank Public Company Limited (CIMBT), Kasikorn Bank Public Company Limited (KBANK), Kiatnakin Bank Public Company Limited (KK), Krung Thai Bank Public Company Limited (KTB), The Siam Commercial Bank Public Company Limited (SCB), Thanachart Capital Public Company Limited (TCAP), TISCO Financial Group Public Company Limited (TISCO), and TMB Bank Public Company Limited (TMB). The newly listed bank LH Financial Group Public Company Limited (LH) is excluded from this study because of limited data availability. This study employs daily returns on bank stocks from 4 January 2005 to 31 May 2012 obtained from Datastream.

Banks are separated into three groups based on bank size because previous literature reveals different impacts between groups (Neuberger, 1991). This study employs the same criteria as those applied by Neuberger (1991), which are different from Wetmore and Brick (1994), who based their criteria on common banking practices. Table 1 presents the descriptive statistics of the individual banks in each group.

Table 1
Descriptive statistics of bank returns

Bank	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis	Jarque-Bera
Large Banks							
BBL	0.0287%	8.5714%	–17.7455%	0.0206	–0.7879	11.4585	5573.77 (0.0000)
KBANK	0.0576%	11.4880%	–20.3828%	0.0221	–0.4236	8.9003	2675.19 (0.0000)
KTB	0.0262%	14.4934%	–24.3126%	0.0235	–0.5511	12.3427	6663.42 (0.0000)
SCB	0.0577%	13.9356%	–23.2446%	0.0229	–0.4593	12.7132	7167.00 (0.0000)
Medium Banks							
BAY	0.0452%	15.5414%	–21.2027%	0.0254	–0.2883	12.6222	6996.08 (0.0000)
TBANK	0.0368%	24.1772%	–23.4281%	0.0247	0.0491	16.5857	13897.35 (0.0000)
TMB	–0.0347%	27.3650%	–19.3132%	0.0276	0.5051	14.3590	9791.41 (0.0000)
Small Banks							
CIMB	0.0001%	26.3255%	–35.5455%	0.0310	0.8419	31.4581	61189.28 (0.0000)
KK	–0.0013%	11.9603%	–18.0748%	0.0209	–0.2795	10.4795	4235.53 (0.0000)
TISCO	0.0198%	11.7783%	–21.0565%	0.0243	–0.1104	8.7982	2534.88 (0.0000)

This table reports the descriptive statistics of the returns of Thai commercial bank stocks. Banks are classified into three groups based on bank size. This study employs daily data from 4 January 2005 to 31 May 2012. The Jarque-Bera test of normality is performed. The *p*-values are given below in parentheses.

During the sample period, the mean returns of SCB and KBANK are the highest while TMB and CIMBT exhibit negative mean returns. However, the volatility is the highest for CIMBT while other banks exhibit the same level of standard deviation with BBL and KK having the lowest stock return volatility. Most of the samples exhibit negative skewness, except for three banks, TBANK, TMB, and CIMBT, which exhibit positive skewness. All sample kurtoses values exceed the normal value of three. Further, the Jarque-Bera test statistics also confirm that return samples are not normally distributed.

For the sensitivity of the bank-return-generating process to interest rates, this study focuses on the short-term rates as supported by Booth and Officer (1985), Choi et al. (1992), Bae (1990), Faff and Howard (1999), and Ryan and Worthington (2002).

In the past, commercial banks have had a substantial exposure to long-term interest rate risks as a result of the maturities mismatch between the major components of banks' balance sheets in the form of deposits and loans (Adrian & Shin, 2008; Diamond & Rajan, 2009). As the importance of the traditional bank product mix has declined and the banking sector's balance sheet has embraced shorter-term market-linked securities, the maturity length of the interest rate risk has declined. Further, banks generally hedge the long-term exposure compared to the shorter-term interest rate risk because they are more risk averse to the long-term interest rate risk and therefore engage in a more rigorous hedging action for this maturity. These are possible explanations for the insignificance of the long-term interest rate sensitivity that was found in previous literature. Therefore, in this study, I am concerned with the short-term interest risk when exploring various maturities of short-term rates regarding different impacts, including daily data of the 1-month, 3-month, 6-month, and 1-year T-bill yields, which are obtained from the Thai Bond Market Association.

Correlation coefficients presented in Table 2 indicate a high degree of correlation between the 3-month and 1-month T-bill yields as well as the 3-month and 6-month T-bill yields. The correlation between 1-month and 1-year T-bill yields is the lowest. Thus, the longer the term difference, the lower the degree of correlation among the T-bill yields in this study.

Table 2
Correlation between short-term interest rates

	1-month	3-month	6-month	1-year
1-month	1.0000	0.8519	0.7145	0.5395
3-month	0.8519	1.0000	0.8129	0.6092
6-month	0.7145	0.8129	1.0000	0.7033
1-year	0.5395	0.6092	0.7033	1.0000

This table reports the correlation coefficients between the short-term interest rates for 1-month, 3-month, 6-month, and 1-year T-bill yields. This study employs daily data from 4 January 2005 to 31 May 2012.

The SET index is used as a proxy for the market portfolio, while the rate of change in the value of the Thai baht against the U.S. dollar is used as a proxy for the change in the foreign exchange rate. Thus, there are three main factors in the multi-index model explored in this study. The descriptive statistics of those exogenous variables are presented in Table 3.

Table 3
Descriptive statistics of market, interest rate, and foreign exchange variables

Variables	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis	Jarque-Bera
SET index	0.0283%	10.5770%	–16.0633%	0.0145	–1.0679	17.7013	16616.07
							(0.0000)
1-month T-bill	0.0145%	4.1145%	–5.9131%	0.0054	–1.1283	27.9813	47370.14
							(0.0000)
3-month T-bill	0.0116%	4.2472%	–4.6033%	0.0049	–0.9299	27.3219	44799.44
							(0.0000)
6-month T-bill	0.0085%	5.0916%	–4.6729%	0.0046	–0.7860	35.0118	77341.71
							(0.0000)
1-year T-bill	0.0060%	5.3172%	–5.2993%	0.0050	0.1278	30.0819	55226.09
							(0.0000)
THB/USD	-0.0109%	4.2103%	–4.2551%	0.0031	0.0731	41.2415	110109.00
							(0.0000)

This table reports the descriptive statistics of the exogenous variables explored in this study: returns on the SET index, changes in 1-month, 3-month, 6-month, and 1-year T-bill yields, and the rate of change in the value of the Thai baht against the US dollar. This study employs daily data from 4 January 2005 to 31 May 2012. The Jarque-Bera test of normality is performed. The *p*-values are given below in parentheses.

Among the exogenous variables employed in this study, the market return proxy, which is the return on the SET index, has the highest mean and also the highest standard deviation. Regarding the changes in the interest rates, the change in the 1-month T-bill yield has the highest mean while the change in the 1-year T-bill yield is the lowest. The volatilities of these interest rate variables are approximately the same. Negative skewness is found in the market and interest rate variables, with the exception of the change in the 1-year T-bill yield, whereas the distribution of the foreign exchange rate presents positive skewness. The sample kurtosis reveals the violation of normality because it exceeds the normal value of three. This result is consistent with the Jarque-Bera test statistics that confirm the non-normality in all variables.

EMPIRICAL RESULTS

The empirical results of the estimation of the GARCH(1,1) model for large, medium, and small banks are presented in Tables 4, 5 and 6, respectively. The tests on the standardised residuals of the GARCH(1,1) models, which are the correlograms and Q statistics, support the hypothesis that the standardised residuals are independent. Thus, these tests suggest that the GARCH(1,1) models are well specified.

This table gives the maximum likelihood estimates of the GARCH(1,1) model for large banks, namely Bangkok Bank Public Company Limited (BBL), Kasikorn Bank Public Company Limited (KBANK), Krung Thai Bank Public Company Limited (KTB), and The Siam Commercial Bank Public Company Limited (SCB). The *p*-values are given below in parentheses.

$$R_{i,t} = \beta_0 + \beta_1 R_{m,t} + \beta_2 R_{r,t} + \beta_3 R_{f,t} + \varepsilon_{i,t}$$
$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1}$$

This table gives the maximum likelihood estimates of the GARCH(1,1) model for medium banks, namely Bank of Ayudhya Public Company Limited (BAY), Thanachart Capital Public Company Limited (TCAP), and TMB Bank Public Company Limited (TMB). The *p*-values of the tests are given below in parentheses.

$$R_{i,t} = \beta_0 + \beta_1 R_{m,t} + \beta_2 R_{r,t} + \beta_3 R_{f,t} + \varepsilon_{i,t}$$
$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1}$$

Table 4
Estimation of the GARCH model for large banks

Large Bank		β_1	β_2	β_3	α_1	α_2	Adjusted R-squared
BBL	1-month	1.0804***	0.1102**	–0.1540*	0.0600***	0.9147***	0.6259
		(0.0000)	(0.0242)	(0.0931)	(0.0000)	(0.0000)	
	3-month	1.0807***	0.1431***	–0.1501	0.0589***	0.9159***	0.6265
		(0.0000)	(0.0093)	(0.1042)	(0.0000)	(0.0000)	
	6-month	1.0791***	0.1312**	–0.1533*	0.0597***	0.9153***	0.6255
		(0.0000)	(0.0465)	(0.0951)	(0.0000)	(0.0000)	
	1-year	1.0785***	0.0277	–0.1506*	0.0601***	0.9145***	0.6249
		(0.0000)	(0.5944)	(0.0991)	(0.0000)	(0.0000)	
KBANK	1-month	1.2553***	0.0937	0.0629	0.0697***	0.8283***	0.6538
		(0.0000)	(0.1058)	(0.5410)	(0.0000)	(0.0000)	
	3-month	1.2558***	0.1321**	0.0643	0.0706***	0.8281***	0.6539
		(0.0000)	(0.0296)	(0.5335)	(0.0000)	(0.0000)	
	6-month	1.2554***	0.1367**	0.0626	0.0726***	0.8231***	0.6536
		(0.0000)	(0.0197)	(0.5434)	(0.0000)	(0.0000)	
	1-year	1.2542***	–0.0146	0.0675	0.0684***	0.8327***	0.6532
		(0.0000)	(0.7973)	(0.5102)	(0.0000)	(0.0000)	
KTB	1-month	1.2100***	–0.0116	–0.1660	0.1105***	0.7746***	0.5719
		(0.0000)	(0.8339)	(0.1308)	(0.0000)	(0.0000)	
	3-month	1.2106***	0.0322	–0.1681	0.1099***	0.7760***	0.5719
		(0.0000)	(0.5815)	(0.1252)	(0.0000)	(0.0000)	
	6-month	1.2091***	–0.0925	–0.1616	0.1083***	0.7783***	0.5725
		(0.0000)	(0.1641)	(0.1419)	(0.0000)	(0.0000)	
	1-year	1.2093***	–0.1483***	–0.1604	0.1094	0.7781***	0.5727
		(0.0000)	(0.0040)	(0.1464)	(0.0000)	(0.0000)	
SCB	1-month	1.2431***	0.1094**	–0.0352	0.0906	0.8411***	0.6067
		(0.0000)	(0.0476)	(0.7383)	(0.0000)	(0.0000)	
	3-month	1.2419***	0.0841	–0.0334	0.0891	0.8448***	0.6065
		(0.0000)	(0.1921)	(0.7517)	(0.0000)	(0.0000)	
	6-month	1.2415***	0.1206*	–0.0348	0.0899	0.8448***	0.6062
		(0.0000)	(0.0773)	(0.7420)	(0.0000)	(0.0000)	
	1-year	1.2404***	0.0045	–0.0311	0.0884	0.8479***	0.6057
		(0.0000)	(0.9376)	(0.7671)	(0.0000)	(0.0000)	

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

This table gives the maximum likelihood estimates of the GARCH(1,1) model for small banks, namely CIMB Thai Bank Public Company Limited

(CIMBT), Kiatnakin Bank Public Company Limited (KK), and TISCO Financial Group Public Company Limited (TISCO). The *p*-values of the tests are given below in parentheses.

$$R_{i,t} = \beta_0 + \beta_1 R_{m,t} + \beta_2 R_{r,t} + \beta_3 R_{f,t} + \varepsilon_{i,t}$$
$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1}$$

Table 5
Estimation of the GARCH model for medium banks

Medium Bank		β_1	β_2	β_3	α_1	α_2	Adjusted R-squared
BAY	1-month	1.2124***	0.1011*	–0.0114	0.1304***	0.7895***	0.5737
		(0.0000)	(0.0846)	(0.9205)	(0.0000)	(0.0000)	
	3-month	1.2127***	0.0979	–0.0085	0.1309***	0.7888***	0.5737
		(0.0000)	(0.1170)	(0.9408)	(0.0000)	(0.0000)	
	6-month	1.2097***	0.1835***	–0.0158	0.1362***	0.7794***	0.5734
		(0.0000)	(0.0019)	(0.8888)	(0.0000)	(0.0000)	
	1-year	1.2116***	0.1949***	–0.0160	0.1307***	0.7899***	0.5748
		(0.0000)	(0.0003)	(0.8895)	(0.0000)	(0.0000)	
TBANK	1-month	1.0723***	–0.0465	0.1147	0.1218***	0.7326***	0.4403
		(0.0000)	(0.4862)	(0.1457)	(0.0000)	(0.0000)	
	3-month	1.0719***	–0.0860	0.1126	0.1214***	0.7350***	0.4402
		(0.0000)	(0.2274)	(0.1532)	(0.0000)	(0.0000)	
	6-month	1.0720***	–0.1122	0.1138	0.1216***	0.7345***	0.4402
		(0.0000)	(0.1217)	(0.1490)	(0.0000)	(0.0000)	
	1-year	1.0724***	–0.0729	0.1124	0.1228***	0.7324***	0.4398
		(0.0000)	(0.3062)	(0.1549)	(0.0000)	(0.0000)	
TMB	1-month	1.1229***	–0.0253	0.3372**	0.4005***	0.3180***	0.3439
		(0.0000)	(0.7559)	(0.0363)	(0.0000)	(0.0000)	
	3-month	1.1227***	–0.0047	0.3329**	0.3973***	0.3178***	0.3441
		(0.0000)	(0.9565)	(0.0394)	(0.0000)	(0.0000)	
	6-month	1.1239***	0.1718*	0.3150*	0.3813***	0.3225***	0.3460
		(0.0000)	(0.0957)	(0.0537)	(0.0000)	(0.0000)	
	1-year	1.1264***	0.2039**	0.3236**	0.3812***	0.3167***	0.3463
		(0.0000)	(0.0197)	(0.0500)	(0.0000)	(0.0000)	

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

The empirical results indicate that bank returns are highly sensitive to the return on the market. The beta coefficients are all statistically significant. Large banks, except for BBL, are more sensitive to change in market conditions than medium and small banks. This result is invariant to the specification of the interest rate. Considering Hypothesis 1, the null hypotheses are rejected in all cases.

Regarding the hypotheses concerned with the interest rate risk, the direction of the influence of interest rates on large bank returns shows that the short-term interest rates are significant with positive coefficients, except for KTB that exhibits negative coefficients. The magnitude of the positive effect is the lowest for the longest short-term interest rate, the 1-year T-bill yield. The result is consistent with Faff and Howard (1999) and Ryan and Worthington (2002), who find a decline in the longer-term interest rate sensitivity. Thus, large bank returns are more sensitive to the short-term interest rate. Significant positive coefficients are also found for medium banks; however, the magnitude tends to be larger when longer-term interest rates are employed. CIMBT, which is categorised as a small bank in this study, exhibits a significant positive interest rate sensitivity, whereas TISCO exhibits the opposite result.

Table 6
Estimation of the GARCH model for small banks

Small Bank		β_1	β_2	β_3	α_1	α_2	Adjusted R-squared
CIMBT	1-month	0.7236***	0.0829	−0.1819*	0.3866***	0.6298***	0.1247
		(0.0000)	(0.2367)	(0.0909)	(0.0000)	(0.0000)	
	3-month	0.7229***	0.0612	−0.1793*	0.3897***	0.6278***	0.1244
		(0.0000)	(0.3272)	(0.0771)	(0.0000)	(0.0000)	
	6-month	0.7222***	0.1260**	−0.1840*	0.3848***	0.6289***	0.1253
		(0.0000)	(0.0381)	(0.0604)	(0.0000)	(0.0000)	
	1-year	0.7245***	0.1222***	−0.1827*	0.3932***	0.6266***	0.1254
		(0.0000)	(0.0051)	(0.0578)	(0.0000)	(0.0000)	
KK	1-month	0.8132***	−0.0051	−0.3795***	0.1490***	0.7054***	0.3195
		(0.0000)	(0.9360)	(0.0000)	(0.0000)	(0.0000)	
	3-month	0.8130***	−0.0809	−0.3779***	0.1479***	0.7071***	0.3198
		(0.0000)	(0.2479)	(0.0000)	(0.0000)	(0.0000)	
	6-month	0.8136***	−0.1026	−0.3760***	0.1483***	0.7061***	0.3201
		(0.0000)	(0.1178)	(0.0000)	(0.0000)	(0.0000)	
	1-year	0.8132***	−0.1158	−0.3766***	0.1485***	0.7056***	0.3199
		(0.0000)	(0.1135)	(0.0000)	(0.0000)	(0.0000)	
TISCO	1-month	1.0204***	−0.1387*	−0.1093	0.0759***	0.8407***	0.3675
		(0.0000)	(0.0930)	(0.4835)	(0.0000)	(0.0000)	
	3-month	1.0207***	−0.1419	−0.1160	0.0750***	0.8426***	0.3676
		(0.0000)	(0.1281)	(0.4555)	(0.0000)	(0.0000)	
	6-month	1.0214***	−0.1389	−0.1132	0.0744***	0.8441***	0.3677
		(0.0000)	(0.1591)	(0.4679)	(0.0000)	(0.0000)	
	1-year	1.0214***	−0.0890	−0.1158	0.0749***	0.8428***	0.3672
		(0.0000)	(0.3555)	(0.4589)	(0.0000)	(0.0000)	

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

The interest rate risk arises from the maturity mismatching of a bank's assets and liabilities. The interest rate change has the potential to influence a bank's net interest income as well as the market values of its assets and liabilities, which is reflected in the negative effect on bank stock returns found in the sample. Regarding the presence of positive sensitivity to the interest rate risk, this finding is consistent with the findings in Williams (2007). The positive effect reveals that some Thai commercial banks, namely BBL, KBANK, SCB, BAY, TMB and CIMBT, are able to increase net interest margins and thus profitability as a consequence of increased market power. Therefore, an increase in interest rates may enable banks to pass on these costs leading to higher income. For example, when interest rates increase, some Thai banks can benefit from the interest rate sensitivity by accelerating the lending rate, while the borrowing rate is sticky. In doing so, these banks can enjoy a higher net interest margin and thus a higher profitability as a consequence of high market power. In contrast, when interest rates decrease, the banks can benefit from the interest rate sensitivity by conducting the opposite operation.

The only two banks for which I cannot find any significant short-term interest rate effects, TBANK and KK, are medium and small banks, respectively. By observing these two banks, I found that the unexpected insignificant results arise from changes in the structure and business of their banks and related companies due to mergers and restructurings in 2011.

In conclusion, there is evidence to support the influence of the interest rate on the bank-stock-return-generating process, verified by the rejection of the null hypothesis of no interest rate effect outlined in Hypothesis 2, where both statistically significant positive and negative effects are found. Nevertheless, Choi et al. (1996), Allen and Jagtiani (1997), and Benink and Wolff (2000) discuss that the interest rate sensitivity has decreased in the late 1980s and early 1990s due to the availability of interest rate derivatives contracts for hedging purposes; thus, there is a tendency toward an insignificant influence of the interest rate change.

Next, regardless of the interest rate maturity under consideration, the empirical evidence reveals significant negative effects of the foreign exchange rate risk in small banks. The negative influence is consistent with the findings of Choi et al. (1992), Wetmore and Brick (1994), and Tai (2000). Nevertheless, there is no significant evidence for large and medium banks, except of BBL and TMB. A potential explanation for the insignificant result is that those banks are not exposed to a significant foreign exchange rate risk over the sample period. Only some banks do have a significant on-balance sheet foreign currency exposure. Furthermore, while exposed to adverse fluctuations in the foreign exchange rate, those banks may have adequately hedged their foreign exchange rate exposure throughout the sample period. Therefore, as outlined in Hypothesis

3, the null hypothesis of no foreign exchange rate sensitivity can be rejected for some banks.

All estimated GARCH(1,1) parameters are non-negative and statistically significant. This result confirms that the bank-stock-return-generating process follows the GARCH process and that the volatility is time variant. The magnitude of the parameter α_1 is smaller than the parameter α_2, except for TMB. This result is consistent with Elyasiani and Mansur (1998), who indicate that the effect of the last period's shock on bank volatility is smaller than the effect of previous surprises. Further, the sums of α_1 and α_2 , as a measure of volatility persistence, are all less than unity irrespective of interest rates, indicating second-order stationary, except for CIMBT. From the results, the relatively high value of the persistence measure provides evidence that shocks to the banking sector have highly persistent effects and that the response function of volatility decays slowly.

CONCLUSION

This paper examines the relationship between the market, interest rate, and foreign exchange rate risk and bank stock returns in Thailand. It is apparent that market risk is the major component, with large banks being more sensitive to the change in market conditions than medium and small banks. There is evidence to support the influence of the interest rate on the bank-stock-return-generating process, both positive and negative. The results reveal important information on the Thai banking industry; that is, some banks can use their competitiveness and high market power to take advantage of interest rate changes, leading to higher profitability and indicating a positive sensitivity to the interest rate risk, whereas banks with low market power and less efficient banks may not efficiently manage their risk exposures, resulting in negative effects of interest rate risk from the maturity mismatching of their assets and liabilities. The empirical results also indicate a decline in longer-term interest rate sensitivity. Furthermore, this study also confirms that the foreign exchange rate risk is the relevant risk for small banks. There is no significant evidence for most of the large and medium banks, which may arise from the fact that they were not exposed to significant foreign exchange rate risk over the sample period or that those banks may have adequately hedged their foreign exchange rate exposure throughout the sample period. The estimation under the GARCH(1,1) framework confirms that the bank-stock-return-generating process follows the GARCH process and that the volatility is time variant. Furthermore, there is evidence of the relatively high value of the persistence measures.

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