



THE IMPACT OF INTEREST RATE SHOCKS ON THE PERFORMANCE OF THE BANKING SECTOR

Key points :

- *This note assesses the effects of a rise in the Hong Kong dollar interest rate on banking sector's profitability. In particular, the 3-month HIBOR is decomposed into LIBOR and the spread over LIBOR (a measure of the risk premium) to investigate their respective impact on the net interest margin defined as a ratio of net interest income to interest-bearing assets.*
- *Empirical estimates using data between 1992 and 2002 suggest that a rise in the risk premium of 105 basis points (one standard deviation for the sample period) reduced the net interest margin by 4 basis points in the same quarter and by a cumulative 11 basis points in the long run. However, interest rate changes due to US rate movements appeared to have little impact.*
- *Analysis of grouped data of large-, medium- and small-sized banks provides further evidence on the significance of the risk premium in driving the net interest margin. Sensitivity to the risk premium was slightly lower for large banks than the other two groups, possibly owing to lower liquidity pressures for large banks (as manifested in a smaller HKD loan-to-deposit ratio).*
- *The insignificance of US interest rates during the period under study was attributable to an equal pass-through of changes in US interest rates to the best lending rate and an effective deposit rate, leaving an unchanged intermediation spread. In contrast, the pass-through of the risk premium to the deposit rate was larger than to the lending rate.*
- *The estimates also suggest that an increase of 105 basis points in the interest rate would raise the classified-loan ratio by about 0.5 percentage point at its worst. The impact of the shock reached its peak in five quarters, but gradually diminished thereafter.*

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I. INTRODUCTION

This note provides an assessment of how an increase in the interest rate affects the profitability of the banking sector. For this purpose, Hong Kong dollar interest rates are decomposed into the US interest rate and the spread over the US rate. The latter reflects the risk premium of the Hong Kong dollar, which is determined by speculative pressures on the currency.

There are different ways of considering the effects of interest rate changes on banks' financial conditions. One is to examine the impact on the value of bank assets, liabilities and off-balance sheet positions. Another approach focuses on the implications for the future cash flows accruing to banks.¹ To assess the impact of interest rate changes from either of these two perspectives requires detailed information about a number of sources of interest rate risk. These include re-pricing risk, yield curve risk and basis risk, originating largely from differences in the characteristics of banks' assets and liabilities (e.g. composition of fixed-rate and floating-rate instruments, maturity structure, re-pricing period and base rates).² Given the inherent complexity in terms of both the methodology and data requirements, this note focuses on the empirical relationship between the market interest rate, and banks' net interest margin and the classified-loan ratio (which determines charges for provisions).³ The latter two have been the main factors influencing bank profits.

The note is organised as follows. The next section offers some observations on the profitability of the banking sector in recent years. It shows that the pre-tax return of the retail banks in Hong Kong has been mainly driven by the net interest margin and net charges for provisions. Section III provides estimates of the sensitivity of banks' net interest margin to changes in interest rates and discusses how it is related to the pass-through of interbank interest rates to deposit and lending rates. Section IV looks into how interest rate changes may affect the classified-loan ratio and thus net charges for provisions. The final section concludes.

¹ Since the present discounted value of banks' cash flows must equal the economic value of banks, theoretically these two approaches are consistent and complementary to each other.

² Re-pricing risk is present when average yields on banks' assets and liabilities are of different sensitivity to changes in market interest rates, reflecting mismatches in the characteristics of assets and liabilities. Yield curve risk refers to the differential impact of changes in the slope or curvature of the market yield curve on assets and liabilities, while basis risk reflects the risk of divergence of base rates of different financial instruments of banks. For details, please see BIS (2002).

³ A similar analysis of the OECD economies was covered in BIS (2002).

II. OBSERVATIONS ON PROFITABILITY OF THE BANKING SECTOR

A natural starting point for examining banks' profit position is the aggregate profit and loss account (P&L account) of the banking sector. For the purpose of this study, the banking sector is confined to retail banks.⁴ The major components of the P&L account can be summarised as follows:

Net interest income
+ Non-interest income
– General and administrative expenses
– Net charges for provisions
= Pre-tax operating profit

Total income is broken down into net interest income and non-interest income, while expenses are classified as general and administrative expenses and net charges for provisions.⁵ To measure profitability in terms of a rate of return on assets, these components are divided by the average level of total assets for the period. Specifically,

$$\pi = nim + nii - ga - pv$$

Where π = pre-tax return on assets (ratio of pre-tax operating profit to total assets)

nim = net interest margin (ratio of net interest income to total assets)

nii = non-interest income as a ratio to total assets

ga = general and administrative expenses as a ratio to total assets

pv = net charges for provisions as a ratio to total assets

⁴ Retail banks include all locally incorporated banks plus the local offices of a number of relatively large foreign banks. The foreign banks in this group have significant local presence and, similar to their local counterparts, have substantial retail banking activities conducted within a branch network. Hence retail banks are representative of mainstream banking trends in Hong Kong. Retail banks altogether accounted for over three quarters of HKD assets of all Authorized Institutions and 90% of HKD deposits.

⁵ General and administrative expenses include both recurring expenses (e.g. staff and rental expenses) as well as non-recurring expenses. It should be noted that exceptional items are not included here. Accordingly, the pre-tax operating profit is before exceptional items.

Chart 1 depicts the movements of these ratios in the 1993-2001 period. Variations in the pre-tax return on assets were largely driven by movements in the net interest margin before the Asian financial crisis, and by the net charge for provisions in the subsequent period. Both non-interest income and general and administrative expenses were relatively stable.

Chart 1. Movements of the Performance Ratios

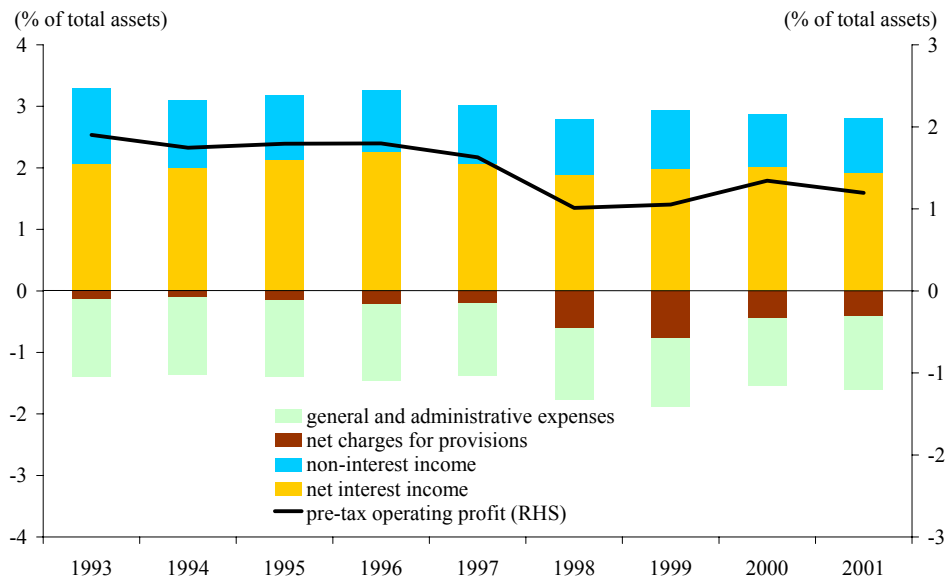
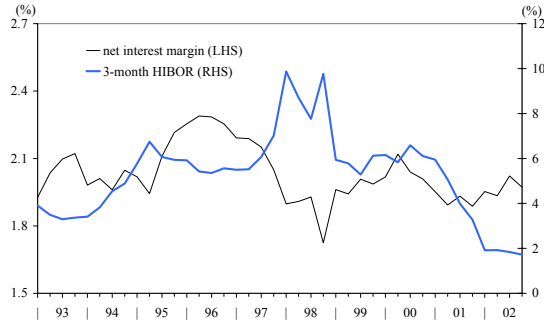
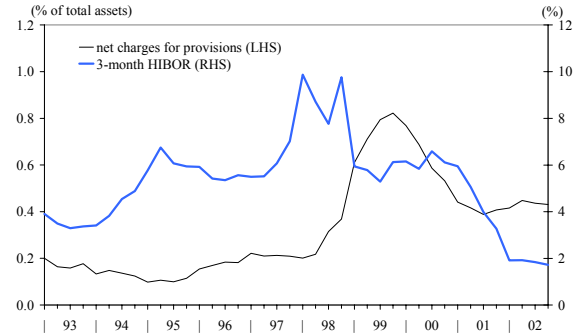
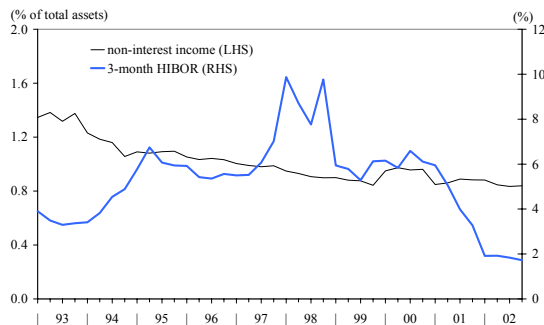
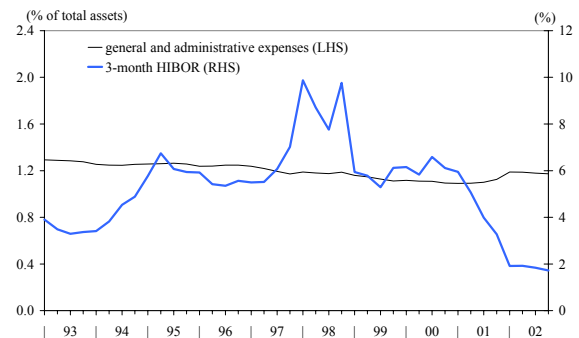


Chart 2 compares the 3-month interbank interest rate with the performance ratios. The marked contraction in the net interest margin seemed to follow the significant rise in the Hong Kong dollar interest rate, which reflected an increased risk premium during the Asian financial crisis. The net charge for provisions also increased with a lag of about one year. The other two ratios, however, appeared unrelated to changes in the interest rate.

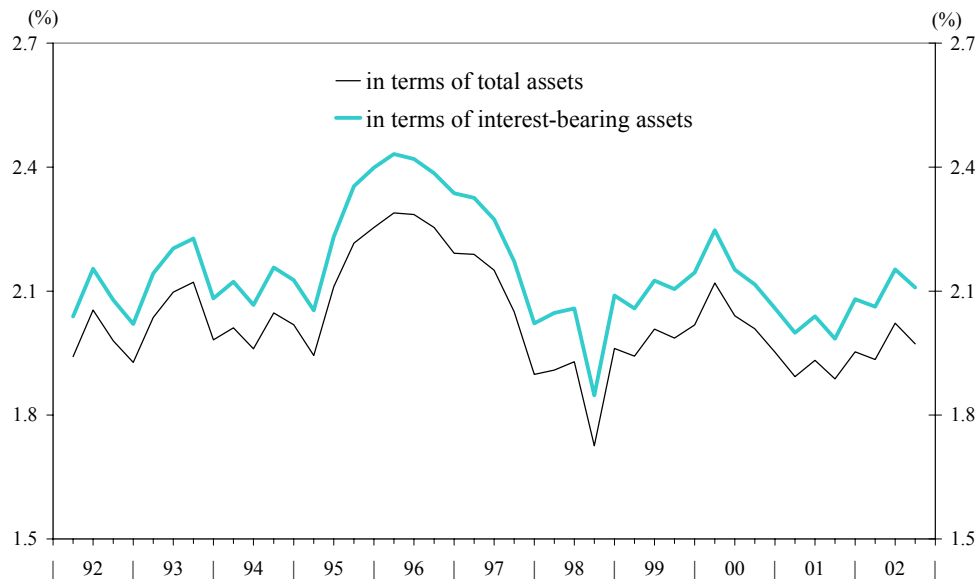
In sum, the pre-tax return of the retail banks in Hong Kong has been mainly driven by the net interest margin and the net charge for provisions. They seem to have been affected by movements in the market interest rate to a significant degree.

Chart 2. Performance Ratios and the Interest Rate**a. Net Interest Margin****b. Net Charges for Provisions****c. Non-Interest Income****d. General and Administrative Expenses**

Note: The performance ratios in panels b, c, and d are smoothed to even out seasonal effects.

III. THE IMPACT OF INTEREST RATE CHANGES ON THE NET INTEREST MARGIN

This section provides estimates of the impact of changes in US interest rate and the risk premium on the net interest margin. Estimates using both aggregate and grouped data of large-, medium-, and small-sized banks are provided. It is noted that a more conventional definition of the net interest margin uses interest-bearing assets instead of total assets as the denominator. This would avoid any distortion given rise by changes in other assets, say owing to valuation effects. The two measures of the net interest margin moved in step with a small difference, however, as interest-bearing assets account for over 90% of total assets (Chart 3). The empirical estimates were very similar for the two, thus only the results for the more conventional measure of the net interest margin are presented.

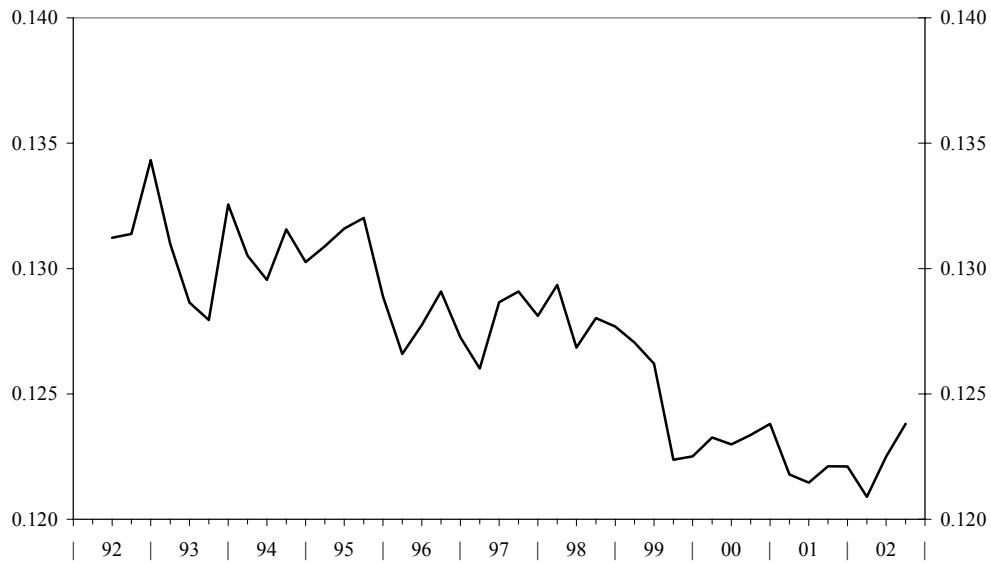
Chart 3. The Alternative Measures of the Net Interest Margin

1. *Estimates using aggregate data*

A regression was estimated relating the net interest margin to 3-month LIBOR, 3-month HIBOR-LIBOR spread (*prem*) and the Herfindahl-Hirschman index (*hh*)⁶. The latter was intended to capture the effect of competition in the banking system. An increase in the index is associated with higher concentration of market share and thus lower degree of competition. As an increase in competition may exert a negative influence on banks' interest margins, a positive sign is expected for the coefficient on the index. Chart 4 shows a decline in the index over time, indicating increasing competition.

⁶ The Herfindahl-Hirschman index is a concentration index, which is calculated by taking the sum of the squares of market share (in terms of total assets) of individual bank. It provides a proxy measure of competition in the banking industry. The BoC group is treated as a single entity in compiling the index.

Chart 4. The Herfindahl –Hirschman index



Following the general-to-specific approach, the following results were obtained.⁷

$$(1) \quad nim_t = -0.457 + 0.642 nim_{t-1} - 0.039 prem_t + 0.974 hh_{t-3}$$

(0.43) (0.09) (0.01) (0.34)

Sample period	1992Q2-2002Q3
\bar{R}_2	0.69
Equation standard error	0.07
Mean of the dependent variable	2.15
LM test for serial correlation	F-statistic = 0.49 [0.49]
White test for heteroskedasticity	F-statistic = 0.83 [0.59]

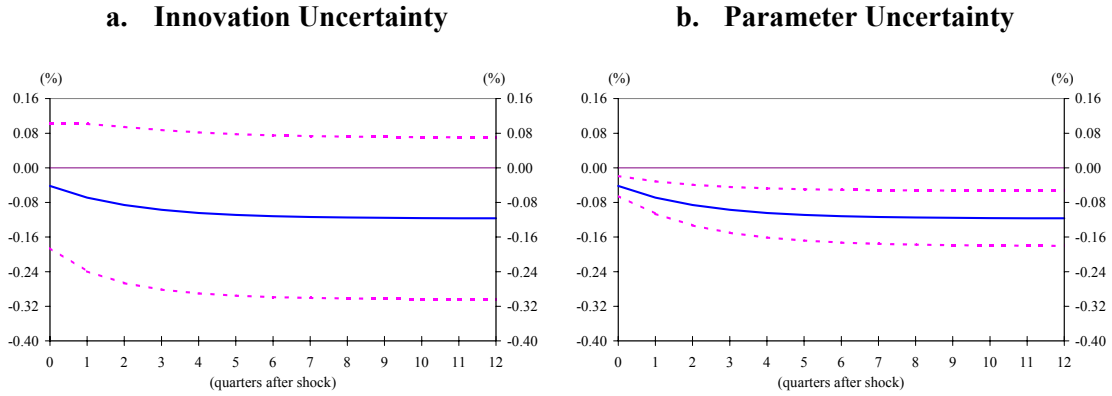
Note: Numbers in parentheses are t-ratios and those in brackets are p-values.

It is noted that LIBOR is insignificant at all lags and thus not included in the final specification of the model. The parameter on the dependent variable captures the speed of adjustment following a shock, say, to the interest rate spread. The estimated coefficients suggest that a rise of about 105 basis points in the spread between 3-month HIBOR and LIBOR (one standard deviation of the spread for the period from 1992Q2 to 2002Q3) would reduce the net interest

⁷ Four lags of the dependent and independent variables were included in the initial specification. LIBOR was insignificant at all lags. Macroeconomic variables such as real GDP growth and property price changes were also included, but were found to be either insignificant or had a wrong sign.

margin by 4 basis points in the same quarter, and by a cumulative 11 basis points in the long run (Chart 5).⁸

Chart 5. Cumulative Effect on the Net Interest Margin of a 105-Basis-Point Increase in the Risk Premium for One Quarter (with 2-Standard-Error Bands)



2. Estimates using grouped data

Further analysis was conducted for grouped data of large, medium and small banks, according to their market share of HKD assets.⁹ Following the general-to-specific approach, regressions relating the net interest margin to its determinants were estimated for each bank group. The final specifications take the following common form:

$$(2) \quad nim_t = c_1 + c_2 nim_{t-1} + c_3 prem_t + c_4 hh_{t-3}$$

where: *nim* is the net interest margin, *prem* is the interest rate spread between 3-month HIBOR and LIBOR, and *hh* is the Herfindahl-Hirschman index.

The equations were estimated jointly by the technique of seemingly unrelated regression (SUR). The results are shown below.

⁸ Standard error bands in panel a capture innovation uncertainty, while those in panel b capture parameter uncertainty associated with the estimated coefficient on the interest rate spread.

⁹ Specifically, the three groups are defined according to the following criterion:

- Large-sized bank : market share $\geq 8\%$
- Medium-sized bank : $8\% > \text{market share} \geq 2\%$
- Small-sized bank : $2\% > \text{market share}$

Large banks together account for about 60% of HKD assets of retail banks, while medium- and small-sized banks each account for about 20%.

Dependent Variable: nim_t

Sample period: 1992Q2 – 2002Q3

	Large-sized	Medium-sized	Small-sized
Constant	0.00624 (0.00549)	-0.0220 (0.00542)	-0.0214 (0.00620)
nim_{t-1}	0.623 (0.0927)	0.525 (0.0826)	0.704 (0.0716)
$prem_t$	-0.0337 (0.0120)	-0.0537 (0.0132)	-0.0526 (0.0145)
hh_{t-3}	0.0157 ⁺ (0.0375)	2.44 (0.483)	2.27 (0.558)
\bar{R}_2	0.547	0.788	0.842
Equation standard error	0.000848	0.000906	0.00103

Note: Numbers in bracket are standard errors.

⁺ Not significant

The coefficients on the interest rate spread are highly significant and negatively associated with the net interest margin across all equations. It is notably larger (i.e. more negative) for medium and small banks than for large banks. Nevertheless, pairwise comparisons between the coefficients on the risk premium for large and medium banks suggest only weak statistical significance at 16% level, and that, between large and small banks at 21% level.¹⁰

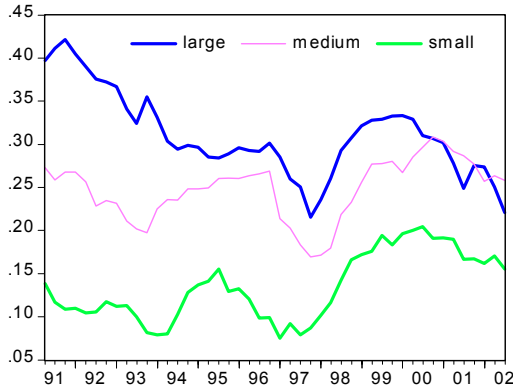
Possible factors that may explain the varying degree of sensitivity to a rise in HIBOR over LIBOR include the reliance on the interbank funds and the liquidity pressure. In this connection, two explanatory variables – net interbank position and the HKD loan-to-deposit ratio – were considered (Chart 6). A bank which is a net lender in the interbank market is expected to have its margin less affected by a rise in the HIBOR over LIBOR, as compared to a bank which is a net interbank borrower. To assess the significance of differences in the balance sheet structure of different bank groups, the interest rate spread was multiplied by the potential explanatory variable. If the net interbank position or the loan-to-deposit ratio helps explain the differing responses across the three equations, the estimated coefficients on the interaction term should not be significantly different from each other. The estimation results suggest that inclusion of net interbank position does

¹⁰ The results may be sensitive to the grouping of banks. For example, within the large group, with only a few banks, their characteristics may differ significantly, and the aggregate data may not give a very accurate picture.

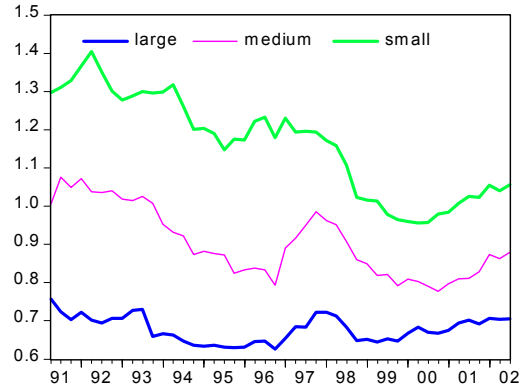
not help reduce the difference in the sensitivity of the net interest margin to the HIBOR-LIBOR spread. This is perhaps not surprising because the three groups of banks were on an aggregate basis all net lenders in the interbank market.

Chart 6. Balance Sheet Structure of Different Bank Groups

a. Net HK\$ Interbank Lending as a Ratio of Interest-bearing Assets



b. HKD Loan-to-Deposit Ratio



On the other hand, the response of the net interest margin to the risk premium is found to be similar for the three groups of banks after controlling for the influence of the loan-to-deposit ratio (ld). This may be because banks with a larger loan-to-deposit ratio are likely to face high liquidity pressures when the interest rate increases, thus putting a larger squeeze on the net interest margin.

Dependent Variable: nim_t

Sample period: 1992Q2 – 2002Q3

	Large-sized	Medium-sized	Small-sized
Constant	0.00625 (0.00549)	-0.0219 (0.00541)	-0.0211 (0.00620)
nim_{t-1}	0.623 (0.0927)	0.523 (0.0827)	0.706 (0.0716)
$prem_t * ld_{t-1}$	-0.0481 (0.0171)	-0.056 (0.0139)	-0.0446 (0.0124)
hh_{t-3}	0.0156 ⁺ (0.0374)	2.43 (0.483)	2.25 (0.557)
\bar{R}_2	0.548	0.788	0.842
Equation standard error	0.000847	0.000906	0.00103

Note: Numbers in bracket in each equation are standard errors.

⁺ Not significant

In sum, the risk premium significantly influenced the net interest margin of banks during the sample period. The sensitivity to the risk premium was slightly lower for large banks than the other two groups, although the difference was only weakly significant. Because larger banks faced lower liquidity pressures—as evidenced by a lower loan-to-deposit ratio—their net interest margins were less susceptible to a change in interest rates.

3. *Pass-through of interbank rates to deposit and lending rates*

To further understand why only changes in the risk premium, but not LIBOR, seem to have mattered in the sample period, the net interest margin is decomposed into three components: the interest yield, the interest cost and the endowment effect (Appendix 1). The difference between interest yield and interest cost is termed the net interest yield, which is closely related to the lending spread defined as the difference between lending and deposit rates. Thus, it is useful to examine how different sources of changes in the interbank interest rate impact on lending and deposit rates.

Regressions were performed to gauge the pass-through of changes in the three-month interbank interest rate to lending and deposit rates respectively. To this end, the best lending rate (*blr*) was used as a proxy for the average lending rate, and an effective deposit rate (*dr*) was constructed to measure the average funding cost.¹¹

An error-correction framework was employed to investigate the pass-through of interest rate shocks to lending and deposit rates:

$$(3) \quad \Delta r_t = c_0 - c_1(r_{t-1} - c_2libor_{t-1} - c_3prem_{t-1}) + c_4\Delta r_{t-1} \\ + c_5\Delta libor_t + c_6\Delta prem_t$$

where: *r* is the best lending rate (*blr*) or the deposit rate (*dr*) and *libor* is the 3-month LIBOR

¹¹ The effective deposit rate was computed as the average of the interest rates on demand, savings and time deposits. As the banking statistics classify deposits by remaining maturities, certain assumptions were made regarding the maturity distribution.

When (3) was estimated individually for lending and deposit rates, c_2 and c_5 were similar for the two equations. A Wald test confirmed the joint hypothesis that c_2 and c_5 were identical in the two equations ($\chi^2 = 1.77$ [0.41]). Therefore, the two equations were estimated jointly using the seemingly unrelated regression estimator (SURE) with the restrictions of an equal short-run and long-run pass-through from the US interest rate. The final specifications were as follows:

$$\begin{aligned} \Delta blr_t = & 1.55 - 0.53(blr_{t-1} - libor_{t-1} - 0.48prem_{t-1}) + 0.10\Delta blr_{t-1} \\ & (9.23) \quad (-9.58) \qquad \qquad \qquad (-10.92) \qquad \qquad (2.04) \\ & + 0.60\Delta libor_t + 0.13\Delta prem_t \\ & (14.46) \qquad \qquad (4.68) \end{aligned}$$

Sample period	1992Q2-2002Q2
\bar{R}_2	0.91
Equation standard error	0.15

$$\begin{aligned} \Delta dr_t = & -0.51 - 0.36(dr_{t-1} - libor_{t-1} - 0.83prem_{t-1}) + 0.25\Delta dr_{t-1} \\ & (-5.91) \quad (-5.96) \qquad \qquad \qquad (-13.12) \qquad \qquad (4.60) \\ & + 0.60\Delta libor_t + 0.38\Delta prem_t \\ & (14.46) \qquad \qquad (14.49) \end{aligned}$$

Sample period	1992Q2-2002Q2
\bar{R}_2	0.94
Equation standard error	0.14

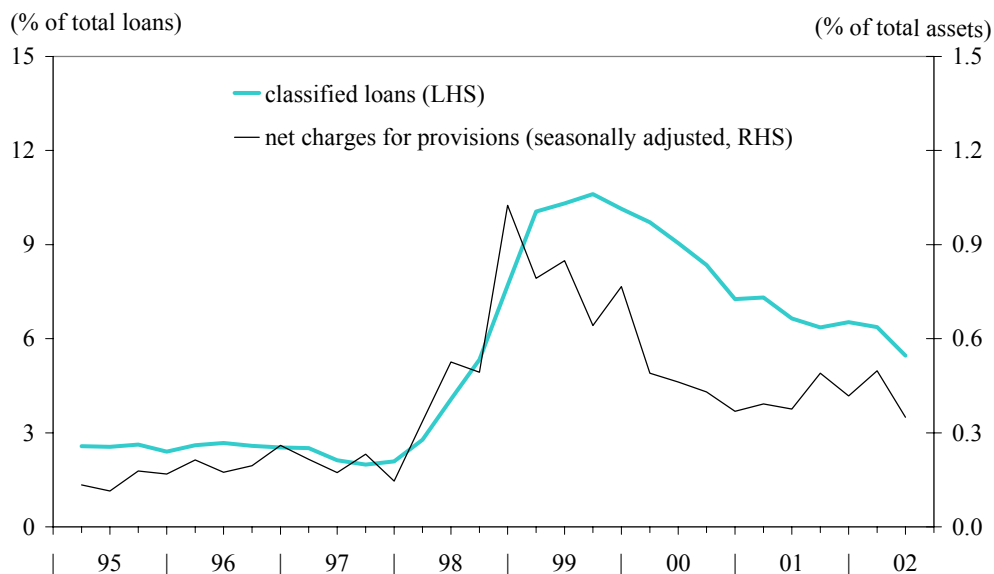
The empirical results suggested that the best lending rate and the effective deposit rate were equally responsive to changes in LIBOR, with a full pass-through in the long run. However, the deposit rate was much more responsive than the lending rate to changes in the interest rate spread. Specifically, a rise of 100 basis points in the spread would increase lending and deposit rates by 48 and 83 basis points respectively in the long run. The short-run dynamics offer a similar conclusion. An increase of 100 basis points in the interest rate spread would raise lending and deposit rates by 13 and 38 basis points respectively in the same quarter. The same amount of increase in LIBOR would increase the two customer rates equally by 60 basis points. Consequently, while a rise in LIBOR would have little effect on the lending spread, an increase in the risk premium would reduce it both in the short and long run.

In sum, for the period under study, a rise of the interest rate differential was found to have reduced net interest margins owing to a relatively low pass-through to the asset side of the banks' balance sheet. On the other hand, changes in the US interest rate had little impact because of an equal pass-through to both lending and deposit rates.¹²

IV. NET CHARGES FOR PROVISIONS

A rise in the market interest rate may affect asset quality by raising borrowing costs and the risk of default, thereby increasing net charges for provisions. The latter (as a ratio to total assets) seemed to be closely related to the classified-loan ratio (Chart 7).

Chart 7. Classified Loans and Net Charges for Provisions



¹² Caution is required in interpreting the estimates. It is possible that when interest rates are already at very low levels, further declines in the US interest rate may squeeze the net interest margin of banks as the deposit rate approaches zero.

To examine the impact of changes in the interest rate on loan quality, a Vector Autoregression (VAR) model was constructed in order to capture the interaction among economic variables. The VAR contains the 3-month HIBOR, real GDP growth, inflation, and the classified-loan ratio as a measure of loan quality.¹³ Specifically, the model can be succinctly written as:

$$y_t = c + \Phi_1 y_{t-1} + \dots + \Phi_p y_{t-p} + \varepsilon_t,$$

with :

$$y_t = \begin{bmatrix} ir_t \\ grow_t \\ \pi_t \\ clr_t \end{bmatrix} \quad \text{and} \quad \varepsilon_t \sim \text{i.i.d. } N(\mathbf{0}, \mathbf{\Omega});$$

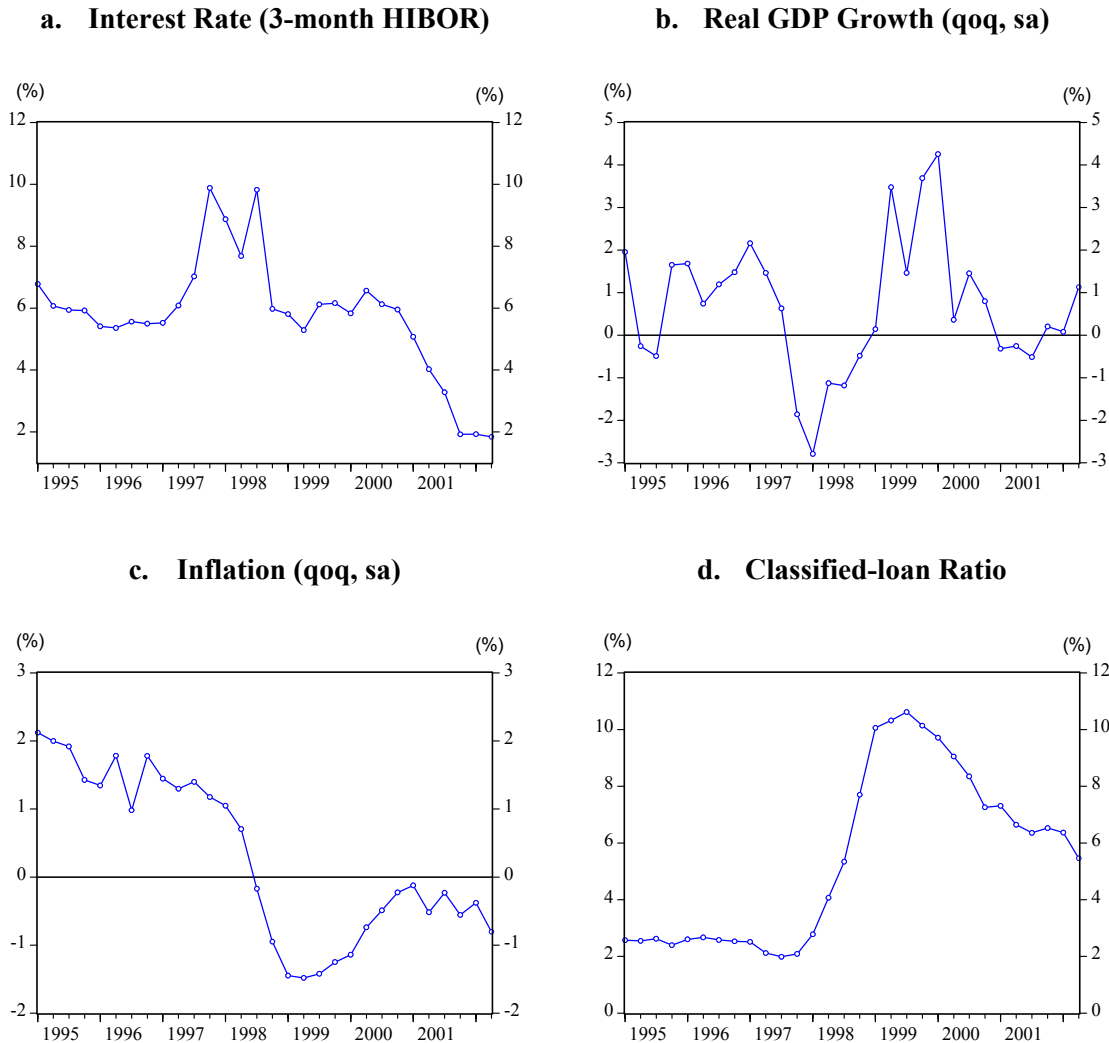
where:

- ir = three-month HIBOR
- $grow$ = real GDP growth
- π = CPI inflation
- clr = the ratio of classified loans to total loans.

¹³ Note that the risk premium does not explicitly appear in the estimated VAR, and its impact can be assessed only through HIBOR in the specification. Unlike net interest margin, an increase in HIBOR would worsen asset quality, regardless of whether the increase in HIBOR is attributable to a rise in LIBOR or in the risk premium.

Chart 8 depicts the developments of the endogenous variables in the VAR over the 1995Q1 to 2002Q2 sample period.¹⁴

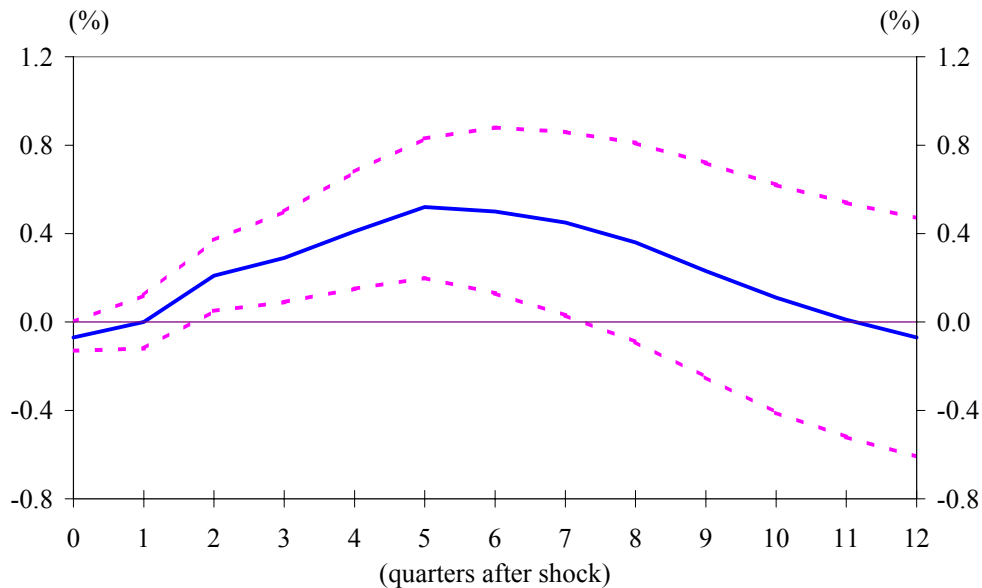
Chart 8. Endogenous Variables in the VAR



Employing the general-to-specific approach, the lag length was chosen to be three. The estimated specification suggests that the interest rate had a significant impact on the classified-loan ratio. An increase in 3-month HIBOR by 105 basis points would raise the classified-loan ratio by around 0.5 percentage point at its worst. The impact of the shock reached its peak in five quarters, but gradually diminished thereafter.

¹⁴ Consistent data on asset quality became available after the Hong Kong Monetary Authority introduced a standardised loan classification system in December 1994. The system contains five categories – pass, special mention, substandard, doubtful and loss loans. The last three of these are referred to collectively as classified loans.

Chart 9. Response of the Classified-Loan Ratio to a 105 Basis Point Increase in the Interest Rate (with 95% Confidence Bands)



V. CONCLUSION

The pre-tax profit of the retail banks has been primarily driven by movements in the net interest margin and the net charge for provisions. This note examines the impact of changes in the interest rate on the performance of the banking sector in Hong Kong. To this end, the Hong Kong dollar interbank interest rate was decomposed into the corresponding LIBOR and the spread over LIBOR (which captures the risk premium of the Hong Kong dollar). The empirical estimates show that during the study period, a rise in the spread over LIBOR squeezed the net interest margin and worsened asset quality. In contrast, an increase in the US interest rate did not have material effects on the net interest margin. This was attributable to an equal pass-through of changes in US interest rates to the best lending rate and the effective deposit rate, leaving an unchanged intermediation spread. On the other hand, the pass-through of the interest rate differential to the deposit rate was much larger than to the lending rate, leading to a narrowed intermediation spread.

DECOMPOSITION OF NET INTEREST MARGIN

The net interest margin (*nim*) is defined as net interest income in relation to interest-bearing assets, and net interest income represents the difference between interest income and interest expenses.¹⁵ Specifically,

$$\begin{aligned}
 nim &= \frac{in - ie}{ia} \\
 &= \underbrace{\frac{in}{ia} - \frac{ie}{il}}_{\text{net interest yield}} + \underbrace{\frac{ie}{il} \cdot \left(1 - \frac{il}{ia}\right)}_{\text{endowment effect}} \\
 &= \text{net interest yield} + \text{endowment effect}
 \end{aligned}$$

where: *in* denotes interest income, *ie* interest expenses, *ia* interest-bearing assets and *il* interest-bearing liabilities.

Hence, the net interest margin represents the sum of the net interest yield and the endowment effect. The latter captures the impact of the part of credits that are financed by equity instead of deposits. Its size, however, is likely to be small relative to the net interest yield.

Note that the net interest margin applies to the stock of assets instead of new loans and deposits. Thus, it reflects largely past decisions on the pricing of credits and deposits, and their adjustments to market conditions are likely to be slow. The spread of a representative lending rate over a deposit rate would be a more responsive proxy for intermediation margins, because they are less affected by the outstanding amount of credits and deposits.

¹⁵ This approach follows ECB (2000).

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