Hong Kong Monetary Authority

December 2002

THE IMPACT OF MACROECONOMIC ENVIRONMENT ON THE ASSET QUALITY OF HONG KONG'S BANKING SECTOR

Key points :

- *This study examines the impact of macroeconomic developments on the asset quality of the banking sector. While emphasis is placed on classified, and overdue and rescheduled loans, macroeconomic determinants of other bad loans are also studied.*

- *The results suggest that banks' asset quality is affected by macroeconomic factors such as economic growth, inflation and interest rates, and by variables reflecting financial fragility such as property prices and bankruptcies. The rise in bad loans between 1995 and 2002 was mainly attributable to changes in macroeconomic conditions.*

- *The banking sector's exposure to the Mainland and the appreciation of the nominal effective exchange rate also contributed to the deterioration of banks' portfolios during the Asian financial crisis.*

Prepared by : Chang Shu
Economic Research Division
Research Department
Hong Kong Monetary Authority

Acknowledgement: I am greatly indebted to Jimmy Ha for his guidance and support throughout the project. My special thanks also go to Stefan Gerlach and Wensheng Peng for their critical comments. I have benefited from discussions with Martin Cihak, Cho-hoi Hui, Dora M. Iakova, Helena Liu, Joanna Shi, Daniel Wong and Rita Yeung. I would also like to thank Wendy Woo for research assistance. The views expressed are those of the author, and do not necessarily reflect those of the Hong Kong Monetary Authority.

I. INTRODUCTION

Recent financial crises have demonstrated that a resilient banking sector is essential for macroeconomic and financial stability. A fragile banking system weakens the efficient allocation of credit, and disrupts monetary policy signals, leading to adverse consequences for stabilisation and growth. As a result, many national authorities have stepped up efforts to monitor the sector. One key aspect of surveillance is to assess from different perspectives the sector's ability to withstand shocks. This study examines the impact of macroeconomic developments on banks' asset quality in Hong Kong.

The rest of the paper is organised as follows. Section II introduces methodologies for stress testing, while Section III reviews the development of asset quality in the banking sector since 1995 when consistent data on bad loans became available after the Hong Kong Monetary Authority (HKMA) introduced the loan classification system in 1994. Section IV investigates empirically the major macroeconomic determinants of loan quality. It first presents benchmark specifications which contain variables typically considered in stress tests. The models are then extended to include factors specific to Hong Kong such as the exposure to the Mainland. Section V carries out stress tests by investigating the volatility of the loan quality indicators in response to macroeconomic shocks. Section VI evaluates forecasting performance of the models, while Section VII presents forward projections. Section VIII summaries the major findings.

II. STRESS TESTING

Financial regulators typically assess financial stability from different perspectives using a wide range of tools. Stress testing is one such tool employed to analyse the resilience of the system to macroeconomic and other shocks.

Stress testing can be conducted at different levels. At the microstructural level, it has, in recent years, become an integral part of risk management to supplement value-at-risk (VaR) and other frameworks (Fender and Gibson, 2001). Financial institutions typically devise scenarios based on types of risks, asset classes or geographical regions, and estimate how the value of their portfolios changes under those circumstances.

At the system level, stress tests can also be undertaken to help identify structural weaknesses and overall risk exposures. There are three approaches to assess systemic vulnerabilities – bottom-up, aggregative, and macroeconomic (Lindgren *et al.*, 1996). In the first of these, a judgement on banking soundness is made by stress testing individual banks' balance-sheets. The second method applies shocks such as exchange and interest rate changes to the sector's aggregate balance-sheet. The macroeconomic approach seeks to establish relationships between macroeconomic variables and indicators of financial sector health.

This study adopts the last method, complementing the stress tests conducted by the Banking Policy Department which have followed the first two.

III. DEVELOPMENT OF ASSET QUALITY IN HONG KONG'S BANKING SECTOR

Hong Kong has a robust banking sector which has withstood well the Asian financial crisis and the more recent adverse economic environment. The International Monetary Fund (2001) observes that the resilience of the system results from prudent banking practice, strong legal institutions and effective supervision.

As the banking supervisor, the Hong Kong Monetary Authority (HKMA) introduced a loan classification system in 1994, which contains five categories: pass, special mention, substandard, doubtful and loss.[1] The last three of these are referred to collectively as classified loans, which, together with those of special mention, are referred to collectively as criticised loans. In addition, the HKMA also publishes data on overdue and rescheduled loans. Classified, and overdue and rescheduled loans overlap each other to a certain extent. However, in addition to information on repayment arrears or rescheduling, assessments on borrowers' ability to meet their obligations are also taken into account in categorising the former. Table 1 summarises the key asset quality indicators.

[1] Appendix I provides more details on the loan classification system.

Table 1. Asset Quality Indicators

1. Based on the loan classification system

Loans not experiencing difficulties	Pass		
Loans experiencing difficulties	Criticised	Special mention	
		Classified	Substandard
			Doubtful
			Loss

2. Based on loan arrears and rescheduling

Overdue and rescheduled	Overdue
	Rescheduled

The HKMA focuses on the asset quality of retail banks, which include locally incorporated banks and a number of foreign banks which are active in the retail business. With the exclusion of authorized institutions whose activities are primarily of an offshore or wholesale nature, this group is more representative of developments in the sector (HKMA, 2001).

Charts 1a-b show that the two major loan quality indicators, namely classified, and overdue and rescheduled loans, of the retail banks experienced similar developments from 1995. Before the Asian financial crisis, these two categories accounted for around 2% of total lending. Asset quality did not immediately suffer when the crisis started in the middle of 1997. However, the sector's loan portfolio deteriorated substantially from 1998 onwards as higher borrowing costs and a sharp slowdown of the economy caused severe financial difficulties for corporate and individual borrowers. The collapse of a number of large Mainland companies in 1998 worsened the situation.[2] Classified, and overdue and rescheduled loan ratios peaked in the third quarter of 1999, reaching 10.61% and 8.58% respectively. During the crisis period, the former indicator rose faster than the latter, reflecting banks' more

[2] The Guangdong International Trust and Investment Corporation (GITIC) was closed down by the People's Bank of China in October, 1998. The exposure of Hong Kong's banking sector to GITIC and its subsidiaries amounted to HK$11 billion at the time.

prudent approach in categorising assets by not only relying on the period overdue as the criterion (HKMA, 1998), but also by evaluating borrowers' repayment ability. Asset quality has improved steadily subsequently with the classified, and overdue and rescheduled loan ratios falling to 5.46% and 3.98% respectively in the second quarter of 2002. Other loan quality indicators also followed similar developments as shown in Charts 1a-b.

Chart 1. Asset Quality Indicators of Hong Kong's Banking Sector

Chart 1a. Classified Loan Ratio

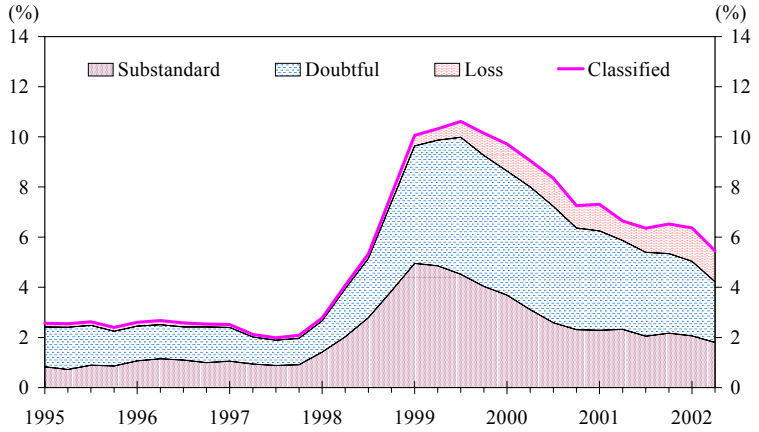
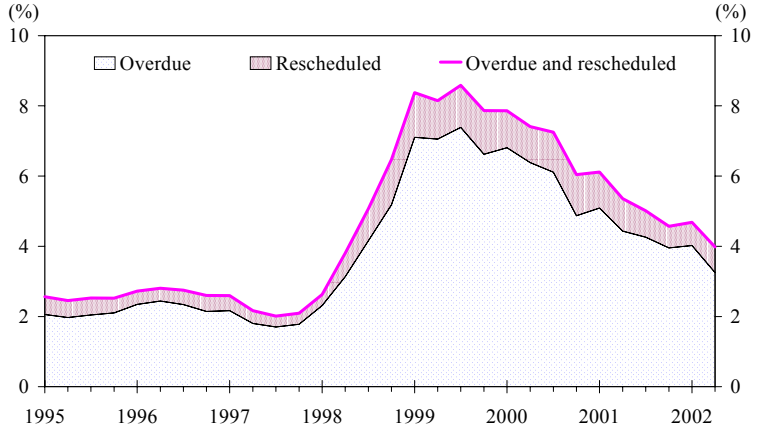


Chart 1b. Overdue and Rescheduled Loan Ratio



IV. DETERMINANTS OF ASSET QUALITY

Empirical framework

An empirical equation for asset quality determination is specified as follows:

$$\left(\frac{Bad\ Loans}{Total\ Loans}\right)_t = \alpha_0 + \underset{(-)}{\alpha_1}\,\Delta gdp_{t-i} + \underset{(-)}{\alpha_2}\,\Delta p_{t-i} + \underset{(+)}{\alpha_3}\,umr_{t-i} + \underset{(?)}{\alpha_4}\,i_{t-i} + \underset{(-)}{\alpha_5}\,\Delta propp_{t-i} + \underset{(-)}{\alpha_6}\,\Delta equity_{t-i} + \underset{(+)}{\alpha_7}\,\Delta bankruptcy_{t-i} + \varepsilon_t \quad (1)$$

Note: The expected signs of the variables are indicated in parentheses.

Where:

Δgdp	= real economic growth
Δp	= CPI inflation
umr	= unemployment rate
$\Delta propp$	= % change in property prices
$\Delta equity$	= % change in equity prices
i	= nominal interest rates
$\Delta bankruptcy$	= % change in personal and business bankruptcies.

Equation (1) links the bad loan ratio to a number of risk factors which are typically considered in stress tests. They can be broadly divided into indicators of macroeconomic conditions such as economic growth, unemployment, inflation and interest rates, and those of financial fragility such as asset prices, and personal and business bankruptcies (Lindgren *et al.*, 1996). It should be noted that the two groups are closely linked to each other. Macroeconomic conditions may well affect asset prices and the number of bankruptcies, while financial fragility often reflects macroeconomic weaknesses. Aggregated microprudential indicators such as asset quality have been found to be primarily contemporaneous or lagging indicators of banking soundness. Macroeconomic variables, on the other hand, can give early signals on imbalances that affect the banking system (Hilbers, 2001). Therefore, the bad loan ratio is specified as influenced by past values of the risk factors with the lag structure to be determined empirically.

The risk factors influence the loan quality indicator through their impact on borrowers' ability to repay and the banking sector's portfolio position. More specifically, higher economic growth reduces the bad loan ratio through its effects both on the numerator and denominator. Economic expansion is often

associated with higher corporate profitability, reducing the default probability. Banks also increase lending more rapidly in an economic boom. There are several reasons to expect a negative coefficient on inflation. One is that it lowers *ex post* real interest rates, and thus increases loan demand. Inflation can also improve borrowers' ability to meet obligations by eroding the real value of repayment. In addition, it is positively correlated with economic growth, implying that higher inflation is associated with lower default rates and an acceleration in credit expansion. Bankruptcies and unemployment can directly lead to loan defaults. Furthermore, these two variables can reflect cyclical conditions as they increase in an economic downturn. The value of collateral for property and stock investment related lending grows with rises in asset prices. This can lead to a lower bad loan ratio because higher levels of collateral reduce the default probability as well as increase the size of new loans. Equity prices are also frequently cited as a leading indicator of economic conditions. The overall effect of higher nominal interest rates on the dependent variable is ambiguous. They encourage banks to lend more, while at the same time reduce loan demand, and raise borrowing costs, causing more defaults.

Benchmark results

Quarterly data between 1995Q1 and 2002Q2 are used to estimate equation (1). More detailed description of the data is provided in Appendix II. Tables 2-3 present the results for the two major asset quality indictors. The models are well specified, and pass all the diagnostic tests. They are also stable over the sample period as indicated by recursive estimates. Given that the two specifications are similar, the discussion below focuses on that for the classified loan ratio.

All explanatory variables have plausible signs. The estimation results suggest that bad loans as a fraction of total lending rise with increases in nominal interest rates and faster growth of bankruptcies, but fall with higher CPI inflation, economic growth and property price inflation. The unemployment variable is not significant after controlling for output growth. The constant is also found to be statistically insignificant, and therefore omitted from the equation. The results are not sensitive to the inclusion of a constant.

The current deflation is harmful to asset quality as it squeezes corporate profitability and adversely affects borrowers' ability to repay. The estimation suggests that, other things being equal, a fall of one percentage point in inflation will raise the classified loan ratio by 0.3 percentage point. The positive coefficient on nominal interest rates suggests that the effects of increased borrowing cost and restraining loan demand dominate those of credit expansion. A one-percentage-point increase in economic growth reduces the ratio by about 0.04 percentage point.

Among the financial fragility indicators, property price inflation is estimated to have a significant impact on asset quality, while equity price movements are not. This may be explained by the fact that property related lending accounts for nearly half of total loans, while stock related lending is less than 7%. Growth of bankruptcies leads to a deterioration of banks' loan portfolios. In addition, a dummy variable which takes the value of one during the Asian financial crisis, and zero in other periods is found to be highly significant.

Appendix III reports specifications for other problem loan categories. They are similar to those for the two major indicators.

Table 4 presents the relative impact of macroeconomic condition and financial fragility indicators on asset quality. The results suggest that the increases in bad loans between 1995 and 2002 were largely attributable to changes in macroeconomic conditions.

Table 2. Macroeconomic Determinants of the Classified Loan Ratio

$$\left(\frac{Classified\ Loans}{Total\ Loans}\right)_t = \underset{(32.82)}{0.782}\left(\frac{Classified\ Loans}{Total\ Loans}\right)_{t-1} \underset{(-3.70)}{-0.035\Delta gdp_{t-3}} \underset{(-4.63)}{-0.283\Delta p_{t-1}} \underset{(5.57)}{+0.142 i_{t-2}}$$

$$\underset{(-6.42)}{-0.047\Delta propp_{t-3}} \underset{(2.27)}{+0.006\Delta bankruptcy_{t-2}} \underset{(6.06)}{+0.781 Crisis} + Seasonals$$

Adjusted R^2=0.99
Equation standard error = 0.1214
LM test for serial correlation: F-statistics = 0.07 [0.79]
Jarque-Bera test for normality: $\chi^2(2)$ = 5.95 [0.05]
White test for heteroskedasticity: F-statistic = 0.24 [0.99]
Ramsey RESET test for model specification: F-statistic = 1.55 [0.23]

Note: Figures in ( ) are t-statistics, and those in [ ] are p-values.

Table 3. Macroeconomic Determinants of the Overdue and Rescheduled Loan Ratio

$$\left(\frac{Overdue\ and\ rescheduled\ loans}{Total\ Loans}\right)_t = \underset{(24.63)}{0.746}\left(\frac{Overdue\ and\ rescheduled\ loans}{Total\ Loans}\right)_{t-1} \underset{(-5.17)}{-0.056}\Delta gdp_{t-4}$$

$$\underset{(-4.45)}{-0.265}\Delta p_{t-1} + \underset{(6.02)}{0.159} i_{t-2} \underset{(-4.01)}{-0.027}\Delta propp_{t-3} + \underset{(1.93)}{0.005}\Delta bankruptcy_{t-2}$$

$$+ \underset{(4.49)}{0.534} Crisis + Seasonals$$

Adjusted R^2=0.99
Equation standard error = 0.2209
LM test for serial correlation: F-statistics = 0.38 [0.54]
Jarque-Bera test for normality: $\chi^2(2)$ = 0.59 [0.75]
White test for heteroskedasticity: F-statistic = 0.80 [0.66]
Ramsey RESET test for model specification: F-statistic = 2.56 [0.13]

Note: Figures in ( ) are t-statistics, and those in [ ] are p-values.

Table 4. Relative Contributions of Macroeconomic Condition and Financial Fragility Indictors

	Classified Loans Ratio	Overdue and Rescheduled Loans Ratio
Macroeconomic conditions	73%	78%
Financial Fragility	27%	22%

Additional factors influencing asset quality in Hong Kong

We extend the study by considering other potentially important factors, which include the exposure to the Mainland and the nominal effective exchange rate. The issue of whether the exposure to the Mainland affects banking stability arises given the close link between Hong Kong and the Mainland. In the benchmark models, a dummy taking the value of one during the Asian financial crisis is highly significant. This suggests that there are other factors influencing asset quality which are not captured by the variables included in the specifications. One possibility is the exchange rate, which can affect the lending portfolio through its impact on loans denominated in foreign currencies or used abroad.

Estimation results suggest that the exposure to the Mainland led to a deterioration of asset quality during 1998-2000, as reported in Column 3 of Tables 5-6 for the classified, overdue and rescheduled loan ratios respectively. In the estimation, the variable $Claims^{CN}$ is defined as claims to the Mainland as a fraction of total banking assets, while the dummy variable D^{CN} takes the value of one for the period between 1998Q3 and 2000Q2, but zero otherwise. As mentioned in Section III, the collapse of a number of large Mainland companies in 1998 further weakened banks' loan portfolios. A survey by the HKMA in September 1999 revealed that asset quality of Mainland related lending was worse than that of the sector's overall portfolio. The negative impact from the Mainland exposure was largely unwound by mid-2000 as bad debt was written off or rescheduled.

Hong Kong banks have been reducing the exposure to the Mainland since the collapse of the Guangdong International Trust & Investment Corporation (Gitic) and other similar non-bank financial entities. Claims to the Mainland as a fraction of banking sector assets declined steadily from the peak of 5.07% in 1998Q1 to 2.15% in 2002Q2. More recently a number of banks, attracted by higher mortgage rates, started to fund cross-border property purchases. However, they are cautious in extending loans for the purchase of Mainland properties. The average loan-to-value ratio of these mortgages stood between 60% and 70%, lower than the 80% limit stipulated by the People's Bank of China (South China Morning Post, October 27, 2002).

Turning to the nominal effective exchange rate, we consider a measure calculated as trade weighted exchange rates of Hong Kong's major trading partners excluding the Mainland and United States. Column 4 of Tables 5-6 shows that the appreciation of the Hong Kong dollar leads to a deterioration in asset quality. This may be explained by the impact of exchange rate fluctuations on loans denominated

in foreign currencies or used abroad. Hong Kong's nominal effective exchange rate appreciated sharply during the Asian crisis, which reflected weakening of its trading partners' currencies in general. This increased the burden on foreign borrowers to repay debts that were not denominated in their own national currencies. Business failures could also rise due to higher production cost as a result of higher import prices. These factors could lead to more foreign loan defaults.

Table 5. Alternative Specifications for the Determination of the Classified Loan Ratio

	Benchmark	China Factor	Impact of NEER
$\left(\frac{Classified\ Loans}{Total\ Loans}\right)_{t-1}$	0.782 (32.82)	0.766 (34.55)	0.724 (27.08)
Δgdp_{t-3}	-0.035 (-3.70)	-0.032 (-3.67)	-0.029 (-2.71)
Δp_{t-1}	-0.283 (-4.63)	-0.268 (-4.88)	-0.348 (-4.73)
i_{t-2}	0.142 (5.57)	0.148 (6.45)	0.203 (8.16)
$\Delta propp_{t-3}$	-0.047 (-6.42)	-0.042 (-6.05)	-0.035 (-4.08)
$\Delta bankruptcy_{t-2}$	0.005 (2.27)	0.005 (2.45)	0.007 (2.52)
$D^{CN} * Claims^{CN}_{t-4}$	-	0.077 (2.52)	0.136 (4.16)
$\Delta neer_{t-4}$	-	-	0.043 (2.54)
Crisis	0.781 (6.06)	0.619 (4.70)	-
$\overline{R}^2$	0.99	0.99	0.99
Equation standard error	0.2381	0.2125	0.2592
LM test for serial correlation	1.98 [0.18]	0.19 [0.66]	0.62 [0.44]
Jarque-Bera test for normality	0.52 [0.77]	0.05 [0.98]	1.59 [0.45]
White test for heteroskedasticity	1.37 [0.28]	1.70 [0.18]	1.91 [0.15]
Ramsey RESET test for model specification	2.08 [0.16]	0.003 [0.96]	2.51 [0.13]

Note: Figures in ( ) are t-statistics, and those in [ ] are p-values.

Table 6. Alternative Specifications for the Determination of the Overdue and Rescheduled Loan Ratio

	Benchmark	China Factor	Impact of NEER
$\left(\frac{Overdue\ and\ \mathrm{Re}scheduled\ Loans}{Total\ Loans}\right)_{t-1}$	0.746 (24.62)	0.727 (26.17)	0.679 (25.69)
$\Delta gdp_{t\text{-}4}$	-0.056 (-5.17)	-0.052 (-5.42)	-0.056 (-5.15)
$\Delta p_{t\text{-}1}$	-0.265 (-4.45)	-0.246 (-4.67)	-0.296 (-5.31)
$i_{t\text{-}2}$	0.159 (6.02)	0.167 (7.12)	0.202 (9.48)
$\Delta propp_{t\text{-}3}$	-0.027 (-4.01)	-0.023 (-3.67)	-0.024 (-3.47)
$\Delta bankruptcy_{t\text{-}2}$	0.005 (1.93)	0.004 (1.94)	0.004 (1.55)
$D^{CN} * Claims_{t-4}^{CN}$	-	0.075 (2.66)	0.136 (4.81)
$\Delta neer_{t\text{-}1}$	-	-	0.028 (1.95)
Crisis	0.534 (4.49)	0.368 (3.02)	-
$\overline{R}^2$	0.99	0.99	0.99
Equation standard error	0.2209	0.1945	0.2153
LM test for serial correlation	0.38 [0.54]	1.32 [0.26]	1.22 [0.28]
Jarque-Bera test for normality	0.59 [0.75]	1.27 [0.53]	0.87 [0.65]
White test for heteroskedasticity	0.80 [0.66]	2.03 [0.11]	2.26 [0.09]
Ramsey RESET test for model specification	2.56 [0.13]	0.11 [0.74]	1.18 [0.29]

Note: Figures in ( ) are t-statistics, and those in [ ] are p-values.

V. VOLATILITY OF BAD LOANS

Based on the estimated equations, the unconditional and conditional volatilities of asset quality indicators in response to shocks to explanatory variables are calculated. The formula for calculating volatility is given as:

$$(2)\ \sigma_{\frac{Bad\ loans}{Total\ Loans}} = \sqrt{\alpha^2 \cdot \sigma_i^2 + \beta^2 \sigma_{\Delta p}^2 + \gamma^2 \sigma_{\Delta gdp}^2 + \varphi^2 \sigma_{\Delta propp}^2 + \ldots + 2 \cdot \alpha \cdot \beta \cdot \sigma_{i,\Delta p}^2 + \ldots}$$

where:

α = coefficient on nominal interest rates
σ_i^2 = variance of nominal interest rates
β = coefficient on inflation
$\sigma_{\Delta p}^2$ = variance of inflation
γ = coefficient on unemployment rates
$\sigma_{\Delta gdp}^2$ = variance of unemployment rates
φ = coefficient on changes in property prices
$\sigma_{\Delta propp}^2$ = variance of changes in property prices
$\sigma_{i,\Delta p}^2$ = pairwise covariance among explanatory variables.

Applying formula (2), the unconditional volatility is calculated using variances and covariances of the original series of explanatory variables. To obtain an estimate of the conditional volatility, an AR(1) model is fitted for each risk factor. The residuals from these models are then used to calculate conditional variances and covariances as inputs for formula (2). As additional information is used, the conditional volatility is significantly smaller than the unconditional volatility.

The unconditional volatility of the classified loan ratio is 3.20%, which is 60% of the sample mean. The unconditional volatility of the overdue and rescheduled loan ratio is 2.95%, or 65% of the sample mean. The calculations suggest that based on the historical movement of the risk factors and co-movement among them, the loan quality indicators are likely to vary in the ranges of 2.24%-8.64%, and 1.68%-7.68% respectively.

The conditional volatility of the classified loan ratio is 0.40%, which is 7.4% of the sample mean. The conditional volatility of the overdue and rescheduled loan ratio is 0.33%, or 7.1% of the sample mean. That is, with additional information on the data generating process of the risk factors, the two asset quality indicators can be expected to move within the bands of 5.04%-5.84%, and 4.30%-4.96% respectively.

As a measure of uncertainty, volatility can be used to generate stress test scenarios. For example, a central projection of bad loans plus four times the calculated volatility can be taken as the worst case, and analysis can be carried out as to whether the banking sector is able to withstand this shock.

VI. Out-of-sample projection of bad loans

The models are used to generate out-of-sample projections of loan quality indicators to evaluate their forecasting performance. For this purpose, equations presented in Section IV are re-estimated for the period between 1995Q1 and 2001Q2, leaving the last four quarters' data for projection. Tables 7-8 show that the best out-of-sample dynamic forecasts track the actual data closely, with mean absolute percent errors of about 3%. Charts 2a-b plot the forecasts with confidence intervals, which are given as the point projections plus and minus two standard errors – an approximate 95% forecast interval.

Table 7. Out-of-sample Four-quarter ahead Projection of the Classified Loan Ratio (%)

	2001Q3	2001Q4	2002Q1	2002Q2
Actual	6.36	6.53	6.37	5.46
Projection	6.42	6.27	6.33	5.75

Root Mean Squared Error = 0.20
Mean Absolute Percent Error = 2.71
Theil Inequality Coeffficient = 0.02

Table 8. Out-of-sample Four-quarter ahead Projection of the Overdue and Rescheduled Loan Ratio (%)

	2001Q3	2001Q4	2002Q1	2002Q2
Actual	5.01	4.57	4.69	3.98
Projection	5.27	4.57	4.67	4.17

Root Mean Squared Error = 0.16
Mean Absolute Percent Error = 2.56
Theil Inequality Coeffficient = 0.02

Chart 2. Out-of-Sample Projection of the Asset Quality Indicators with Two-Standard-Error Bands

Chart 2a. Classified Loan Ratio

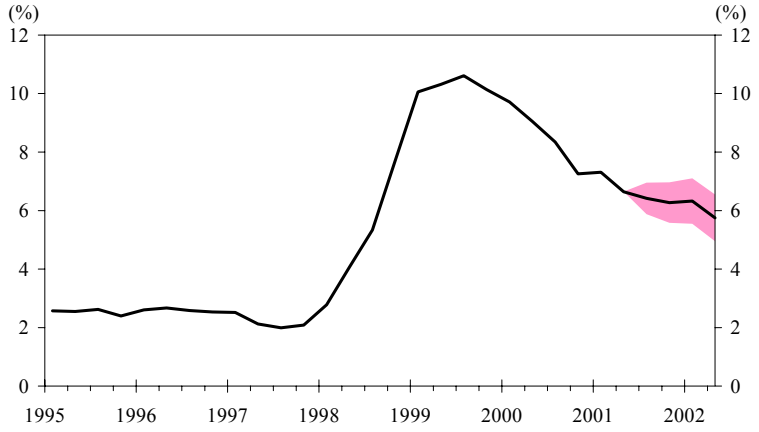
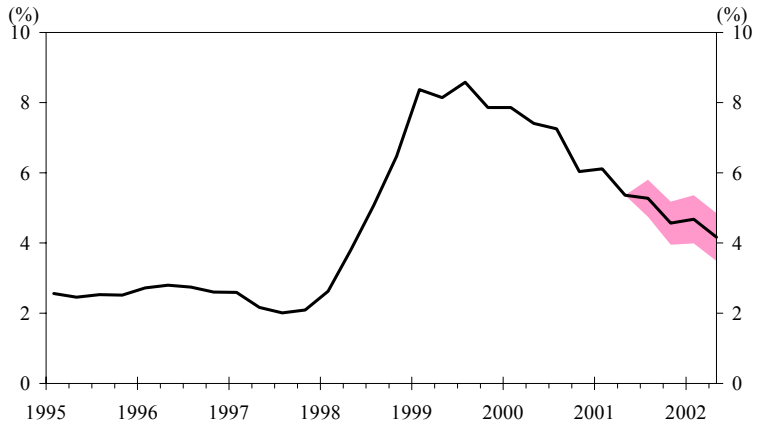


Chart 2b. Overdue and Rescheduled Loan Ratio



VII. FORWARD PROJECTION OF BAD LOANS

The benchmark models are then employed to project the loan quality indicators forward for the period of 2002Q3-2003Q4. Appendix IV provides details of assumptions on exogenous variables for projection. Those for interest rates, growth and inflation are derived from the latest *Asian Pacific Consensus Forecasts*. In the baseline, they are assumed to be the same as the consensus forecasts. In the high case, interest rates take the highest projected values in the survey, while inflation and growth take the lowest projections. The opposite assumptions are made for the low case. Property prices continue to fall at the rate of the five-year average in the high case. In the other two scenarios, the market improves along with an economic recovery combined with the impact from the recent housing policy initiatives[3] – property prices stabilising in the baseline, and rising by 10% over a year in the low case. Historical data are used to generate the assumptions for changes in bankruptcies.[4]

Table 9 presents the forward projections for the two major loan quality indicators. In the baseline and low scenarios, asset quality improves on the back of an economic recovery and improvements in the property market. In the high case, bad loan ratios first fall mainly due to lagged effects of low interest rates and some moderation in deflation. However, stagnation and a continuing decline in property prices eventually lead to a deterioration of the loan portfolio.

---

[3] The government announced a set of new housing policies on November 13, 2002 in a bid to restore public confidence in the property market. These policies aim at minimising intervention in the market while continuing to help families in need. In line with these objectives, the government will focus on its role in ensuring an adequate supply of land to meet market demand and the provision of rental assistance.

[4] The variable takes the mean value of the past five years in the baseline, and the five-year average plus and minus one standard deviation in the high and low cases respectively.

Table 9. Six-Quarter-Ahead Projection of the Bad Loan Ratios (%)

	Classified Loans			Overdue and Rescheduled Loans		
	Low	Baseline	High	Low	Baseline	High
2002Q3	5.15	5.15	5.15	3.71	3.71	3.71
2002Q4	4.69	4.69	4.69	3.42	3.42	3.42
2003Q1	4.01	4.25	4.42	2.87	3.09	3.24
2003Q2	3.56	3.96	4.37	2.48	2.84	3.20
2003Q3	2.82	3.53	4.38	1.94	2.56	3.27
2003Q4	2.24	3.19	4.39	1.54	2.34	3.31

VIII. CONCLUSION

This study investigates the impact of macroeconomic developments on asset quality of the banking sector. While emphasis is placed on the major indicators – classified, and overdue and rescheduled loans, macroeconomic determinants of other problem loans are also studied.

The results suggest that asset quality is affected by macroeconomic factors such as economic growth, inflation and interest rates, and by variables reflecting financial fragility such as property prices and bankruptcies. The increases in bad loans between 1995 and 2002 were largely attributable to changes in macroeconomic conditions. The banking sector's exposure to the Mainland and the appreciation of the nominal effective exchange rate also contributed to a deterioration of banks' portfolios during the Asian financial crisis. The unconditional and conditional volatilities of loan quality indicators are calculated to carry out stress testing for the banking sector. The models generate good out-of-sample forecasts. In projecting bad loans forward, assumptions on macroeconomic conditions are derived from the latest *Asian Pacific Consensus Forecasts*, while those for property prices and bankruptcies are made based on historical data as well as consistent with the macroeconomic scenarios. The forward projections show that asset quality improves in the baseline and low scenarios on the back of an economic recovery and improvements in the property market, while in the high case, stagnation and a continuing decline in property prices eventually lead to a deterioration of the loan portfolio.

References

Fender, Ingo and Gibson, Michael S. (2001). Stress testing in practice: a survey of 43 major financial institutions. *Bank for International Settlements Quarterly Review*, **2001(June)**, 58-62.

Hilbers, Paul (2001). The IMF/World Bank Financial Sector Assessment Program. http://www.imf.org/external/np/vc/2001/022301.htm.

Hong Kong Monetary Authority (1998). *Annual Report 1998*.

Hong Kong Monetary Authority (2001). *Annual Report 2001*.

International Monetary Fund (2001). People's Republic of China – Hong Kong Special Administrative Region: 2000 Article IV Consultation. *IMF Country Report*, **01/43**.

Lindgren, Carl-Johan, Garcia, Gillian and Saal, Matthew I. (1996*). Bank Soundness and Macroeconomic Policy*. Washington, DC: IMF.

South China Morning Post (October 27, 2002). SAR banks return to Mainland.

Appendix I

The HKMA's Loan Classification System

Category	Definition	Typical Overdue Period *	Provisioning
Pass	Loans where borrowers are current in meeting commitments & full repayment of interest & principal is not in doubt.		A general provision of at least 1% across-the-board should be established. Alternatively, the provision may be calculated according to a formula based on past loan loss experience in respect of different categories of loans (e,g. ½% on residential mortgages, 2% on taxi loans, etc.).
Special mention	Loans where borrowers are experiencing difficulties which may threaten the institution's position. Ultimate loss is not expected at this stage but could occur if adverse conditions persist.	Unsecured or partially-secured : Up to 3 months [N.B. downgrading to substandard may be justified, even if the loan has not been overdue for more than 3 months, where other significant deficiencies are present which threaten the borrower's business, cash flow & payment capability.] Fully secured : Up to 12 months [N.B. fully secured loans need not be downgraded to substandard until they are over 12 months overdue]	No specific provision is necessary against loans classified as special mention, but it may be appropriate to increase the general provision against such loans to, say, 2% (whether secured or unsecured). For taxi loans a specific provision of 2% on top of a general provision of 2% is recommended.
Substandard	Loans where borrowers are displaying a definable weakness that is likely to jeopardise repayment. Includes loans where some loss of principal or interest is possible after taking account of the "net realisable value" of security, & rescheduled loans where concessions have been made to the customer on interest or principal (i.e. which have been made on non-commercial terms). N.B. Such loans may be upgraded to pass once they have been serviced according to the revised terms for 6 months (monthly repayments) / 12 months (other than monthly repayments).	Unsecured or partially-secured : Generally more than 3 months up to 6 months [N.B. downgrading to doubtful may be justified, even if the loan has not been overdue for more than 6 months, where other significant deficiencies are present which threaten the borrower's business, cash flow & payment capability.] Fully secured : Over 12 months	Specific provisions should normally be made as soon as a loan is classified as substandard, unless there are good reasons to the contrary (however, provisions against substandard loans may not be necessary where the policy of the AI is to classify loans promptly as doubtful & to provision accordingly). Provisions should be determined on a loan-by-loan basis, with full provision being made for the likely loss (i.e. the irrecoverable amount). However, in practice it may be difficult to reliably estimate the likely loss (particularly at the comparatively early stage of a loan being downgraded to substandard). Generally speaking, therefore, the level of provisions in respect of individual loans tends to be related to the loan classification. In the case of substandard loans, an AI may typically provide 20-25% against the unsecured portion of those loans that it is unable to assess on a loan-by-loan basis. In the case of portfolios of loans with similar characteristics (e.g. credit cards) the provision may be based on past loan loss experience.

Doubtful	Loans where collection in full is improbable & the institution expects to sustain a loss of principal &/or interest after taking account of the net relisable value of security.	Unsecured or partially-secured : Generally more than 6 months	Given that, generally speaking, the level of provisions in respect of individual loans tends to be related to the loan classification, higher provisions will generally be required when loans are downgraded into a lower category (e.g. from substandard to doubtful). Typically, loans will be reclassified from substandard to doubtful when the overdue period increases to more than 6 months. With this passage of time the position of the borrower & therefore the position as regards the degree of recoverability of the loan may become clearer, & it may be possible to more accurately assess the likely loss on a loan-by-loan basis. Consequently a range of provisioning levels is possible. Typically, however, provisions are likely to be in the range of 50-75% against the unsecured portion. Provisions at the higher end of this range (& perhaps as high as 100%) may be appropriate where there has been no sign of progress/improvement over time (e.g. further provision should be considered against loans which show no improvement from one review period to the next). If it is still not possible to reliably estimate the likely loss on some loans, it is prudent for an AI to provide at least 50% against those doubtful loans that it is unable to assess on a loan-by-loan basis.
Loss	Loans which are considered uncollectible after exhausting all collection efforts such as realisation of collateral, institution of legal proceedings, etc.		All outstanding principal & interest which are not covered by the value of collateral should be fully provided for or written off (e.g. 100% provision)

* In the case of loans under restructuring, the overdue period should be measured from the time the loan first went overdue [no "grace period' should be given because the loan is under restructuring],

Interest accrual

Interest should be placed in suspense or cease to be accrued in respect of (1) loans where there is reasonable doubt about the ultimate collectibility of principal &/or interest (irrespective of whether the contractual terms of the loan have been breached or if the period of arrears is not more than 3 months); (2) loans on which contractual repayments of principal &/or interest are more than 3 months in arrears & the net realizable value of security is insufficient to cover the payment of principal & accrued interest, & (3) loans on which principal &/or interest is more than 12 months in arrears, irrespective of the net realizable value of collateral.

Appendix II

Data Description

Δgdp	economic growth
Δp	CPI inflation
umr	unemployment rate
$\Delta propp$	changes in the property price index
$\Delta equity$	changes in the Hang Seng Index
i	three-month Hong Kong interbank offered rates
$\Delta bankruptcy$	changes in the number of business and personal bankruptcy cases.
$claims^{CN}$	claims to the Mainland's banks and non-bank customers as a fraction of total banking assets
$\Delta neer$	changes in the index of nominal effective exchange rates
$Crisis$	dummy variable which takes the value of 1 during the period of 1997Q4-1999Q3, 0 otherwise;
D^{CN}	dummy variable which takes the value of 1 during the period of 1998Q3-2000Q2, 0 otherwise;

Appendix III

Determination of Other Asset Quality Indicators

Criticised loans

$$\left(\frac{Criticised\ Loans}{Total\ Loans}\right)_t = 0.684\left(\frac{Criticised\ Loans}{Total\ Loans}\right)_{t-1} - 0.071\Delta gdp_{t-3} - 0.499\Delta p_{t-1} + 0.215 umr_{t-1} + 0.352 i_{t-2}$$
(14.56) (-3.66) (-4.16) (1.88) (5.75)

$$- 0.061\Delta propp_{t-3} + 0.009\Delta bankruptcy_{t-1} + 1.129 Crisis + Seasonals$$
(-4.08) (1.71) (4.38)

Adjusted R^2=0.99
Equation standard error = 0.4824

Special mention loans

$$\left(\frac{Special\ Mention\ Loans}{Total\ Loans}\right)_t = 0.272\left(\frac{Special\ Mention\ Loans}{Total\ Loans}\right)_{t-1} - 0.195\Delta p_{t-1} + 0.514 umr_{t-2} + 0.339 i_{t-2} - 0.031\Delta propp_{t-3}$$
(2.26) (-2.79) (4.14) (6.51) (-2.63)

$$- 0.012\Delta equity_{t-1} + 0.007\Delta bankruptcy_{t-1} + 0.673 Crisis + Seasonals$$
(-2.40) (1.99) (3.58)

Adjusted R^2=0.97
Equation standard error = 0.3263

Substandard loans

$$\left(\frac{Subs\tan dard\ Loans}{Total\ Loans}\right)_t = 0.695\left(\frac{Subs\tan dard\ Loans}{Total\ Loans}\right)_{t-1} - 0.065\Delta gdp_{t-4} - 0.109\Delta p_{t-1} + 0.119 i_{t-2} - 0.024\Delta propp_{t-3}$$
(21.93) (−3.50) (-3.18) (8.30) (-5.72)

$$+ 0.002\Delta bankruptcy_{t-1} + 0.365 Crisis + Seasonals$$
(1.70) (5.27)

Adjusted R^2=0.99
Equation standard error = 0.1254

Doubtful loans

$$\left(\frac{Doubtful\ Loans}{Total\ Loans}\right) = -0.452 + 0.754\left(\frac{Doubtful\ Loans}{Total\ Loans}\right)_{t-1} - 0.024\Delta gdp_{t-2} - 0.226\Delta p_{t-1} + 0.184 i_{t-1}$$
$$(-2.36)\ (17.41) \qquad (-2.21) \qquad (-4.31) \qquad (8.01)$$

$$- 0.034\Delta propp_{t-4} + 0.004\Delta bankruptcy_{t-2} + Seasonals$$
$$(-4.59) \qquad (2.07)$$

Adjusted R^2=0.98
Equation standard error = 0.1973

Loss loans

$$\left(\frac{Loss\ Loans}{Total\ Loans}\right)_t = 0.927\left(\frac{Loss\ Loans}{Total\ Loans}\right)_{t-1} - 0.007\Delta gdp_{t-3} - 0.031\Delta p_{t-1} + 0.003\Delta bankruptcy_{t-2} + Seasonals$$
$$(25.53) \qquad (-2.06) \qquad (-2.21) \qquad (3.14)$$

Adjusted R^2=0.96
Equation standard error = 0.0863

Overdue loans

$$\left(\frac{Overdue\ Loans}{Total\ Loans}\right)_t = -0.490 + 0.813\left(\frac{Overdue\ Loans}{Total\ Loans}\right)_{t-1} - 0.065\Delta gdp_{t-4} - 0.136\Delta p_{t-1} + 0.169 i_{t-2} - 0.021\Delta propp_{t-3}$$
$$(-2.14)\ (20.36) \qquad (-6.77) \qquad (-2.30) \qquad (5.51) \qquad (-3.27)$$

$$+ 0.004\Delta bankruptcy_{t-2} + 0.406 Crisis + Seasonals$$
$$(1.93) \qquad (3.77)$$

Adjusted R^2=0.99
Equation standard error = 0.1952

Rescheduled loans

$$\left(\frac{\text{Re}\,scheduled\ Loans}{Total\ Loans}\right)_t = 0.730\left(\frac{\text{Re}\,scheduled\ Loans}{Total\ Loans}\right)_{t-1} - 0.009\Delta gdp_{t-2} - 0.064\Delta p_{t-1} + 0.037 i_{t-1}$$
$$(13.22) \qquad (-2.78) \qquad (-3.49) \qquad (4.67)$$

$$- 0.007\Delta propp_{t-1} + Seasonals$$
$$(-2.84)$$

Adjusted R^2=0.94
Equation standard error = 0.0814

Loans Overdue for 3-6 months

$$\left(\frac{\textit{Loans Overdue for 3-6 months}}{\textit{Total Loans}}\right)_t = \underset{(3.05)}{0.190}\left(\frac{\textit{Loans Overdue for 3-6 months}}{\textit{Total Loans}}\right)_{t-1} \underset{(-3.68)}{-0.049}\Delta gdp_{t-4} \underset{(-5.26)}{-0.094}\Delta p_{t-1}$$

$$\underset{(10.68)}{+0.116}i_{t-2} \underset{(-5.75)}{-0.020}\Delta propp_{t-3} \underset{(5.27)}{+0.268}Crisis + Seasonal$$

Adjusted R^2=0.97
Equation standard error = 0.0897

Appendix IV

Assumptions on Exogenous Variables for Forward Projection

	Historical data					Projection assumptions					
	2000	2001	2002Q1	2002Q2	2002Q3	2002Q3-Q4			2003Q1-Q3		
						Low	Baseline	High	Low	Baseline	High
3-month HIBOR (% per annum)	6.12	3.58	1.92	1.84	1.72	1.5	1.8	2.1	1.4	2.1	2.9
Growth (change during the period)	10.1	0.6	0.1	0.4	-	0.8	0.5	0.3	1.0	0.7	0.3
Inflation (change during the period)	-3.8	-1.6	-1.1	-0.6	-0.7	0.2	-0.5	-0.8	0.3	-0.2	-0.7
Property prices (change during the period)	-10.4	-12.2	-0.1	-2.4	-5.3	2.4	0.0	-3.0	2.4	0.0	-3.0
Bankruptcy (change during the period)	42.7	85.2	25.7	36.4	18.3	10.0	17.1	33.2	10.0	17.1	33.2

Note:
1. Data for growth and inflation are seasonally adjusted.
2. The assumptions for interest rates, growth and inflation are derived from the October issue of *Asian Pacific Consensus Forecast*, while those for changes in bankruptcies are based on historical data.
3. The assumptions for growth start from 2002Q3, but from 2002Q4 for the other three variables.