



## THE FOREIGN EXCHANGE EXPOSURE OF CHINESE BANKS

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### Abstract

Using the Capital Market Approach and equity-price data of 14 listed Chinese banks, this empirical study finds that there is a positive relationship between bank size and foreign-exchange exposure, which may reflect larger foreign-exchange operations and trading positions of larger Chinese banks, and their significant indirect foreign-exchange exposure arising from impacts of the renminbi exchange-rate movements on their customers. Empirical evidence also suggests that the average foreign-exchange exposures of state-owned and joint-stock commercial banks in China are higher than those of banks in Hong Kong, notwithstanding that their participation in international banking businesses is still limited compared with their Hong Kong counterparts. It is also found that negative foreign-exchange exposure is prevalent for larger Chinese banks, suggesting that an appreciation of the renminbi tends to reduce their equity values, and is therefore likely to hamper the banking sector's performance. Together with the fact that decreases in equity values generally imply higher default risk, how Chinese banks would be affected under different scenarios of renminbi appreciation should be closely monitored.

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### ***Executive Summary***

- *Using equity-price data of 14 listed Chinese banks, this study adopts the capital-market approach to examine Chinese banks' foreign-exchange exposure which comprises the direct exposure arising from banks' unhedged foreign assets and liabilities, and the indirect exposure due to effects of exchange-rate movements on cash flows, and credit risk of banks' customers.*
- *Empirical evidence suggests that there is a positive relationship between bank size and foreign-exchange exposure. This may be partly due to the fact that larger banks tend to have more significant foreign-exchange operations and trading positions. Larger banks may also have more businesses with large and international corporations, of which competitiveness and profitability are sensitive to exchange-rate movements. These may contribute to the more significant foreign-exchange exposure of larger Chinese banks.*
- *In addition, the average foreign-exchange exposures of state-owned and joint-stock commercial banks in China are higher than those of banks in Hong Kong, notwithstanding that their participation in international banking businesses is still limited compared with their Hong Kong counterparts. This may reflect the lack of financial instruments available for Chinese banks to hedge their foreign-exchange risk, or that the banks were less experienced in managing foreign-exchange risk.*
- *It is also found that foreign-exchange exposure tends to be different among Chinese banks, with negative foreign-exchange exposure more prevalent for larger Chinese banks, suggesting that an appreciation of the renminbi tends to reduce their equity values. Since larger banks constitute a major portion of assets in the Chinese banking industry, this empirical result suggests that an appreciation of the renminbi is likely to hamper the Chinese banking sector's performance. Together with the fact that decreases in equity values generally imply higher default risk, how Chinese banks would be affected under different scenarios of renminbi appreciation should be closely monitored.*

## I. INTRODUCTION

Foreign exchange rate movements could be an important source of risk for banking institutions.<sup>2</sup> In the worst case, large foreign exchange losses could lead to bank failures.<sup>3</sup> Even for a mild scenario, foreign exchange losses could cause huge burdens on banks' profitability. Due to their serious implications for risk management and banking sector stability, measuring banks' foreign exchange exposure has long been a core interest of risk management professionals, academics, and central banks.

In the literature, a large number of empirical works have been carried out to examine the foreign exchange exposure of banks. However, past studies mainly focused on banking markets which are well developed, including the US (Grammatikos et al. (1986), Choi et al. (1992), Choi and Elyasiani (1997), and Martin and Mauer (2003, 2005)), Japan (Chamberlain et al. (1997)), Canada (Atindéhou and Gueyie (2001)), and Australia (Chi et al. (2007)), or large banking institutions (Martin (2000)). By comparison, studies focusing on less developed banking markets are relatively scant.<sup>4</sup>

For China's banking sector, the growing internationalisation of Chinese banks on both their fund raising activities and banking businesses, the lack of financial instruments available in the local market for Chinese banks to hedge their foreign exchange risk, together with the structural change in China's exchange rate regime in July 2005 may suggest that Chinese banks in general have become increasingly exposed to foreign exchange risk. Given this, a comprehensive empirical study on foreign exchange exposure of Chinese banks could provide useful insights for both exchange rate and banking policies in China.

However, partly due to the lack of data, past analyses on the foreign exchange exposure of Chinese banks are rather primitive which mainly focused on the quantification of foreign exchange exposure arising from the banks' unhedged foreign assets and liabilities (i.e. direct or accounting exposures). As shown by Chamberlain et al. (1997), to the extent that banks' direct exposure generally provides a significant explanation for banks' foreign exchange exposure, it only measures banks' foreign exchange risk partially. Using a bank's loan to an exporter as an example, Chamberlain et al. (1997) demonstrate that banks that perfectly hedge their accounting exposure could still be exposed to significant foreign exchange risk if exchange rate movements affect cash flows, competitiveness, and credit risk of banks' customers significantly (i.e. indirect or

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<sup>2</sup> Reflecting this, most banks have been required to measure and apply regulatory capital charges in respect of their foreign exchange risk since the issuance of Basel (1996).

<sup>3</sup> For example, the failure of Franklin National Bank of New York in 1974 in the US, and the liquidation of Bankhaus (I.D.) and Herstatt KG in 1974 in West Germany. For details, see Aharony and Swary (1983).

<sup>4</sup> There were only a few studies on less developed banking markets, such as Hahm (2004) on the Korean banking market and de Wet and Gebreselasie (2004) on the African banking market.

economic exposures).<sup>5</sup> This indicates that the sources of foreign exchange risk of banks are far more than just their holdings of net foreign assets.

As for the identification of foreign exchange exposure of individual banks, while the direct exposure can be discerned largely from their accounting data, the indirect exposure, which arises from impacts of exchange rate fluctuations on the economy in general and banks' customers in particular, is more subtle to be identified from these data. Because of this, past analyses on the foreign exchange exposure of Chinese banks may not have been able to give a comprehensive picture on how Chinese banks are exposed to foreign exchange risk. This is particularly so given that the indirect foreign exchange exposure of Chinese banks appears to be significant or even a dominant component of their overall foreign exchange exposure, as Chinese banks generally have a significant portion of loans that are related to export-import activities, such as lending to the manufacturing industry, of which competitiveness and profitability are sensitive to exchange rate movements.

With the increased availability of time series and cross-section data for Chinese banks' equity prices as a result of the listing of a number of major state-owned Chinese banks in stock markets since mid-2005, it has now become possible to investigate overall foreign exchange exposure (which comprises all direct and indirect foreign exchange exposures) of the Chinese banking sector more accurately and comprehensively using the capital market approach. Compared with the cash flow approach, another commonly adopted approach, which is based on data of banks' financial statements, the capital market approach has various advantages. Specifically, the estimates from the capital market approach are forward looking and facilitate analyses of default risk of Chinese banks. More importantly, it remedies the problem of a lack of observations in the cash flow approach. Because of these, the capital market approach is chosen in this study. A brief introduction of the two empirical approaches and detailed discussions on the choice of the empirical approach are provided in Appendix A.<sup>6</sup>

Using the capital market approach with equity price data of 14 listed Chinese banks in the Chinese stock market (i.e. A-share market) and the Hong Kong stock market (i.e. H-share market), this study attempts to investigate the overall foreign exchange exposure of Chinese banks individually.

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<sup>5</sup> For an exporter in the US, if the US dollar appreciates, the competitiveness of the exporter may deteriorate, which would imply a higher default risk of the exporter. The bank that lends money to this exporter is therefore exposed to foreign exchange exposure indirectly. For details, see footnote 18 of Chamberlain et al. (1997).

<sup>6</sup> Comprehensive review of these two empirical approaches on banking studies can be found in Martin and Mauer (2005). It should be noted that these two approaches are also widely applied for studying other industries, see Muller and Verschoor (2006).

The reminder of the paper is organised as follows. Sections II and III describe empirical specifications, and data and estimation methods respectively. Section IV presents estimation results. Section V concludes.

## II. THE EMPIRICAL SPECIFICATION

Past empirical studies such as Choi et al. (1992), Wetmore and Brick (1994), and Choi and Elyasiani (1997) using the capital market approach to study foreign exchange risk of banks are essentially based on the following asset pricing model with different modifications<sup>7</sup>,

$$R_{n,t} - RF_t = \alpha_n + \beta_n^m (R_{m,t} - RF_t) + \beta_n^I I_t + \beta_n^X X_t + \varepsilon_{n,t} \quad (1)$$

where  $R_{n,t}$  and  $RF_t$  are the holding period rate of return of the  $n^{\text{th}}$  bank stock from  $t-1$  to  $t$  and risk-free interest rate at time  $t$  respectively.  $(R_{m,t} - RF_t)$  is the excess rate of return of the market portfolio. The other two risk factors,  $I_t$  and  $X_t$ , represent the rate of change in the yield of a risk-free bond<sup>8</sup> from  $t-1$  to  $t$ , and that of exchange rate respectively.  $\varepsilon_{n,t}$  is a risk component for the  $n^{\text{th}}$  bank related to other risks and measurement errors.

While the empirical specification in equation (1) is widely applied in past empirical studies to estimate foreign exchange exposure of banks, it is not without drawbacks. Various theories and empirical evidence suggest that the specification in equation (1) could be extended and improved. In the first part of this section, the relevant theoretical and empirical considerations for model specifications will be discussed. Different empirical specifications for dual-listed Chinese banks and locally listed Chinese banks which incorporate relevant theoretical and empirical considerations will be given in the latter part of this section.

For the market risk sensitivity,  $\beta_n^m$ , the specification in equation (1) assumes that only the return of the market portfolio where a bank is listed affects the bank's stock return. However, this assumption may not be appropriate for dual-listed firms. Theoretically, the expected return of a dual-listed firm depends not only on the return of domestic market portfolio, but also on the return of foreign market portfolio (See Alexander et al. (1987)). Empirically, using daily equity price data for 16 dual-listed

<sup>7</sup> For past empirical works using the capital market approach, see Appendix A.

<sup>8</sup> In the literature, various alternative interest rate variables are frequently adopted to estimate the interest rate sensitivity of banks' equity returns. For example, Flannery and James (1984) separately use the rate of change in the yield of 7-year Treasury bonds and the rate of change in the price of 1-year Treasury bills as a proxy for the interest rate variable. They show that commercial bank stock returns in the US are sensitive to interest rate changes no matter which interest rate variable is employed.

Chinese stocks (in A- and H-share markets) for the period June 1995 to September 2001, Wang and Jiang (2004) find that the H-shares of Chinese stocks are exposed significantly to both the Hong Kong and Chinese stock markets, which is consistent with the asset pricing theory for dual-listed firms. In addition, the relative weights of the exposure of a firm's A- and H-share returns to the Hong Kong market portfolio and the Chinese market portfolio are found to be different generally. As the largest 6 listed Chinese banks are dual-listed in the A- and H-share markets, ignoring this feature may result in misspecifications and thus biased estimation results.

For the exchange rate sensitivity,  $\beta_n^x$ , earlier empirical studies generally assumed that firms' equity returns only depend on contemporaneous changes in exchange rates. However, empirical evidence by Amihud (1994), Bartov and Bodnar (1994), and Walsh (1994) suggest that there is a lagged relation between changes in exchange rates and firm values due to mispricing. Bartov and Bodnar (1994) formulate this *Lagged Response Hypothesis* and conjecture that investors may have difficulties to characterise the relation between changes in exchange rates and firm performances, and thus equity values, if time series data are limited. The *Lagged Response Hypothesis* may therefore be relevant to Chinese firms in general, and Chinese banks in particular, as the exchange regime in China was only switched in July 2005 and the time span available for either investors or bank staff to obtain the relevant information to understand the relationship between changes in the renminbi exchange rate and banks' performance is short.

To incorporate relevant theoretical considerations and empirical evidence, we modify equation (1) and consider the following empirical specification for dual-listed Chinese bank stocks,

$$\begin{aligned}
 R_{n,t} - RF_t = & \alpha_n + \beta_n^{CH} (R_{CH,t} - RF_{CH,t}) + \beta_n^{HK} (R_{HK,t} - RF_{HK,t}) \\
 & + \beta_n^{CH,A} (R_{CH,t} - RF_{CH,t}) Dum_A + \beta_n^{HK,A} (R_{HK,t} - RF_{HK,t}) Dum_A \\
 & + \beta_n^A Dum_A + \beta_n^I I_t + \sum_{j=0}^J \beta_{j,n}^x X_{t-j} + \varepsilon_{n,t}
 \end{aligned} \tag{2}$$

where  $R_{n,t}$  and  $RF_t$  are the holding period rate of return of the  $n^{\text{th}}$  bank stock shares, either A-shares or H-shares, from  $t-1$  to  $t$  in terms of the renminbi and the risk-free interest rate of the market that the bank is listed.  $(R_{CH,t} - RF_{CH,t})$  is the excess return of the Chinese market portfolio (i.e. either the Shenzhen Stock Exchange or the Shanghai Stock Exchange, depending on where the banks are listed), while  $(R_{HK,t} - RF_{HK,t})$  is the excess return of the Hong Kong market portfolio.  $Dum_A$  is a dummy variable defined as one if the observations are from the Chinese stock market (i.e. banks' A-share equity returns), and zero if the observations are from the Hong Kong stock market (i.e. banks' H-share equity returns in terms of the renminbi). The inclusion of the above market risk related explanatory variables basically follows the spirit of the asset pricing model for dual-listed firms by Alexander et al. (1987) and the empirical evidence by Wang and Jiang (2004). By definition,  $\beta_n^{CH} + \beta_n^{CH,A}$  and  $\beta_n^{HK} + \beta_n^{HK,A}$  are the market sensitivities of the excess returns of the Chinese bank's A-shares to the excess returns of the Chinese market portfolio and that of the Hong Kong market portfolio respectively, while  $\beta_n^{CH}$  and  $\beta_n^{HK}$  are the market sensitivities of the excess returns of a Chinese bank's H-shares in terms of the renminbi to the excess returns of the Chinese market portfolio and that of the Hong Kong market portfolio respectively. We also include the dummy variable  $Dum_A$  in the estimations to capture any structural difference between the excess returns of banks' A-shares and H-shares.

For estimating interest rate sensitivities,  $\beta_n^I$ , we include an explanatory variable in the estimation equation, namely the rate of change in the yield of risk-free bonds ( $I_t$ ).<sup>9</sup> This specification is consistent with the *Maturity Mismatch Hypothesis* by Flannery and James (1984) and facilitates the estimation of the sensitivities of Chinese banks' performance to changes in risk-free interest rates in China.

Regarding the foreign exchange exposure of Chinese banks, it is estimated through the terms  $\sum_{j=0}^J \beta_{j,n}^X X_{t-j}$ . This specification assumes that excess returns of Chinese banks are a function of contemporaneous and lagged exchange rates (up to the  $J^{\text{th}}$  lagged period), which is consistent with the *Lagged Response Hypothesis* by Bartov and Bodnar (1994). Under the specification in equation (2), foreign exchange exposure of the  $n^{\text{th}}$  Chinese bank,  $\beta_n^X$ , is defined as  $\sum_{j=0}^J \beta_{j,n}^X$ . In this study,  $X_t$  is defined as the percentage change of the renminbi exchange rate, which is defined as the US dollar value of a unit of

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<sup>9</sup> This is proxied by the rate of change in the yield of 5-year Chinese government bonds.

the Renminbi.<sup>10,11</sup> An increase in the exchange rate implies an appreciation of the renminbi, and vice versa. A negative (positive)  $\beta_n^X$  suggests therefore that an appreciation of the renminbi would generate negative (positive) impacts on the expected future cash flow of the  $n^{\text{th}}$  Chinese bank, and may therefore reduce (increase) its equity returns.

For Chinese banks that are listed only in the Chinese stock market, we adopt the following empirical specification,

$$R_{n,t} - RF_t = \alpha_n + \beta_n^{CH} (R_{CH,t} - RF_{CH,t}) + \beta_n^I I_t + \sum_{j=0}^J \beta_{j,n}^X X_{t-j} + \varepsilon_{n,t} \quad (3)$$

Equation (3) can be regarded as a simplified version of equation (2), with the regressors related to the excess return of the Hong Kong market portfolio ( $R_{HK,t} - RF_{HK,t}$ ) being excluded from estimations. The adoption of such a specification for locally listed Chinese banks is justified by the fact that locally listed firms in general should only be exposed significantly to risk in the local market.

### III. DATA AND ESTIMATION METHOD

We employ in the estimation a panel dataset that contains 14 listed Chinese banks. Of these, three are state-owned commercial banks<sup>12</sup>, eight are joint-stock commercial banks<sup>13</sup>, and the remaining three are city commercial banks<sup>14</sup>. In terms of asset size, the sample banks together accounted for over 55% of total assets of the Chinese

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<sup>10</sup>  $X_t$  could be also defined as the renminbi exchange rate against currencies other than the US dollar (e.g. the renminbi exchange rate against the Japanese Yen). In the literature, when different pairs of exchange rates are considered, estimations are usually performed separately for each pair of exchange rate. In this study, we focus on the renminbi exchange rate against the US dollar, as most discussions in the academic and media regarding China's exchange rate movements focus on the renminbi exchange rate against the US dollar. Nevertheless, the foreign exchange exposures of Chinese banks in terms of the renminbi exchange rate against the Japanese Yen and Euro were also examined. Empirically, we find that larger Chinese banks in general are not significantly exposed to the risk of the renminbi exchange rate against the Japanese Yen and Euro. Therefore, implications of the foreign exchange exposure arising from changes in the renminbi exchange rate against Euro or the Japanese Yen for the Chinese banking sector may not be very significant.

<sup>11</sup> Conventionally, the renminbi exchange rate is quoted as the renminbi value of a unit of the US dollar. We use its inverse in this study mainly for convenience in interpreting the estimated coefficients of  $X_t$ . It should be noted that defining the renminbi exchange rate reciprocally would only affect the sign of the estimated coefficients of  $X_t$ .

<sup>12</sup> These include Industrial and Commercial Bank of China, China Construction Bank, and Bank of China.

<sup>13</sup> These include Bank of Communications, China Merchants Bank, China CITIC Bank, Shanghai Pudong Development Bank, China Minsheng Bank, Industrial Bank, Huaxia Bank, and Shenzhen Development Bank.

<sup>14</sup> These include Bank of Beijing, Bank of Nanjing, and Bank of Ningbo.

banking industry as of end-2006. Therefore, the sample should be adequate to give a representative picture for the market.

The data set contains daily equity price data of the 14 Chinese banks for the period 21 July 2005 to end-February 2008, with the data availability varying across individual banks due to different dates of initial public offerings (IPOs) of the banks. The sample starting date is chosen to be 21 July 2005 when the structural change of China's exchange rate regime took place.<sup>15</sup> Extending the starting date of the sample to an earlier date may not be desirable because (1) the renminbi exchange rate against the US dollar was virtually unchanged before that date, which may result in biased estimation results, and (2) a majority of the 14 Chinese banks were only listed after 21 July 2005.<sup>16</sup>

While using daily equity price data can help remedy the problem of insufficient empirical observations in the study of Chinese banks, one drawback is that the dataset may contain some outliers, which could arise from either sudden changes in market sentiments or some special events of the banks (such as sharp rises in prices in the first trading day after IPOs). Including these outliers in the sample may lead to biased results, as the estimations could be unduly affected by them. Because of this, observations with an excess daily return lower than the 1<sup>st</sup> percentile or higher than the 99<sup>th</sup> percentile of the data for each bank are excluded from the sample for estimations.

Of the 14 Chinese banks, six are dual-listed in both the Chinese and Hong Kong stock markets. In constructing the estimation sample, we utilise their daily equity price data of both their A- and H-shares. Since H-share prices are denominated in Hong Kong dollars, the excess returns of banks' H-shares are converted into the renminbi using the spot exchange rates. For the remaining eight Chinese banks, which are purely locally listed, all observations are constructed using their A-share equity data.

Regarding data for the explanatory variables, the daily returns of the Chinese market portfolio,  $R_{CH,t}$ , are approximated by the Shanghai Stock Exchange A-Share Index (for banks listed in the Shanghai Stock Exchange) or the Shenzhen Stock Exchange Stock A-Share Index (for banks listed in the Shenzhen Stock Exchange). The risk-free interest rate in China is proxied by the 5-year yield of Chinese government bonds.<sup>17</sup> The daily returns of the Hong Kong market portfolio,  $R_{HK,t}$ , is approximated by

<sup>15</sup> Shifting from de facto pegging the renminbi exchange rate to the US dollar to determining the renminbi exchange rate based on market supply and demand conditions with reference to a basket of currencies.

<sup>16</sup> In fact, only five of the 14 listed banks were listed in the A-share market before 21 July 2005. They are China Merchants Bank, Shanghai Pudong Development Bank, China Minsheng Bank, Huaxia Bank, and Shenzhen Development Bank.

<sup>17</sup> We consider three different maturities for the yield of risk-free government bonds. They are the yields of 1-year, 5-year, and 10-year government bonds in China. It is found that the data for 1-year and 10-year government bonds' yields are not frequently updated in the early part of the sample period which

the Hang Seng Index. We use the 5-year yield of Exchange Fund Notes to proxy for the risk-free interest rate in Hong Kong,  $RF_{HK,t}$ . For the daily percentage changes of China's risk-free interest rate ( $I_t$ ), we calculate it using the 5-year yield of Chinese government bonds. For the daily percentage of appreciation in the renminbi exchange rate against the US dollar,  $X_{t-j}$ , it is calculated by the corresponding renminbi spot rates. All data used in this study, including the equity price data of Chinese banks, are obtained from Bloomberg.

We estimate foreign exchange exposure and other risk parameters for each dual-listed and locally listed Chinese banks by the Ordinary Least Squares (OLS) method using the empirical specification in equations (2) and (3) respectively.<sup>18</sup> For dual-listed Chinese banks, since the sample is constructed using both their A- and H-share prices, the problem of heteroskedasticity may exist. Therefore, *t-statistics* reported for the dual-listed Chinese banks are derived based on the method proposed by White and Domowitz (1984) to accommodate for the heteroskedasticity problem.

In order to obtain the optimal model for each bank, we first run all possible regressions which utilise all combinations of the regressors. Among the estimated regression models, we select the optimal model for each bank using the Akaike (1973) information criterion, which is a widely applied model selection criterion in the literature. Since this model selection method becomes impractical for a large number of explanatory variables, we set the maximum number of lags for  $X_t$  to be 5 (i.e.  $J = 5$  in equations (2) and (3)), so that the number of explanatory variables is limited to 11.

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may be due to inactive trading of these two types of bonds. As a result, the yield of 5-year government bonds is chosen.

<sup>18</sup> Alternatively, a system of regressions using the Seemingly Unrelated Regression (SUR) method, which is essentially a generalised least squares method accounting for the existence of contemporaneous correlation among equations, can be employed to estimate foreign exchange exposure of the 14 Chinese banks jointly. Theoretically, the SUR method could improve the efficiency of the estimates significantly if (1) the contemporaneous correlation among equations is large and can be estimated accurately, (2) the correlation among regressors in different equations is small (See p.452, Judge et al. (1988)). Since the number of observations for some Chinese banks is rather small, in particular the three city commercial banks, we may not be able to estimate the contemporaneous correlation among the 14 Chinese banks accurately. The efficiency gains of using the SUR method may thus be very limited. Therefore, we adopt the OLS method in this study. Nevertheless, we use the SUR method to estimate the foreign exchange exposure for each dual-listed Chinese bank, as their A- and H- shares should exhibit a significant contemporaneous correlation, and the efficiency gains of using the SUR method may be more significant. However, the foreign exchange exposure estimates by using the SUR method turn out to be similar to those obtained from the OLS method.

#### IV. ESTIMATION RESULTS

Estimation results for dual-listed and locally listed Chinese banks are presented in Tables 1 and 2 respectively. Main findings are as follows<sup>19</sup>:

1. Empirical evidence suggests that there is a significant relationship between bank size (as measured by total assets) and overall foreign exchange exposure (which includes all direct and indirect exposures), in terms of either the significance or the magnitude of the estimated  $\beta_n^x$  :
  - (a) For the former, larger banks – the state-owned commercial banks and joint-stock commercial banks – are found more likely to have a significant foreign exchange exposure, either positive or negative, than their smaller counterparts – the city commercial banks. Reflecting this, all the three state-owned commercial banks and five of the eight joint-stock commercial banks in the sample are estimated to have significant foreign exchange exposure (i.e. either have a positive or a negative  $\beta_n^x$ ), while only one of the three city-commercial banks is estimated to have significant foreign exchange exposure.
  - (b) Regarding the magnitude of the estimated  $\beta_n^x$  (measured by its absolute value), it tended to be larger for larger banks. For the state-owned commercial banks as a group, which comprises the three largest banks in the sample, the average magnitude is about 1.8542. The corresponding value for the group of joint-stock commercial banks, which contains eight smaller banks, is 0.6729, while that of the group of city commercial banks, which is the smallest banking group, is only 0.1221.<sup>20</sup> This suggests that the resulting volatility on equity values due to renminbi exchange rate movements, either an appreciation or a depreciation, tended to be larger for larger banks
  - (c) (a) and (b) may be partly due to the fact that larger banks tend to have larger foreign exchange trading positions, and more significant foreign exchange operations through either their overseas branches, subsidiaries, or joint-ventures with foreign financial institutions. At the same time,

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<sup>19</sup> As the main objective of this study is to estimate foreign exchange exposure of Chinese banks, findings other than foreign exchange exposure are presented in Appendix B.

<sup>20</sup> The result is not altered significantly when including only those banks with non-zero  $\beta_n^x$ . Calculating on this basis, the average foreign exchange exposure of state-owned commercial banks, joint-stock commercial banks, and city commercial banks are 1.8542, 1.0767, and 0.3663 respectively.

since they also tend to have more businesses with large and international corporations, of which competitiveness and profitability are sensitive to exchange rate movements, significant foreign exchange exposure of larger Chinese banks may arise from this macro-channel that transmits foreign exchange risk to banks via impacts of the renminbi exchange rate movements on banks' customers. These may contribute to the more significant foreign exchange exposure of larger Chinese banks.

2. To gauge the relative size of the foreign exchange exposure of Chinese banks, we also estimate for comparison the foreign exchange exposure for a group of 12 listed banks in Hong Kong, using the same specification in equation (3), but replacing  $(R_{CH,t} - RF_{CH,t})$  and  $I_t$  with their Hong Kong counterparts.<sup>21</sup>

Such a model specification attempts to reveal how banks in Hong Kong are exposed to the risk of the renminbi exchange rate movements against the US dollar, with  $X_t$  defined as the daily percentage appreciation in the renminbi exchange rate against the US dollar. It should be noted that such a comparison is subject to significant caveats, given the significant differences between Chinese banks and Hong Kong banks.<sup>22</sup>

- (a) The results show that the average magnitude of foreign exchange exposure of banks in Hong Kong is 0.4264. This is significantly lower than 1.8542 for the three state-owned commercial banks, and 0.6729 for the eight joint-stock commercial banks in China. In contrast, the average magnitude of foreign exchange exposure of the three city commercial banks (0.1221) is smaller than that of Hong Kong banks. This suggests that larger Chinese banks are in general exposed more to the risk of renminbi exchange rate movements against the US dollar than either banks in Hong Kong or their smaller counterparts in China.
- (b) Even when  $X_t$  in the estimation of Hong Kong banks is replaced by the daily percentage change of the Hong Kong dollar trade-weighted effective nominal exchange rate index ( $EERI_t$ ), which is a broader definition of exchange rate movements, the average magnitude of

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<sup>21</sup> The sample includes Bank of China (HK), Bank of East Asia, Chong Hing Bank, CITIC Ka Wah Bank, Dah Sing Bank, Fubon Bank, Hang Seng Bank, HSBC, ICBC (Asia), Standard Chartered Bank, Wing Hang Bank, and Wing Lung Bank. We also estimate the average foreign exchange exposure of Hong Kong banks by excluding two of the larger banks, namely HSBC and the Standard Chartered Bank from the sample, as they are to a large extent more internationalised and have significantly different asset compositions from other Hong Kong banks. The average magnitude of foreign exchange exposure thus estimated turned out to be very similar to the result of using the complete sample.

<sup>22</sup> For example, in the context of foreign exchange businesses, banks in Hong Kong in general would have a larger autonomy regarding business strategies and operations than banks in China.

foreign exposure of banks in Hong Kong, estimated to be 0.6459, is still lower than that of state-owned and joint-state commercial banks.

- (c) It is not apparent that why the foreign exchange exposure of Chinese banks as estimated is larger than Hong Kong banks, particularly given that the participation of Chinese banks in international banking businesses should still be limited when compared with Hong Kong banks. It is, however, possible that the estimated larger foreign exchange exposure of Chinese banks may reflect the lack of financial instruments available in the local market to hedge their foreign exchange risk, or perhaps because they are less experienced in managing foreign exchange risk.
3. Consistent with past empirical findings for other banking markets, foreign exchange exposure tends to be different amongst Chinese banks. Of the 14 listed Chinese banks, six are estimated to have a negative  $\beta_n^x$ , suggesting that an appreciation of the renminbi against the US dollar tends to generate negative impacts on banks' values. On the other hand, three banks are estimated to have positive  $\beta_n^x$ , which indicates the opposite, and the remaining five are estimated to have no significant foreign exchange exposure.
  4. To the extent that foreign exchange exposure tends to be different amongst Chinese banks, negative foreign exchange exposures are more prevalent for larger Chinese banks, suggesting that an appreciation of the renminbi tends to reduce their equity values. Specifically, we find that an appreciation of the renminbi by 1% would on average reduce the excess equity returns for larger banks – state-owned commercial banks by 1.27% and joint-stock commercial banks by 0.41% – but may boost the excess equity returns for smaller banks (city-commercial banks), by 0.12%. On the whole, since the state-owned and joint-stock commercial banks constitute more than 67% of assets in the Chinese banking market (as of end-2006)<sup>23</sup>, an appreciation of the renminbi is likely to hamper the Chinese banking sector's performance.

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<sup>23</sup> According to the People's Bank of China (2007), the total asset values of stated-owned commercial banks, joint-stock commercial banks, and the banking sector as a whole are RMB 24,236 billions, RMB 5,445 billions, and RMB 43,950 billions respectively as of end-2006.

## V. CONCLUSION

Using equity-price data of 14 listed Chinese banks, this study adopts the capital-market approach to examine Chinese banks' foreign-exchange exposure which comprises the direct exposure arising from banks' unhedged foreign assets and liabilities, and the indirect exposure due to effects of exchange-rate movements on cash flows, and credit risk of banks' customers.

Empirical evidence suggests that there is a positive relationship between bank size and foreign-exchange exposure. This may be partly due to the fact that larger banks tend to have more significant foreign-exchange operations and trading positions. Larger banks may also have more businesses with large and international corporations, of which competitiveness and profitability are sensitive to exchange-rate movements. These may contribute to the more significant foreign-exchange exposure of larger Chinese banks.

In addition, the average foreign-exchange exposures of state-owned and joint-stock commercial banks in China are higher than those of banks in Hong Kong, notwithstanding that their participation in international banking businesses is still limited compared with their Hong Kong counterparts. This may reflect the lack of financial instruments available for Chinese banks to hedge their foreign exchange risk, or that the banks were less experienced in managing foreign-exchange risk.

It is also found that foreign-exchange exposure tends to be different among Chinese banks, with negative foreign-exchange exposure more prevalent for larger Chinese banks, suggesting that an appreciation of the renminbi tends to reduce their equity values. Since larger banks constitute a major portion of assets in the Chinese banking industry, this empirical result suggests that an appreciation of the renminbi is likely to hamper the Chinese banking sector's performance.

The empirical results suggest that an appreciation of the renminbi will likely have a negative impact on the performance, and thus the equity values, of Chinese banks, with the impacts on larger banks being more pronounced. Together with the fact that decreases in equity values generally imply higher default risk, how Chinese banks would be affected under different scenarios of renminbi appreciation should be closely monitored.

**Table 1: Estimation results of foreign exchange exposure of dual-listed Chinese banks**

| Explanatory variables         | State-owned commercial bank 1 | State-owned commercial bank 2 | State-owned commercial bank 3 | Joint-stock commercial bank 1 | Joint-stock commercial bank 2 | Joint-stock commercial bank 3 |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <i>Intercept</i>              | 0.0004<br>(0.61)              | 0.0002<br>(0.29)              | -0.0006<br>(-1.12)            | 0.0004<br>(0.74)              | 0.0003<br>(0.45)              | -0.0023**<br>(-2.55)          |
| $(R_{CH,t} - RF_{CH,t})Dum_A$ | 0.8429***<br>(21.59)          | 0.7053***<br>(7.75)           | 0.7752***<br>(20.25)          | 0.8614***<br>(14.81)          | 0.8625***<br>(16.70)          | 0.8968***<br>(14.29)          |
| $(R_{HK,t} - RF_{HK,t})Dum_A$ | -0.9282***<br>(-12.37)        | -0.9759***<br>(-10.60)        | -0.7527***<br>(-12.18)        | -1.0020***<br>(-11.69)        | -0.8628***<br>(-10.90)        | -0.6449***<br>(-7.62)         |
| $Dum_A$                       |                               |                               |                               |                               |                               |                               |
| $R_{CH,t} - RF_{CH,t}$        |                               |                               |                               |                               |                               |                               |
| $R_{HK,t} - RF_{HK,t}$        | 1.0877***<br>(21.20)          | 1.1650***<br>(24.45)          | 0.8698***<br>(22.98)          | 1.1239***<br>(20.09)          | 1.0905***<br>(20.51)          | 0.6897***<br>(12.70)          |
| $I_t$                         | -0.2261**<br>(-2.22)          |                               |                               | -0.1054**<br>(-2.30)          |                               | -0.2546***<br>(-2.73)         |
| $X_t$                         |                               |                               | -0.8633*<br>(-1.88)           | -0.8120**<br>(-2.07)          |                               |                               |
| $X_{t-1}$                     |                               |                               | -0.9323*<br>(-1.87)           |                               |                               |                               |
| $X_{t-2}$                     | -1.1209**<br>(-2.23)          |                               | -0.9168**<br>(-2.24)          |                               |                               |                               |
| $X_{t-3}$                     | -0.8564*<br>(-1.68)           |                               |                               |                               |                               |                               |
| $X_{t-4}$                     |                               |                               |                               |                               |                               |                               |
| $X_{t-5}$                     |                               | 0.8730*<br>(1.75)             |                               |                               |                               | 1.0657<br>(1.47)              |
| $R^2$                         | 0.6386                        | 0.5587                        | 0.5605                        | 0.5221                        | 0.5094                        | 0.5394                        |
| Adjusted $R^2$                | 0.6350                        | 0.5559                        | 0.5571                        | 0.5189                        | 0.5076                        | 0.5333                        |
| DW statistics                 | 1.872                         | 1.817                         | 2.097                         | 1.736                         | 1.959                         | 2.030                         |
| $\sum_{j=0}^J \beta_{j,n}^X$  | -1.9773<br>[0.8153]           | 0.8730<br>[0.5188]            | -2.7124<br>[0.9126]           | -0.8120<br>[0.4164]           | 0.0000<br>[NA]                | 1.0657<br>[0.7655]            |

Notes:

(1) Figures in parentheses are t-statistics. Figures in brackets are standard errors.

(2) \*, \*\*, and \*\*\* denote statistical significance at the 10%, 5% and 1% levels respectively.

(3) For each bank, all possible regressions that utilise all combinations of the regressors are estimated firstly. Among the estimated models for each bank, the optimal model using the Akaike (1973) information criterion is selected and shown in the table. Therefore, the optimal model specification varies across the banks and some explanatory variables that with low explanatory power are not included in the optimal model (i.e. variables with blank coefficient estimates).

(4) NA: Not applicable.

**Table 2: Estimation results of foreign exchange exposure of locally listed Chinese banks**

| Explanatory variables        | Joint-stock<br>commercial bank<br>4 | Joint-stock<br>commercial bank<br>5 | Joint-stock<br>commercial bank<br>6 | Joint-stock<br>commercial bank<br>7 | Joint-stock<br>commercial bank<br>8 | City-commercial<br>bank 1 | City-commercial<br>bank 2 | City-commercial<br>bank 3 |
|------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|---------------------------|---------------------------|---------------------------|
| <i>Intercept</i>             | 0.0010<br>(1.06)                    | 0.0012<br>(0.74)                    | 0.0009<br>(1.06)                    | 0.0009<br>(0.90)                    | 0.0009<br>(0.92)                    | -0.0006<br>(-0.32)        | -0.0013<br>(-0.79)        | -0.0025<br>(-1.10)        |
| $R_{CH,t} - RF_{CH,t}$       | 0.9133***<br>(17.66)                | 0.9851***<br>(13.91)                | 0.9654***<br>(19.80)                | 1.0565***<br>(19.98)                | 0.7167***<br>(14.70)                | 0.9031***<br>(10.64)      | 0.8161***<br>(10.88)      | 0.9464***<br>(9.94)       |
| $I_t$                        |                                     | -0.3977*<br>(-1.77)                 |                                     |                                     | -0.1221*<br>(-1.74)                 | -1.0585***<br>(-3.54)     | -0.6159**<br>(-2.42)      | -0.7615**<br>(-2.40)      |
| $X_t$                        |                                     |                                     |                                     |                                     |                                     |                           |                           |                           |
| $X_{t-1}$                    |                                     |                                     |                                     |                                     |                                     |                           |                           | -2.6138<br>(-1.55)        |
| $X_{t-2}$                    |                                     |                                     | -0.9842<br>(-1.53)                  | -1.3447*<br>(-1.86)                 |                                     |                           |                           |                           |
| $X_{t-3}$                    |                                     |                                     |                                     |                                     |                                     |                           |                           |                           |
| $X_{t-4}$                    | -1.1769<br>(-1.59)                  |                                     |                                     |                                     |                                     |                           |                           |                           |
| $X_{t-5}$                    |                                     |                                     |                                     |                                     |                                     |                           |                           | 2.9801*<br>(1.72)         |
| R <sup>2</sup>               | 0.3650                              | 0.4420                              | 0.4216                              | 0.4398                              | 0.2736                              | 0.5606                    | 0.4658                    | 0.4717                    |
| Adjusted R <sup>2</sup>      | 0.3627                              | 0.4376                              | 0.4195                              | 0.4377                              | 0.2711                              | 0.5517                    | 0.4583                    | 0.4565                    |
| DW statistics                | 1.9330                              | 1.732                               | 2.017                               | 1.918                               | 1.866                               | 2.167                     | 1.832                     | 1.939                     |
| $\sum_{j=0}^J \beta_{j,n}^X$ | -1.1769<br>[0.7420]                 | 0.0000<br>[NA]                      | -0.9842<br>[0.6436]                 | -1.3447<br>[0.7240]                 | 0.0000<br>[NA]                      | 0.0000<br>[NA]            | 0.0000<br>[NA]            | 0.3663<br>[2.3504]        |

Notes:

- (1) Figures in parentheses are t-statistics. Figures in brackets are standard errors.
- (2) \*, \*\*, and \*\*\* denote statistical significance at the 10%, 5% and 1% levels respectively.
- (3) For each bank, all possible regressions that utilise all combinations of the regressors are estimated firstly. Among the estimated models for each bank, the optimal model using the Akaike (1973) information criterion is selected and shown in the table. Therefore, the optimal model specification varies across the banks and some explanatory variables that with low explanatory power are not included in the optimal model (i.e. variables with blank coefficient estimates).
- (4) NA: Not applicable.

## **Appendix A: Literature Review and Discussions of the Choice of Empirical Approach**

Most past empirical studies about the foreign exchange exposure of banks have tried to quantify the sensitivity of banks' values or incomes to exchange rate movements. In the literature, there are two main approaches to quantify foreign exchange exposure of banks, namely the capital market approach and the cash flow approach. The capital market approach assesses banks' foreign exchange exposure by analysing the sensitivity of equity returns of banks to exchange rate movements, while the cash flow approach identifies foreign exchange exposure of banks by studying the relationship between banks' operating incomes reported in their financial disclosures and exchange rates. In the first part of this appendix, we introduce briefly the two approaches by discussing some past empirical works. At the end of this appendix, we discuss the selection of empirical approach in this study.

### The Capital Market Approach

In essence, the capital market approach assumes that the valuation of a bank is reflected by its equity returns. Given this, any factor that affects the valuation of a bank is correlated with the bank's equity returns. Since there are many factors such as interest rates, stock market returns, and exchange rates that may affect banks' values and thus their equity returns, multi-factor models, which regress equity returns of banks on various relevant factors jointly, are usually applied for the capital market approach. Earlier studies usually include the following risk factors to explain banks' equity returns.

1. Excess returns of the market portfolio,  $(R_{m,t} - RF_t)$ : The inclusion of  $(R_{m,t} - RF_t)$  as one of the risk factors to explain the excess rate of return of a bank stock  $(R_{n,t} - RF_t)$  essentially follows the Capital Asset Pricing Model (CAPM). The estimated coefficient of  $(R_{m,t} - RF_t)$ , which measures the sensitivity of a bank's excess equity return to the excess market portfolio return, is generally found to be positive and statistically significant in past empirical studies, which is consistent with the CAPM.
2. The rate of change in yield of a risk-free bond,  $I_t$ : The consideration of  $I_t$  as a risk factor of banks' equity returns is advocated by Flannery and James (1984), which postulates and tests the *maturity mismatch hypothesis* which states that differences in the maturity composition of net nominal assets of banks cause differences in the interest rate sensitivity of bank stock returns. For a typical bank, since the average maturity of nominal assets (which mainly comprise loans) in general should be higher than that of nominal liabilities (which mainly comprise deposits), the market value of net nominal assets of a bank

should behave similar to a long position of a bond with maturity equal to the average maturity of the bank's net nominal assets. Therefore, unanticipated changes in interest rates tend to result in a decrease in a bank's equity value, implying a negative estimated coefficient (i.e.  $\beta_n^I < 0$ ). Empirically, using data on weekly stock returns of 67 US commercial banks for the period January 1976 to November 1981, Flannery and James (1984) find that for an equally weighted portfolio of US commercial bank stocks as a whole, there is an inverse relation between unanticipated interest rate changes and the returns of bank stocks, which is statistically significant and robust to various interest rate definitions. Although later studies usually include  $I_t$  as a major risk factor of banks, it should be noted that recent studies estimating financial risk of individual banks exhibit less solid evidence of the relevance of  $\beta_n^I$  than those reported by Flannery and James (1984). For example, using data for 59 large US commercial banks for the period 1975 to 1992, Choi and Elyasiani (1997) find that  $\beta_n^I$  is significant for only 23 banks out of 59, although the estimated values of  $\beta_n^I$  that are significant are all negative.

3. The rate of change in exchange rate,  $X_t$ : The study of foreign exchange exposure of banks using the capital market approach is advocated by Choi et al. (1992) in which a multifactor model is estimated to examine the sensitivity of equity returns of 48 largest US commercial banks to changes in stock market returns, interest rates, and exchange rates based on monthly data over the period 1975 to 1987. Empirically, the degree of a bank's foreign exposure is gauged by the value and statistical significance of the estimated coefficient of exchange rates (i.e.  $\beta_n^X$  in equation (1)), which essentially measures the sensitivity of bank stock returns to exchange rate movements. The consideration of foreign exchange risk as a main factor affecting banks' values by Choi et al. (1992) opened a new avenue in the literature, which differs from earlier studies that generally suggested that only market returns and interest rates are the main risk factors of banks.<sup>24</sup> In order to provide theoretical foundation for this consideration, Choi et al. (1992) develop a theoretical model which predicts that bank equity returns only respond to unexpected changes in financial risk factors including exchange rates, and foreign currency exposure of banks due to their unhedged foreign currency positions in balance sheets. Using a trade-weighted multilateral foreign exchange value of the US dollar against a basket of currencies<sup>25</sup> as a proxy for the exchange rate, Choi et al. (1992) estimate the unexpected movements in the exchange rate by using an

<sup>24</sup> See Flannery and James (1984), Sweeney and Warga (1986), Chen and Chan (1989), Mitchell (1989), Bae (1990) and Yourougou (1990).

<sup>25</sup> The US dollar against the currencies of the other Group of Ten countries plus Switzerland.

ARIMA model<sup>26,27</sup>, and found that unexpected appreciation in the US dollar tended to reduce bank stock returns before October 1979, while it was the reverse in the post-October 1979 period. They pointed out that the empirical finding was consistent with the structural change around the late 1970s that the US banking system gradually shifted from a positive net position in some major foreign currencies<sup>28</sup> to a negative net position. While the theory was not formally tested in Choi et al. (1992), a later study by Wetmore and Brick (1994) provide empirical evidence to support the theory that foreign exchange exposure of banks is related to their unhedged foreign currency positions.

Chamberlain et al. (1997) followed Choi et al. (1992) and adopted the capital market approach to examine the foreign exchange exposure of US banks, as well as Japanese banks. The study contributes to the literature in various ways. First, it extends the study of foreign exchange exposure to Japanese banks by which international differences in foreign exchange exposure were assessed. Second, they show that higher frequency data, namely daily data, are more appropriate for estimating foreign exchange exposure compared to lower frequency data such as monthly data. Third, Chamberlain et al. (1997) show that banks' unhedged foreign currency positions could only partially explain their exchange rate exposures. They argue that even for banks that perfectly hedge their foreign currency positions in balance sheets could be exposed to foreign currency risk because exchange rate movements could affect cash flows, competitiveness, and credit risk of banks' customers, which in turns may affect banks' values and incomes.<sup>29</sup>

Later studies such as Choi and Elyasiani (1997), Martin (2000), Atindéhou and Gueyie (2001), Ryan and Worthington (2002), de Wet and Gebreselasie (2004), Hahm (2004), and Chi et al. (2007) essentially followed the capital market approach using equation (1) for different markets or with modified model specifications. Despite their differences, empirical evidence generally suggests that the signs and values of  $\beta_n^x$  (i.e. foreign exchange exposure) vary substantially amongst individual banks even in the same banking market.

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<sup>26</sup> Autoregressive Integrated Moving Average model.

<sup>27</sup> An alternative way to derive the unexpected movements of the exchange rate is based on the orthogonalisation method, in which the residuals obtained from a regression of the exchange rate on all other factors serve as the unexpected component of the exchange rate. However, various studies, such as Giliberto (1985) and Kane and Unal (1988) pointed out that the orthogonalisation method may lead to biased estimation results.

<sup>28</sup> Mainly the Canadian dollar, Swiss franc, and British pound.

<sup>29</sup> Chamberlain et al. (1997) used the following example to illustrate this potential source of foreign currency exposure of banks: For an exporter in the US, if the US dollar appreciates, the competitiveness of the exporter may deteriorate, which would imply a higher default risk of the exporter. The bank that lends money to this exporter is therefore exposed to foreign exchange exposure indirectly. For details, see footnote 18 of Chamberlain et al. (1997).

### The Cash Flow Approach

The application of the cash flow approach on banking studies is advocated by Martin and Mauer (2003).<sup>30</sup> Similar to Choi et al. (1992), Martin and Mauer (2003) focus on the US banking market and try to estimate the foreign exchange exposure of 105 US banks over the period 1988 to 1998. Instead of estimating foreign exchange exposure of banks from equity data, Martin and Mauer (2003) identify banks' foreign exchange exposure by exploring the relationship between banks' quarterly operating incomes (before adjustments for depreciation and exchange rate gains and losses) disclosed in their financial statements and five selected bilateral exchange rates against the US dollar.<sup>31</sup> Martin and Mauer (2003) first derive the time series of unanticipated operating income for each bank as the residuals from a regression that the current value of operating income is regressed by its previous four-quarter lagged value. The unanticipated operating income is then standardised<sup>32</sup> and regressed on the current and lagged values of the percentage change in an exchange rate factor, where the optimal lag length of the exchange rate factor is determined statistically<sup>33</sup>. The exchange rate factor, which captures exchange rate variations not explained by the changes in interest rates and economic activity, is defined as the residuals from regressing a bilateral exchange rate on the interest rate differential between the foreign country and the US, and the ratio of real GDP of the foreign country to the US. Martin and Mauer (2003) classify a bank as having short-term foreign exchange exposure if the optimal lag length of the exchange rate factor is found to be four quarters or less, and having long-term exposure if the optimal lag length is larger than eight quarters.

Empirically, Martin and Mauer (2003) find that domestically oriented banks tend to more frequently exhibit significant foreign exchange exposure than their internationally oriented counterparts, suggesting that economies of scale in exchange rate risk management may exist in the US banking industry. In addition, they find that long-term exposure is more prevalent than short-term exposure. According to Martin and Mauer (2003), this is because it is more difficult to identify, measure, and hedge long-term foreign exchange exposure<sup>34</sup>. A later study by Martin and Mauer (2005) also employ the cash flow approach to estimate foreign exchange exposure of large US banks.

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<sup>30</sup> It should be noted that, however, Martin and Mauer (2003) is not the first empirical work that adopted the cash flow approach to study exchange rate exposure. See Walsh (1994), for example. However, in Walsh (1994), the banking industry is excluded from the analysis.

<sup>31</sup> They are, namely the British pound, Canadian dollar, German mark, Japanese yen, and Mexican peso.

<sup>32</sup> By dividing the residuals by their standard deviation.

<sup>33</sup> The maximum lag term is set to be 12 quarters and the optimal lag length used in each regression is determined by the Akaike (1973) criterion.

<sup>34</sup> It is mainly because publicly available data of individual banks' financial statements are only available since the early of 2000 for a majority of the Chinese banks in the sample. In addition, they are usually released on an annual basis. Quarterly financial data are only available after 2005 for most of the listed Chinese banks.

Conceptually, while the methodologies are different, the two approaches are not contradictory to each other. As long as equity values of banks reflect largely the discounted expected future cash flows of banks, as predicted by discounted cash flow models in equity value analyses (Gordon (1962)), the capital market approach should be similar to the cash flow approach. Empirically, however, there are three advantages of the capital market approach over the cash flow approach for our study on the Chinese banking market.

First, since data on banks' incomes are generally less available than banks' equity data due to lower frequency of banks' financial result announcements, it is hard to apply the cash flow approach for studying banks that have a short financial history. For example, in order to obtain reliable statistical results, Martin and Mauer (2003) only cover banks that have at least 30 consecutive quarterly financial statements in their study. Based on Martin and Mauer's (2003) criterion, none of the Chinese banks in our study meet such requirement. On the other hand, of the 14 listed Chinese banks covered in this study, although most have only been listed in or after 2005, by employing the capital market approach, the problem of a lack of observations is partially remedied by the high frequency of data on equity prices, exchange rates, and interest rates.

Second, as noted by Martin and Mauer (2003) and Muller and Verschoor (2006), the foreign exchange exposure estimated by the capital market approach is forward looking<sup>35</sup>, while that estimated by the cash flow approach is backward looking. From a policy analysis perspective, the capital market approach would therefore be more appropriate. This is particularly so given that China's exchange rate regime and banking industry have recently undergone significant structural changes. Backward looking estimates derived from the cash flow approach may not be able to reflect the effect of these structural changes adequately.

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<sup>35</sup> According to the discounted cash flow model for equity price analyses, the equity value of a firm is the sum of discounted expected future cash flow. So, by its nature, the capital market approach is forward looking.

## Appendix B: Empirical findings other than foreign exchange exposure of Chinese banks

1. For dual-listed Chinese banks, their A-shares are found to be affected more by the returns of the Chinese market portfolio than the Hong Kong market portfolio, which is consistent with empirical findings by Wang and Jiang (2004). Specifically, the performance of the Chinese market appears to be an important factor to determine the performance of Chinese banks' A-shares, as excess returns of the Chinese market portfolio are found to be a significant factor affecting banks' A-share equity returns for all banks, with the estimated market risk sensitivity ranging from 0.7053 to 0.8968.<sup>36</sup> In contrast, Chinese banks' A-share equity returns are exposed only by a limited degree to the Hong Kong market risk, as suggested by their estimated sensitivities to the Hong Kong market portfolio, which are relatively small in general (ranging from 0.0448 to 0.2277)<sup>37</sup>. For banks' H-share returns, dual-listed Chinese banks are found to be exposed to Hong Kong's market risk, with the estimated coefficient of the excess returns of the Hong Kong market portfolio,  $\beta_n^{HK}$ , being statistically significant at the 1% confidence level for all dual-listed Chinese banks, and the estimates ranging from 0.6897 to 1.1239. However, they are in general not significantly exposed to the risk of the Chinese market portfolio.
2. Regarding interest rate sensitivity of Chinese banks, eight out of the 14 Chinese banks are estimated to have significant interest rate exposure. This result is consistent with empirical results in the US banking market by Choi and Elyasiani (1997) which found that not all US commercial banks are exposed to significant interest rate risk.<sup>38</sup> Unlike foreign exchange exposure which is estimated to have different signs for different Chinese banks, the eight banks that have significant interest rate exposure are all found to have negative interest rate exposure (i.e. negative  $\beta_n^I$ ). This suggests that increases in interest rates tend to reduce banks' equity values. In addition, smaller banks, in particular the three city commercial banks, are found to have higher interest rate sensitivities. This suggests that monetary tightening in general produce negative impacts on Chinese banks, with the effect on smaller banks being more pronounced.<sup>39</sup>

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<sup>36</sup> Note that it refers to  $(\beta_n^{CH} + \beta_n^{CH,A})$  for dual-listed Chinese banks.

<sup>37</sup> It refers to  $(\beta_n^{HK} + \beta_n^{HK,A})$ .

<sup>38</sup> Choi and Elyasiani (1997) found that while 59 large US commercial banks as a whole is estimated to have significant interest rate exposure, only 23 of them are found to have significant interest rate exposure individually.

<sup>39</sup> This empirical finding is consistent with financial news relating to the Chinese banking market. For example, South China Morning Post (10 March 2008) reported that under strict rules on bank lending in 2008, "Small city commercial banks, already struggling to boost deposit levels, have been hit the hardest, prompting them to look for partnerships or consolidation while their customers are left scrambling for financing." This indicates that smaller banks tend to suffer more significantly than larger banks in the phase of monetary tightening.

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