Asia-Pacific Banks' Interest Rate and Exchange Rate Exposures

Abstract

In this paper, we provide an insight into Asia-Pacific banks' interest rate and exchange rate exposures using a market-based model. Our study provides a unique comparative analysis across ten countries, for both short horizon and long horizon risk exposures. Overall, our findings reveal stronger evidence of significant interest rate and exchange rate exposures with long horizon returns. This is consistent with the view that using long horizon return allows us to uncover economic exposures which are difficult to hedge (rather than more transactional exposures). In addition, we find stronger evidence of economies of scale in interest rate risk management with long horizon return. Among the country groups, the newly industrialized economies display the greatest sensitivity to long horizon interest rate and exchange rate factors.

1. Introduction

Banks have been playing an important role in channeling foreign funds to fuel growth in the Asia-Pacific region. In doing so, they are exposed to massive interest rate and exchange rate risks. In fact, a frequently cited reason for the 1997 Asian financial and banking crisis is the interest rate maturity and exchange rate mismatches in the banks' balance sheet. Since then, there is a renewed interest on the interest rate and exchange rate exposures of Asia-Pacific banks. In particular, regulators and investors are concerned about whether these banks have improved their risk position in recent years.

While there have been numerous studies of interest rate and exchange rate exposures of US banks, studies in relation to Asia-Pacific banks are limited to a few developed countries, i.e. Japan and Australia. It is therefore the aim of this paper to provide a more complete picture of the interest rate and exchange rate exposures of banks in the Asia-Pacific region by investigating ten Asia-Pacific countries including developed as well as previously unexplored developing economies.

Although the level of banks' risk exposures is vital for the stability of the banking system, reporting of Asia-Pacific banks' interest rate and exchange rate exposures in their financial statements is generally limited. Even when such information is reported, it offers a poor measure of a bank's risk exposures since it does not account for its hedging activities using derivative instruments (Kho and Stulz, 2000). Therefore, we focus on direct measures of interest rate and exchange rate exposures of banks estimated from equity returns.

Since prior evidence has found that long horizon exchange rate exposure is more frequently detected in US banks (Martin and Mauer, 2003a), we also test the generalisability of this finding by comparing and contrasting Asia-Pacific banks short and long horizon exposures to exchange rate changes. As interest rate exposure is also an important source of banking risk, we extend our analysis to test the Asia-Pacific banks' short and long horizon exposures to interest rate changes. We then further investigate the effect of bank size and countries' level of economic development on banks' interest rate and exchange rate exposures.

Accordingly, this paper aims to address the following research questions: (i) Are Asia-Pacific banks significantly exposed to interest rate and exchange rate risks? (ii) Are long horizon interest rate and exchange rate exposures more prevalent? (iii) Does bank size affect the level of banks' short and long horizon exposures? and (iv) Do banks' interest rate and exchange rate exposures differ across countries' level of economic development?

This study contributes to the literature by providing an insight into Asia-Pacific banks' interest rate and exchange rate exposures which could not be accurately determined from their financial statements. Our findings will enhance regulators' understanding of risk exposures of Asia-Pacific banks in their effort of improving supervision and regulations. If risk exposure is excessive, then more stringent regulations may be needed to limit banks' risk exposures, for example, via the imposition of a higher capital requirement. The investigations of banks' long and short horizon exposures enable bank managers to more effectively hedge their long and short horizon exposures via different operational and/or financial hedging techniques[1]. Comparison of banks' interest rate and exchange rate exposures by size and countries' level of economic development will assist regulators in identifying characteristics of banks that predispose them to higher market risk exposures.

Our findings in the Asia-Pacific context are broadly consistent with the findings of prior literature investigating US, Japanese and Australian banks. With long horizon returns, we found a larger number of significant interest rate and exchange rate exposures. This finding is consistent with prior literature that long horizon return measures economic exposures, which are difficult to hedge. We find stronger evidence of economies of scale in interest rate risk management with long horizon return. Among the country groups, the newly industrialized economies display the greatest sensitivity to long horizon interest rate and exchange rate changes.

The remainder of this paper is organized as follows. Section 2 provides an overview of the prior literature surrounding banks' interest rate and exchange rate exposures

[1] Chow et al. (1997b) highlighted that transactional (short-horizon) exposure can be managed by using financial derivative contracts while economic (long-horizon) exposure can only be managed through operational hedges (e.g. constructing overseas facilities) so that foreign currency inflows and outflows can be matched to reduce the amount of exposed cash flows.

while Section 3 outlines the data and methodology employed in this study. This is followed by presentation of empirical results and discussion in Section 4. Section 5 summarizes and concludes this study.

2. Literature Review

2.1 Banks' interest rate exposure

Banks are exposed to interest rate risk because of the potential mismatch between the maturity or time to repricing of their interest rate sensitive assets and liabilities. As interest rate changes, these mismatches can result in volatility in banks' income and net worth. In addition, banks' non-interest income could also be highly sensitive to interest rate changes. Fraser et al. (2002) found that high interest rates reduce economic growth and subsequently reduce banks' non-interest income from Initial Public Offerings and acquisition related activities. Thus, banks which are reliant on non-interest income are also exposed to interest rate risk.

Empirical research that estimates interest rate exposure by employing an augmented market model generally found that US commercial banks are exposed to interest rate risk (Flannery and James, 1984; Akella and Chen, 1990). Madura and Zarruk (1995) investigating Canadian, German, Japanese, US and British banks, found that bank interest rate risk varies across countries and that interest rate risk is greater for non-US banks relative to US banks. This could be due to cross country differences in bank regulations, comparative advantage in banking operations and bank cost of capital.

Consistent with US studies, other studies focusing on the Asia-Pacific countries (i.e. Australia and Japan) have found that banks are typically more sensitive to changes in long-term interest rates relative to short-term interest rate (Faff and Howard, 1999; Saporoschenko, 2002). Changes in long-term interest rates provide a stronger signal to the market because long-term interest rates are more stable than short-term interest rates in these countries during the sample period. While these studies examined interest rate sensitivity in Australia and Japan, the interest rate exposures of banks in other Asia-Pacific countries remain unexplored.

2.2 Banks' exchange rate exposure

Banks can be affected by exchange rate fluctuations directly due to their international operations and foreign currency transactions and indirectly through the exchange rate influence on the extent of foreign competition, the demand for loans and other banking conditions (Chamberlain et al., 1997). During the 1997 Asian crisis, many Asian banks used extensive offshore financing (typically US dollar denominated) to make domestic loans (Kho and Stulz, 2000). When the local currencies devalued unexpectedly, these Asian banks were exposed to significant exchange rate risk and suffered huge losses.

Similar to the interest rate exposure literature, studies on banks' exchange rate exposure are limited in the Asia-Pacific context except for Japan. Chamberlain et al. (1997) compare the exchange rate risk exposures of US and Japanese banks. They find that Japanese banks less frequently exhibit sensitivity to exchange rates relative to US banks due to differences in the operation and regulatory conditions of banks in the two countries. Martin (2000) presents evidence that over 40% of the key financial institutions in the foreign exchange market are significantly exposed to exchange rate changes during 1994-1996. In particular, US portfolios are consistently insignificant but UK, Swiss and Japanese banks are significantly exposed. However, there are only two Japanese banks in the sample, and thus, the results cannot be generalised to the rest of the Japanese banks.

Kho and Stulz (2000) examine the impact of the 1997 Asian crisis and International Monetary Fund program announcement on bank stocks and also examine banks' currency exposure. They conclude that during the Asian crisis, banks in the Philippines and Indonesia had significant exposures to foreign exchange movements. However, exchange rate changes had no significant impact beyond their impact on general market movements on Korean, Thai and Malaysian banks. Kho and Stulz (2000) suggest that these results may reflect that 'banks were hedging more than commentators believed they are' or that 'the market expected currency losses to be offset by bailouts'. However, their study was based on aggregated banking industry indices for each country and the study period was limited to 1997-1998. Saporoschenko (2002) studies both interest rate and foreign exchange risks assumed

by the various types of Japanese banks, namely city banks, long term credit banks, trust banks and regional banks. He found that individual Japanese bank stock returns are usually negatively related to long term interest rate changes and not very sensitive to foreign exchange rate changes.

2.3 Transaction versus economic exposures

Past literature that employs the augmented-market model to investigate interest rate and exchange rate exposures typically uses short horizon (weekly or monthly) return. Recent studies (for example, Chow et al., 1997a) pointed out that the use of short horizon return may not fully capture the true picture of risk exposure as interest rate and exchange rate changes may contain information about future cash flows of more than one period. As a result, stock prices may not instantaneously respond to exchange rate changes. Accordingly, this could explain why prior studies failed to find an association between stock returns and exchange rates.

Studies that employ long horizon return consistently find that firms' exchange rate exposure becomes more significant as the horizon lengthens (Chow et al., 1997b; Nguyen and Faff, 2003). A possible reason for these results is that short horizon stock returns tends to measure operational or transactional exposure[2] which is short term and can be effectively hedged by firms through various hedging techniques. In contrast, long horizon stock returns tend to capture economic exposures,[3] which are more difficult to identify and hedge against. However, these studies were limited to firms' rather than banks' exchange rate exposures.

Banks need to be aware of the possibility of long horizon economic exposure since a lack of exposure to short horizon interest rate and exchange rate risks does not guarantee the long-term viability of the bank. In the banking context, short horizon (transaction) interest rate and exchange rate exposures typically arise from trading activities, marked to market investments, short term off balance sheet obligations such as letter of credit and financial derivatives (Lee and Solt, 2001). Long horizon

[2] Transaction exposure is the effect of exchange rate changes on cash flows between the time a transaction is "booked" and when it is "settled". It has a shorter time dimension (Chow et al., 1997b).
[3] Economic exposure may arise from changes in the sales prices, sales volumes, and the cost of inputs of the firm and its competitors as a result of exchange rate changes (Martin and Mauer, 2003b).

(economic) interest rate and exchange rate exposures may arise from bank long term lending and leasing portfolios, held to maturity investments and off-balance sheet obligations such as medium-term lines of credit, and long dated financial derivatives obligations (Lee and Solt, 2001).

Martin and Mauer (2003a) investigated both the short and long term exchange rate exposures of US banks using a cash flow based analysis. They estimate exchange rate exposure for each bank as the correlation between operating income (as a proxy for cash flows) generated by banks and contemporaneous and/or lagged exchange rates using an Almon distributed lag model. The optimal lag length of the estimation is determined by the Akaike Information Criterion. Martin and Mauer (2003a) then classify the exposures as short term when the optimal lags are one year or less and long term when the optimal lags are greater than two years.

Martin and Mauer (2003a) found that long horizon exposure is more prevalent than short horizon exposure among the US banks, which is consistent with prior long-horizon exposure studies. They also found that their domestically oriented banks more frequently exhibit significant exposures relative to internationally oriented banks, which supports the argument that banks with a greater extent of international activities enjoy economies of scale in their hedging strategy.

2.4 Asia-Pacific Banks' Country Specific Characteristics and Risks

Madura and Zarruk (1995) found evidence that the interest rate exposures of banks varies across countries due to differences in banking regulations, comparative advantage in operations and costs of capital.

In the Asia-Pacific region, banks are subjected to different regulations across countries. In particular, banks in New Zealand, Hong Kong and the Philippines are allowed to participate in a range of securities, insurance and real estate activities while banks in Australia, Japan and South Korea are prohibited from engaging in real estate development and management related activities. Banks in Taiwan have least freedom in that they are only allowed to participate in securities activities (World Bank, 2004). To the extent that their more diversified activities allow them to reduce their interest

rate and exchange rate exposures, banks in New Zealand, Hong Kong and the Philippines should have less risk exposures relative to counterpart banks in other Asia-Pacific countries.

Banks in more developed countries typically dominate the market for foreign exchange trading and risk management services. Thus, banks in more developed countries such as Japan, Australia and Hong Kong may have greater exposures to interest rate risk and exchange rate risk relative to banks in less developed countries.[4] However, it should be noted that banks in more developed countries might have less exposure to interest rate and exchange rate risk due to their diversified international activities.

Banks that operate in countries where market conditions allow for a low cost of capital could more easily afford to take risk and would be more willing to accept exposure to risk (Madura and Zarruk, 1995). Zimmer and McCauley (1991) found that Japanese banks enjoy a low cost of capital relative to other developed countries. Moshirian and Pham (1999) found that Australian banks have a higher cost of capital than New Zealand, Japan, US and UK, which explains why Australian banks actively expand their operations abroad. These findings suggest that relative to other Asia-Pacific banks, Japanese bank may have a higher level of interest rate and exchange rate exposures.

3. Sample and Methodology

3.1 Sample Selection

A list of locally incorporated commercial banks was obtained from the central bank (or regulatory authority) websites of 10 Asia-Pacific countries being Australia, Hong Kong, Japan, Malaysia, New Zealand, the Philippines, Singapore, South Korea, Taiwan and Thailand.[5] We then obtained the stock price data for each bank from

[4] Patro et al. (2002) found that among the OECD countries, Australia and Japan are significantly exposed to currency risk. Whether developing countries face greater currency risk relative to developed countries remains an empirical question.

[5] The addresses of the central bank or regulatory authority websites are as follows:
Australian Prudential Regulation Authority http://www.apra.gov.au/ADI/ADIList.cfm#AOBC ;
Hong Kong Monetary Authority http://www.info.gov.hk/hkma/eng/site/index.htm ;
Bank of Japan http://www.boj.or.jp/en/ ;
Bank Negara Malaysia http://www.bnm.gov.my/index.php?ch=13&cat=banking ;
Reserve Bank of New Zealand http://www.rbnz.govt.nz/banking/nzbanks/index.html.

Datastream, and after eliminations due to a lack of data, we ended with a final sample of 110 banks.[6] Japanese banks make up a large proportion of the sample (49%), followed by Hong Kong banks (10%). The remaining countries have less than 10% representation in the sample. However, the sample represents more than 40% of total banks in each country except for Taiwan, the Philippines and New Zealand.

Data for estimating interest rate and exchange rate exposures of Asia-Pacific banks were obtained from *Datastream*. The following weekly and 12 monthly overlapping data (sampled weekly) were collected for each sample country: i) equity market index, ii) bond index, iii) short term interest rate (3 month) and iv) exchange rate; and for each sample bank, the stock price data for the period from January 1999 to December 2002.

3.2 Estimation Framework

3.2.1 Estimation of banks' interest rate and exchange rate short run exposures

Following the methodology adopted by the extant literature, the interest rate and exchange rate exposure betas are estimated for each sample bank by employing the following augmented market model regression:

$$R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_t \qquad (1)$$

where R_{it} is the equally weighted bank stock return of country i in period t; R_{mt} is the return on the market index of each country in period t; $LTIR_t$ is the return on a long term (7 to 10 years) government bond index;[7] $STIR_t$ is the holding period return on 3-month Treasury bills or comparable 3-month interest rates[8] and EX_t is the rate of

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Central Bank of the Philippines http://www.bsp.gov.ph/resources/bankdir/bankdir2.asp ;
Monetary Authority of Singapore http://www.mas.gov.sg/frames/directory/index.htm ;
Financial Supervisory Commission of Korea http://www.fsc.go.kr/eng/financial/financial_list.asp ;
Central Bank of China (Taiwan) http://www.cbc.gov.tw/EngHome/Ebankexam/List.htm ;
Bank of Thailand http://www.bot.or.th/bothomepage/databank/Institutions/Institutions_e.htm.

[6] Stock price data are not available for these banks because they are either not listed on an organized stock exchange or have merged with other local banks.

[7] The bond return index for Hong Kong, Taiwan, South Korea, Malaysia and the Philippines are not available from *Datastream* and, hence, the average bond return index of Japan, Singapore and Thailand, adjusted for domestic currency, are used as a proxy of *LTIR* for these countries, assuming that long term interest rates are integrated for this group of Asian countries.

[8] The short term 3 month interest rate used for each country is: the Treasury bill rate for Hong Kong, Singapore, the Philippines and New Zealand, the interbank rate for Malaysia and Thailand, the Gensaki 3 month rate for Japan, the commercial paper rate for Korea, the money market rate for Taiwan and the Australian bank accepted bill rate for Australia.

change in USD per unit of local currency in period *t* for all countries except for Malaysia and Hong Kong. For these two countries, since their currency is pegged to the USD, EX_t is estimated as the rate of change in JPY per unit of local currency. The short term 3-month interest rates (yields) are converted into holding period returns following Faff and Howard (1999). The holding period return is calculated as $STIR_t = (P_t - P_{t-1}) / P_{t-1}$, where $P_t = 100/[1+Y_t (90/36500)]$.

To estimate short horizon interest rate and exchange rate (transactional) exposures, weekly return for each of the variables in Eq. (1) is used. On the other hand, 12 month overlapping returns for each of the variables is used to estimate banks' long horizon interest rate and exchange rate (economic) exposures. Since using an overlapping procedure will cause the error term to be autocorrelated with order T-1 (Chow and Chen, 1998), the Hansen's (1982) GMM technique is used to estimate the long horizon exposure to adjust the variance-covariance matrix of the estimated coefficients for heteroskedasticity and autocorrelation.

Past studies often find that the use of a bond index return and holding period return as interest rate factors will yield a positive coefficient which indicates an inverse relation between interest rate changes and the return on bank stocks (e.g. Flannery and James, 1984). Thus, a positive exposure of β_{LTIR} and β_{STIR} would indicate that an increase in interest rates (decrease in interest rate holding period return) will negatively impact on the return on bank stock. For the exchange rate exposure, a positive exchange rate exposure would imply that when local currency appreciates, a bank's stock return is impacted positively.

4. Results and Discussion

4.1 Short Horizon Interest Rate and Exchange Rate Exposures

Table 1 presents the results from Eq. (1), based on non-overlapping weekly data. The Australian bank portfolio is found exposed to long term interest rate changes, which is consistent with Faff and Howard (1999) findings. On the other hand, we find that the banking portfolios of Japan, Hong Kong and the Philippines are significantly exposed to short term interest rate changes. This finding contradicts the observations from past research that bank stock returns are more sensitive to changes in long term interest

rates (Madura and Zarruk, 1995; Faff and Howard, 1999). A possible explanation for this is that the short term interest rates are more volatile in these countries and were priced by investors over our sample period.

As for the sign of the exposures, we find that most countries are positively exposed to the long term and short term interest rate factors. The positive exposures indicate that when there is an increase in interest rate (decrease in interest rate holding period return), the return on the bank stocks of these countries will be negatively affected (an inverse relationship). Our Japanese bank portfolio result is broadly consistent with Saporoschensko (2002), where 28% of their Japanese bank sample has significant positive exposures to long term interest rate factor over the sample period of 1986-1992. Similarly, Madura and Zarruk (1995) also found an inverse relationship between stock returns and long and short term interest rate changes for their Japanese bank portfolio over the sample period of 1988-1993. The difference in the level of statistical significance could be due to the different sample period and sample size investigated.[9]

For exchange rate exposures, none are statistically significant. The lack of significance could be attributed to the fact that, short horizon exposures are effectively hedged by the banks in these countries since short horizon exposures are more direct and can be relatively easily estimated. The Reserve Bank of Australia has reported that Australian banks have little foreign currency exposure, even though they have large overseas borrowings as these borrowings are hedged back to Australian dollars using instruments such as foreign exchange forwards and cross-currency swaps (Reserve Bank of Australia, 2002).

Overall, banks from countries that have more freedom in their activities, namely, New Zealand, Hong Kong and the Philippines have lower short horizon long term interest rate and exchange rate exposures relative to Taiwan where banks are only allowed to participate in securities activities. Banks in developing countries, i.e. Thailand and Malaysia generally have lower interest rate exposures. Madura and Zarruk (1995) suggest that non-US banks, especially Japanese banks may be more willing to accept

[9] Madura and Zarruk (1995) included 8 major Japanese international banks in their portfolio while the Japanese bank portfolios in the current study consist of 54 Japanese banks.

exposure to interest rate risk due to its low cost of capital. Our results show that among the Asia-Pacific banks, Japanese banks have the greatest exposure to short term interest rate changes but lower long term interest rate and exchange rate exposures. This mix in results could be due to the recent reforms in the Japanese banking industry.

Insert Table 1 about here

4.2 Long Horizon Interest Rate and Exchange Rate Exposures

Table 2 reports the results of estimating Eq. (1) using long horizon (12-month) returns. When long horizon stock returns are regressed against long horizon market, interest rate factor and exchange rate returns, there are a larger number of significant interest rate and exchange rate coefficients. This finding is consistent with prior studies that long horizon return measures economic exposures, which are difficult to hedge.

We find that most banks are exposed to long term and/or short term interest rate changes. Most notably the bank portfolios of Japan, Thailand, Singapore, Australia and New Zealand are positively exposed to the long term interest rate factor. Similarly, most bank portfolios are found to be positively exposed to the short-term interest rate factor. These banks include South Korea, Taiwan, the Philippines, Malaysia, Australia and New Zealand banks.

As compared to long horizon interest rate exposures, the long horizon exchange rate exposures are largely unimportant – consistent with the view that these exposures are well managed by our sample banks. Only Hong Kong, the Philippines and New Zealand banking portfolio show significant long horizon exposures. The Asia-Pacific banks seem to have learned their lesson from the 1997 Asian crisis and have been managing both short and long horizon exchange rate exposures prudently.

Insert Table 2 about here

4.3 Bank Size Effect

Faff and Howard (1999) argue that the interest rate risk of banks could vary according to institutional size. Larger banks are more likely to hedge their risk exposures

because they have sophisticated risk management structures and expertise in place. However, it is also possible that large banks may have greater risk exposures due to moral hazard behavior, where banks that are too big to fail have an incentive to incur risks that are underwritten by the government deposit insurance system. In contrast, smaller banks typically have less sophisticated risk management systems and are likely to have greater risk exposures since their business is also less diversified.

To investigate whether the interest rate and exchange rate exposures of our sample banks vary according to size (proxied by total assets), we disaggregate the banking portfolio in each country into two categories: a large bank portfolio and a small bank portfolio. Banks with total assets greater (less) than the median total assets in a particular country is categorized into the large (small) bank portfolio.[10]

4.3.1 Bank Size Effect in Short Horizon Interest Rate and Exchange Rate Exposures

Table 3 presents the estimated short horizon interest rate and exchange rate exposures for the small and large bank portfolios. We find that smaller Japanese and Thai banks have significant short term interest rate and exchange rate exposures, respectively. However, such exposures are not significant in the corresponding large bank portfolios. Although not statistically significant, the large bank portfolio of Thailand, South Korea and Malaysia generally have smaller long term and short term interest rate exposures, relative to the small bank portfolio. These results provide some support to the argument that larger banks have more sophisticated risk management systems and therefore have less interest rate exposures.

The lack of significant exposures seems to suggest that short horizon interest rate and exchange rate exposures can be effectively hedged using simple financial derivative instruments which are easily available to both large and small banks. Hence, both the large and small banks do not have significant interest rate and exchange rate exposures.

[10] The banking portfolios of Singapore, the Philippines and New Zealand are excluded from this analysis due to the lack of observations.

Interestingly, both large and small Australian banks are significant and positively exposed to the long term interest rate factor. Since the interest rate beta coefficient is greater for large banks, our results suggest that larger Australian banks have greater long term interest rate exposures relative to smaller Australian banks. This finding is consistent with Faff and Howard (1999).

Insert Table 3 about here

4.3.2 Bank Size Effect in Long Horizon Interest Rate and Exchange Rate Exposures

Table 4 shows the estimated interest rate and exchange rate exposures using long horizon return for both large and small bank portfolios. With long horizon returns, there are a greater number of significant interest rate and exchange rate exposures. Again, these results highlight banks' difficulty in measuring and hedging long horizon economic exposure.

Smaller banks tend to have greater long horizon short term interest rate exposures relative to larger banks in all countries investigated. Except for Hong Kong banks, the short term interest rate exposures estimated are statistically significant at least at the 5% level. These results support the argument that economies of scale are important in managing economic exposures. Larger banks that have more diversified operations seem to be able to alleviate their risk exposures through operational and geographical diversification which usually involves high costs. Smaller banks may not have adequate resources to build and manage international operations as operational hedges. On the other hand, both large and small banks of Japan and Australia have significant long term interest rate exposures, suggesting the economies of scale in risk management do not apply in countries that are major financial centers.[11]

Larger banks have more significant long horizon exchange rate exposures relative to smaller banks. This is because large banks tend to be more involved in international operations and are therefore more susceptible to foreign exchange rate changes. Having more diversified operations does not seem to alleviate larger banks' long horizon risk exposures. This argument is consistent with Martin and Mauer (2003a)

[11] In contrast, for Hong Kong being a major financial centre, neither its large nor its small banks are significantly exposed to the long-term interest rate factor possibly due to their risk management expertise and more diversified operations.

findings that internationally oriented banks are more exposed to exchange rate risk relative to domestically oriented banks. Martin and Mauer (2003a) suggest that the prevalence of longer-term exposures within the group of internationally oriented banks is indicative of a focus on hedging short term exposures that are easier to measure and hedge.

Another possible explanation is that large banks that are too big to fail may be taking advantage of government deposit insurance and were undertaking excessive exchange rate risk through massive foreign currency borrowings/ activities (MacKinnon and Pill, 1999). As a result, larger banks are found to be facing greater economic exposures as compared to smaller banks.

Insert Table 4 about here

4.4 Bank's interest rate and exchange rate exposures and level of economic development

We disaggregate the sample into three categories (based on the International Monetary Fund classification) given the disparity in the level of countries' economic development in the Asia-Pacific region. These categories are: Advanced developed economies, newly industrialized economics (NIE) and developing economies. The advanced developed economies consist of Japan, Australia and New Zealand; Newly Industrialized Economies consist of Hong Kong, Singapore, South Korea and Taiwan while developing economies consist of Malaysia, Thailand and the Philippines. Following Madura and Zarruk (1995), the domestic interest rate and exchange rate returns in Eq.(1) are replaced with the return of international interest rate and exchange rate factors. The international interest rate and exchange rate factors are measured as the equally weighted mix of proxies for countries included in this study.

Table 5 presents the short and long horizon estimates of interest rate and exchange rate exposures by grouping country's according to their level of economic development. For short horizon return (Panel A), evidence of sensitivity to interest rate and exchange rate changes is limited for all the three categories of countries. Only the developing economies are exposed to short term interest rate changes at 10% level. Conversely, there is a greater level of significance associated with long horizon

return (Panel B). All three categories have significant long horizon exchange rate exposures while only the more developed countries (advanced and newly industrialized) have exposure to the short term interest rate factor.

Among the three categories, the newly industrialized economies display the greatest sensitivity to long horizon interest rate and exchange rate factors (in magnitude). This is because newly industrialized economies have experienced significant deregulation in recent years, opening up their financial market to foreign investors and giving the domestic players the opportunity to expand overseas. The banks in these countries are therefore more sensitive to financial market changes in the long term. On the other hand, the more advanced developed economies typically strongly influence the financial market and as a result, they are exposed to adverse interest rate and exchange rate movement to a lesser extent.

Insert Table 5 about here

5. Summary and Conclusions

Our findings in the Asia-Pacific context is broadly consistent with the findings of prior literature investigating US, Japanese and Australian banks. However, we find that the banking portfolios of Japan, Hong Kong and the Philippines are significantly exposed to short term interest rate changes over the short horizon which contradicts the observations from past research that bank stock returns are more sensitive to changes in long term interest rates (Madura and Zarruk, 1995). A possible explanation for this is that the short term interest rates are more volatile in these countries and were priced by investors over our sample period. With regard to long horizon return, we found a larger number of significant interest rate and exchange rate exposures. This finding is consistent with prior literature that the long horizon return measures economic exposures, which are difficult to hedge.

We find stronger evidence of economies of scale in interest rate risk management with long horizon return. However, the economies of scale argument does not seem to apply for long-horizon exchange rate exposures because larger banks tend to be more involved in international operations and are therefore more susceptible to foreign exchange rate changes.

Further investigation of the banks' interest rate and exchange rate exposures by country's level of economic development reveals that the newly industrialized economies display the greatest sensitivity to long horizon interest rate and exchange rate changes (in absolute terms) quite possibly because of the liberalization of their financial market in recent years. On the other hand, the more advanced developed economies are less exposed to adverse interest rate and exchange rate changes.

The findings that Asia-Pacific banks are more susceptible to long horizon exposures suggest that more effort should be attributed to hedging long horizon exposures via operational hedges to match foreign currency inflows and outflows. Larger banks' long horizon exchange rate exposures should also be monitored by regulators and possibly introduce greater capital requirement, given the importance of large banks in the Asia-Pacific economy.

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Table 1: Asia-Pacific Banks' Short Horizon Interest Rate and Exchange Rate Exposures by Country

Portfolio	α	β_{im}	β_{iLTIR}	β_{iSTIR}	β_{iEX}	AR(1)	Adj. R^2
Japan	-0.0001 (-0.0947)	0.4204*** (8.1113)	0.0627 (0.2984)	39.9517* (1.8439)	-0.0645 (-0.7414)	-0.1541** (-2.0705)	0.35
Thailand	-0.0005 (-0.2716)	1.2801*** (21.0836)	0.1594 (0.9917)	1.7695 (0.5992)	-0.2526 (-1.6096)	0.0026 (0.0328)	0.86
Hong Kong	0.0014 (0.8378)	0.7103*** (12.2542)	-0.1358 (-0.4113)	8.6014* (1.6706)	-0.1064 (-0.6813)	-0.0175 (-0.2652)	0.55
Singapore	0.0030* (1.8187)	1.2595*** (14.6488)	0.3297 (1.1051)	-2.9904 (-0.5813)	0.1629 (0.4139)	-0.0884 (-1.0229)	0.69
S. Korea	0.0026 (0.6252)	0.9394*** (10.2496)	-0.3254 (-0.7508)	23.1312 (1.3506)	0.2818 (0.7876)	-0.0624 (-0.6660)	0.40
Taiwan	0.0010 (0.3576)	0.7038*** (10.0871)	0.4262 (1.1562)	-0.7363 (-0.0473)	1.2351 (1.5001)	-0.0054 (-0.0742)	0.39
Philippines	0.0016 (0.6746)	0.8094*** (7.6491)	-0.0973 (-0.4518)	4.6577*** (3.4065)	-0.4724 (-1.0176)	-0.1499 (-1.1375)	0.36
Malaysia	0.0008 (0.6068)	1.2007*** (16.7458)	-0.0936 (-0.3819)	-0.6370 (-0.0948)	-0.0160 (-0.0986)	-0.2152** (-2.1843)	0.75
Australia	0.0014 (1.3998)	0.6707*** (9.1342)	0.4408*** (3.3038)	4.4974 (0.7463)	0.0025 (0.0354)	0.0124 (0.1932)	0.41
New Zealand	0.0026 (1.2626)	0.2734* (1.8170)	0.4138 (1.3832)	-2.1609 (-0.3493)	0.1072 (0.7689)	-0.1227 (-1.6232)	0.02

The coefficient estimates and t-statistics (in parentheses) reported in this table are obtained from Eq.(1): $R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_t$

where R_{it} is the weekly equally weighted bank stock return of country i in period t; R_{mt} is the weekly return on the market index of each country; $LTIR_t$ is the weekly return on long-term government bond index; $STIR_t$ is the weekly holding period return on 3 month Treasury bill or comparable 3 month interest rates and EX_t is the weekly rate of change in local currency against JPY for Malaysia and Hong Kong and against USD for all other countries.

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 2: Asia-Pacific Banks' Long Horizon Interest Rate and Exchange Rate Exposures by Country

Portfolio	α	β_{im}	β_{iLTIR}	β_{iSTIR}	β_{iEX}	Adj. R^2
Japan	-0.0767*** (-8.9777)	0.1560*** (5.1432)	0.8161*** (4.2424)	-7.2312 (-0.6118)	0.1431 (1.4997)	0.47
Thailand	-0.1799*** (-6.4882)	1.4902*** (29.0690)	0.8106*** (5.0951)	8.7783 (1.4855)	0.1211 (0.7133)	0.95
Hong Kong	-0.0426 (-0.8893)	0.6311*** (8.0644)	0.7346 (1.2558)	0.5578 (0.1052)	-1.2626*** (-4.1226)	0.58
Singapore	0.0396 (1.1501)	1.5626*** (16.2353)	1.9315*** (3.4335)	-16.5868*** (-3.7232)	0.3453 (0.9816)	0.94
S. Korea	-0.0508 (-0.2523)	1.2579*** (3.3672)	-0.3432 (-0.2048)	167.9448*** (4.3153)	-1.5621 (-0.8854)	0.62
Taiwan	-0.1057 (-1.5943)	0.1965 (1.3430)	-0.0301 (-0.0718)	52.7643*** (6.0924)	-0.4980 (-0.6340)	0.58
Philippines	-0.0403 (-0.3927)	1.0632*** (3.4842)	-1.5497** (-2.0051)	8.5860* (1.8454)	0.6503* (1.6851)	0.39
Malaysia	-0.0122 (-0.4282)	1.4075*** (21.7781)	0.2509 (1.1727)	38.6362*** (5.5100)	0.2323 (1.4533)	0.98
Australia	0.0647*** (3.6985)	0.8950*** (4.6785)	0.9130*** (4.3363)	30.4606*** (8.6878)	0.0331 (0.2095)	0.77
New Zealand	0.1066** (2.6078)	0.4147 (1.6469)	1.0284*** (3.8076)	9.8716** (2.2561)	0.7549*** (5.5812)	0.55

The coefficient estimates and t-statistics (in parentheses) reported in this table are obtained from Eq.(1), using the Hansen's (1982) GMM technique:

$$R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_t$$

where R_{it} is the equally weighted bank stock return of country i in period t; R_{mt} is the return on the market index of each country; $LTIR_t$ is the return on long-term government bond index; $STIR_t$ is the holding period return on 3 month Treasury bill or comparable 3 month interest rates and EX_t is the rate of change in local currency against JPY for Malaysia and Hong Kong and against USD for all other countries. Twelve-month overlapping returns (rolling weekly) are used for each variable in the Eq (1).

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 3: Banks' Short Horizon Interest Rate and Exchange Rate Exposures by Bank Size

Portfolio	α	β_{im}	β_{iLTIR}	β_{iSTIR}	β_{iEX}	AR(1)	Adj. R^2
Panel A: Small Bank Portfolio							
Japan	0.0001 (0.1082)	0.3393*** (6.8384)	-0.0058 (-0.0255)	41.4009** (2.0281)	-0.0796 (-0.8855)	-0.2017** (-2.3904)	0.27
Thailand	-0.0006 (-0.2714)	1.2206*** (16.3501)	0.2194 (1.2116)	3.0016 (0.8592)	-0.3374* (-1.7017)	0.0386 (0.4899)	0.81
Hong Kong	0.0012 (0.5555)	0.7336*** (10.5201)	0.0151 (0.0386)	8.7487 (1.4683)	-0.0956 (-0.5102)	-0.0534 (-0.8101)	0.43
S. Korea	0.0020 (0.3716)	0.9264*** (8.1242)	-0.5133 (-0.8268)	25.1240 (1.0495)	0.1726 (0.3213)	-0.0609 (-0.6716)	0.27
Taiwan	0.0013 (0.4180)	0.6098*** (9.2485)	0.3373 (1.0159)	3.5636 (0.2635)	0.9549 (1.4266)	0.0755 (1.0392)	0.35
Malaysia	0.0007 (0.4706)	1.2320*** (15.7982)	-0.1207 (-0.4441)	-1.5785 (-0.2075)	-0.0302 (-0.1633)	-0.1800* (-1.9651)	0.72
Australia	0.0016* (1.6942)	0.5700*** (7.9087)	0.2456* (1.9055)	7.6264 (1.4396)	0.0062 (0.0819)	-0.0935 (-1.2170)	0.29
Panel B: Large Bank Portfolio							
Japan	-0.0003 (-0.2115)	0.4819*** (8.4873)	0.1084 (0.4921)	38.7317 (1.5738)	-0.0506 (-0.5282)	-0.1132 (-1.5711)	0.36
Thailand	-0.0003 (-0.1483)	1.3920*** (24.0647)	0.0545 (0.2682)	-0.8431 (-0.3111)	-0.0768 (-0.3608)	-0.0185 (-0.2444)	0.85
Hong Kong	0.0019 (1.2844)	0.6774*** (11.9853)	-0.4567 (-1.4610)	8.2656 (1.5588)	-0.1566 (-0.9818)	-0.0531 (-0.7341)	0.56
S. Korea	0.0027 (0.6434)	0.9412*** (10.2124)	-0.2985 (-0.6980)	22.8460 (1.3521)	0.2974 (0.8515)	-0.0620 (-0.6328)	0.39
Taiwan	0.0010 (0.3023)	0.8215*** (9.7790)	0.4929 (1.0987)	-9.0472 (-0.4500)	1.5234 (1.4372)	-0.0754 (-1.0854)	0.37
Malaysia	0.0015 (1.0124)	0.9557*** (9.9040)	0.1140 (0.3629)	-0.1772 (-0.0275)	0.0711 (0.3276)	-0.2563** (-2.4075)	0.55
Australia	0.0011 (0.7550)	0.8217*** (7.6299)	0.7100*** (3.6855)	-1.7708 (-0.2080)	-0.0040 (-0.0403)	-0.0047 (-0.0837)	0.34

The coefficient estimates and t-statistics (in parentheses) reported in this table are obtained from Eq.(1): $R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_t$

where R_{it} is the weekly equally weighted bank stock return of country i in period t; R_{mt} is the weekly return on the market index of each country; $LTIR_t$ is the weekly return on long-term government bond index; $STIR_t$ is the weekly holding period return on 3 month Treasury bill or comparable 3 month interest rates and EX_t is the weekly rate of change in local currency against JPY for Malaysia and Hong Kong and against USD for all other countries. Banks with total assets greater (less) than the median total asset in a particular country is categorized into the large (small) bank portfolio. The banking portfolios of Singapore, the Philippines and New Zealand are excluded from this analysis due to the lack of observations.

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 4: Banks' Long Horizon Interest Rate and Exchange Rate Exposures by Bank Size

Portfolio	α	β_{im}	β_{iLTIR}	β_{iSTIR}	β_{iEX}	Adj. R^2
Panel A: Small Bank Portfolio						
Japan	-0.0389*** (-3.6537)	0.1598*** (3.8787)	0.6458*** (2.9242)	-32.6148** (-2.5337)	0.0727 (0.5099)	0.39
Thailand	-0.2717*** (-6.3174)	1.5748*** (13.8579)	1.1641*** (4.3350)	21.9557** (2.0346)	-0.2091 (-0.8339)	0.91
Hong Kong	-0.0768 (-1.2327)	0.5731*** (5.3341)	0.8129 (1.0963)	2.4374 (0.3509)	-1.4670*** (-3.6103)	0.41
S.Korea	0.5759 (1.2254)	1.5546* (1.8833)	-5.1126 (-1.3546)	302.1909*** (3.4182)	-8.4260** (-2.0654)	0.53
Taiwan	-0.2018*** (-3.2056)	0.1179 (1.0086)	0.4764 (1.0966)	83.5879*** (7.9600)	0.0413 (0.0708)	0.75
Malaysia	0.0106 (0.3304)	1.4020*** (18.1552)	-0.0202 (-0.0801)	40.8802*** (4.7371)	0.0500 (0.2758)	0.98
Australia	0.0877*** (4.8422)	0.8264*** (4.3394)	0.3491* (1.6918)	49.4072*** (13.9492)	0.1653 (1.0521)	0.86
Panel B: Large Bank Portfolio						
Japan	-0.1047*** (-12.5221)	0.1532*** (4.7838)	0.9424*** (4.6286)	11.6018 (0.8837)	0.1954** (2.3707)	0.50
Thailand	0.0037 (0.1128)	1.3210*** (10.7244)	0.1035 (0.4073)	-17.5766 (-1.4824)	0.7817** (2.5290)	0.83
Hong Kong	0.0171 (0.5819)	0.7326*** (16.8213)	0.5976 (1.5249)	-2.7316 (-0.8077)	-0.9048*** (-4.0862)	0.85
S.Korea	-0.1403 (-0.8490)	1.2156*** (3.9116)	0.3382 (0.2429)	148.7668*** (4.6154)	-0.5816 (-0.4026)	0.65
Taiwan	0.0225 (0.2116)	0.3014 (1.3947)	-0.7054 (-1.0743)	11.6662 (0.6948)	-1.2171 (-0.9590)	0.42
Malaysia	-0.1717*** (-5.4581)	1.4457*** (16.6677)	2.1483*** (8.3268)	22.9283** (2.3347)	1.5084*** (10.0293)	0.97
Australia	0.0358 (1.6071)	0.9807*** (3.9566)	1.6178*** (6.0244)	6.7774 (1.6146)	-0.1322 (-0.7072)	0.58

The coefficient estimates and t-statistics (in parentheses) reported in this table are obtained from Eq.(1), using the Hansen's (1982) GMM technique:

$$R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_t$$

where R_{it} is the equally weighted bank stock return of country i in period t; R_{mt} is the return on the market index of each country; $LTIR_t$ is the return on long-term government bond index; $STIR_t$ is the holding period return on 3 month Treasury bill or comparable 3 month interest rates and EX_t is the rate of change in local currency against JPY for Malaysia and Hong Kong and against USD for all other countries. Twelve-month overlapping returns (rolling weekly) are used for each variable in the Eq (1). Banks with total assets greater (less) than the median total asset in a particular country is categorized into the large (small) bank portfolio. The banking portfolios of Singapore, the Philippines and New Zealand are excluded from this analysis due to the lack of observations.

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 5: Banks' Interest Rate and Exchange Rate Exposures by Countries' Level of Economic Development

Portfolio	α	β_{im}	β_{iLTIR}	β_{iSTIR}	β_{iEX}	AR(1)	Adj. R^2
Panel A: Short Horizon Return							
Advanced	0.0006	0.1915***	-0.3324	-4.4147	0.4923	-0.2044***	0.07
	(0.4862)	(3.1058)	(-1.2788)	(-0.8273)	(1.6146)	(-2.6974)	
NIE	0.0019	1.0801***	0.3527	11.0917	-0.0755	-0.0523	0.49
	(1.0459)	(11.0158)	(1.1895)	(1.3052)	(-0.1603)	(-0.6895)	
Developing	0.0004	1.1163***	-0.2574	16.2098*	-0.1449	0.0893	0.45
	(0.1565)	(9.6783)	(-0.7161)	(1.8286)	(-0.2218)	(0.8424)	
Panel B: Long Horizon Return							
Advanced	-0.0561***	0.0766**	0.0618	7.2686***	0.8927***		0.46
	(-4.6238)	(2.1405)	(0.4374)	(2.7853)	(7.0955)		
NIE	0.0013	0.5081***	0.9363	64.8924***	-1.4590***		0.71
	(0.0152)	(3.6678)	(1.1658)	(5.8796)	(-3.6226)		
Developing	0.0618	1.5244***	-0.4455	9.7772	-0.6878***		0.93
	(1.2918)	(11.7035)	(-0.9316)	(1.4349)	(-2.6246)		

The coefficient estimates and t-statistics (in parentheses) reported in this table are obtained from Eq.(1): $R_{it} = \alpha_i + \beta_{im} R_{mt} + \beta_{iLTIR} LTIR_t + \beta_{iSTIR} STIR_t + \beta_{iEX} EX_t + u_t$

where R_{it} is the equally weighted bank stock return of country i in period t; R_{mt} is the equally weighted return on the market index of each country; $LTIR_t$ is the equally weighted return of each countries' long-term government bond index; $STIR_t$ is the equally weighted return of each countries' 3 month interest rates and EX_t is the equally weighted return of each countries' change in local currency against JPY for Malaysia and Hong Kong and against USD for all other countries.

Weekly returns are employed for short horizon estimation while a 12 month overlapping returns (rolling weekly) is used for each variable for the long horizon estimation. The advanced developed economies consist of Japan, Australia and New Zealand; Newly Industrialized Economies (NIE) consist of Hong Kong, Singapore, South Korea and Taiwan while developing economies consist of Malaysia, Thailand and the Philippines.

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level